CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

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

United Nations
Economic Commission
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Forest Condition in Europe

Results of the 1995 Survey

1996 Report

Cover photo by Louis-Michel Nageleisen

ISSN 1020-3729

Printed in Germany

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PREFACE

Since 1992 the United Nations Economic Commission for Europe (UN/ECE) and the European Commission (EC) have been publishing a series of common Forest Condition Reports focusing on large-scale crown condition assessments. The present fifth issue of this series goes beyond that, describing for the first time also the other elements of the common monitoring programme, i.e. the forest soil and foliage surveys. In addition, the present report contains a special chapter on the intensive monitoring of forest ecosystems. These monitoring activities aim at a documentation of forest condition in Europe, as well as at a contribution to a better understanding of cause-effect relationships between forest condition and air pollution.

The monitoring programme is conducted by the International Cooperative Programme on the Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) of UN/ECE under the Convention on Long-range Transboundary Air Pollution (LRTAP) and by the European Commission (EC) under EU legislation (Regulation (EEC) No. 3528/86 on the protection of forests against atmospheric pollution).

Within ICP Forests up to 35 European countries, Canada, and the United States of America, have been monitoring forest condition since 1986. The European countries have been assessing crown condition annually on individual national grids of different density in order to obtain survey results on the national level.

In 1987, the EU-Member States started annual assessments of crown condition and a number of other tree and site parameters on a large-scale transnational grid (16x16 km) in order to obtain results on the Community level. Since then, this large-scale network has been gradually extended not only due to the growing number of EU-Member States but mainly due to the increasing participation of the non-EU countries of ICP Forests.

Today 30 countries comprising all 15 EU-Member States annually submit their transnational crown condition data along with other tree and site related data to Programme Coordinating Centre West (PCC West) of ICP Forests for evaluation. Soil data of currently 4 491 transnational plots of 22 countries are evaluated at the Forest Soil Coordinating Centre (FSCC), and foliage data have so far been collected in 17 countries for evaluation at the Forest Foliage Coordinating Centre (FFCC). The latter two centres are being operated jointly by ICP Forests and EC.

The intensive monitoring of forest ecosystems has been implemented since 1994. In close cooperation with EC, up to now 643 permanent observation plots have been installed in 29 countries. For the wealth of data from the permanent observation plots EC established a special data centre responsible for data validation, storage and evaluations. As regards evaluations, the data centre will be advised by a Scientific Advisory Group (SAG).

The preparation of the present report was made possible thanks to

- the submission of data and information by the participating countries to PCC West, FSCC and FFCC and the EC,
- financial support granted by the EC,
- voluntary financial contributions granted by the parties to the LRTAP Convention of UN/ECE,
- the calculation of geographical coordinates of the inventory grid intersection points by the EC.

SUMMARY

The present report documents the forest condition in Europe, based on transnational and national surveys by the United Nations Economic Commission for Europe (UN/ECE) and the European Commission (EC). 30 European countries submitted national reports. These represent 25 170 plots with 634 993 sample trees, covering about 151 million hectares of forest. 30 countries also participated in the transnational survey on the basis of the 16 x 16 km grid. For the transnational forest condition assessment, 5 388 plots with 117 035 trees were investigated.

The submitted reports give evidence that forest damage still is a serious problem in Europe. Although improvements of forest condition were reported from certain locations, the overall forest damage seems to increase on the European level.

Of the 117 035 trees (transnational sample) assessed in 1995, defoliation by more than 25% was found in 25.3% of the total sample. Discolouration by more than 10% of leaves was observed in 10.2% of the total sample trees.

The share of damaged Common Sample Trees (CSTs) of 1994-1995 increased from 25.2% to 26.8%. Of the individual regions, the largest increase (from 15.3% to 19.4%) occurred in the Mediterranean (lower) and in the Mediterranean (higher) regions (from 20.8% to 25.1%), particularly in *Quercus suber*, *Quercus ilex* and *Eucalyptus* spp., and was mainly attributed to heat and drought. However, the latter species showed the lowest damage in the Mediterranean regions. The Boreal (temperate) region, in contrast, showed a distinct improvement of forest condition (21.3% to 17.6%), where especially the improvement of *Pinus sylvestris* contributed to the better health condition. The changes in forest condition in the Sub-Atlantic, in the Mountainous (north) and in the Atlantic (south) regions did not prove statistically significant. Deterioration in the Boreal, Atlantic (north) and Mountainous (south) regions was mainly influenced by the abundant occurrence of severely damaged trees (e.g. deciduous *Quercus* spp., *Fagus sylvatica* in central Europe). In addition to adverse weather conditions air pollution also was regarded as deteriorating the forest condition in some regions.

In the sub-sample of the common trees of the surveys from 1988 to 1995, the development of the defoliation of 12 species was analyzed. The crown condition of almost all tree species deteriorated. Mainly drought and subsequent insect attacks, but also air pollution were considered as important factors worsening the condition of the tree species. For *Picea abies* and *Pinus sylvestris*, however, decreasing air pollution as well as better weather conditions than in previous years were discussed as positively affecting the tree species in the respective national reports. The most severe deterioration were observed in the main damage areas of Germany, the Czech Republic, Poland and the Slovak Republic in *Fagus sylvatica*, *Quercus robur*, *Quercus petraea* and *Abies alba*. Highest increases in defoliation were observed in the Mountainous (south) for *Fagus sylvatica* and *Quercus petraea*. In the Sub-Atlantic seriously impaired tree species were *Quercus robur* and *Abies alba*. The least affected tree species with respect to long term forest condition were *Pinus sylvestris* and *Pinus pinaster*, the latter one confined to areas under warmer climatic conditions.

The national reports referred to various causes as responsible for deteriorating forest condition. Drought and heat had a particularly high impact. Pest infestation, action of man,

game and grazing also negatively impaired the health status of the assessed forests, as was stated in both transnational and national surveys.

The direct and indirect effects of air pollution are considered to be the cause of forest decline in some areas, particularly in central Europe. However, only in a few cases has air pollution been identified as a cause of damage. Other sources of information, including the national reports submitted by individual countries, suggest that air pollution may predispose trees to decline over much wider areas, but the extent of these effects remains uncertain. Level II and III investigations are being designed to help resolve this.

In addition to the already running forest condition survey on Level I, which is referred to in the above paragraphs, soil and foliar analysis extend the Level I survey. Indirect air pollution effects on forest condition are assessed by means of the forest soil condition survey and chemical analysis of leaves and needles. While sulphur deposition has been drastically reduced in comparison with the seventies, nitrogen deposition from different sources is still high negatively impairing soil chemistry and foliar nutrient status in some areas. The forest soil condition survey and the foliar analyses may help to reveal the impact of air pollution on these parameters.

Also presented in this report is the design for the intensive monitoring (Level II). On 770 permanent plots scattered through Europe, different parameters are monitored on the long term scale. All EU-Member States and 11 additional countries participate in the Level II survey. 440 plots are chosen in the EU, and 330 plots are to be assessed in non-EU countries. Crown condition, soil and foliar analyses and increment studies are carried out on all plots. Atmospheric deposition shall be monitored on 65% of the plots in EU-countries, and on 81% of the plots in the other countries. On many plots additional studies, such as meteorology and phytopathology, are performed.

The general plot data have been recorded and submitted from most of the participating countries. Among the most abundant tree species are two conifers (*Pinus sylvestris* and *Picea abies*) and three broadleaved trees (*Fagus sylvatica*, *Quercus petraea* and *Quercus robur*). Age distribution shows that only a small number of the plots is younger than 20 years. The majority of the plots is located in 41 to 60 years old forest stands. Most of the plots lie within a distance of about 10 km to a meteorological monitoring station or closer.

1. INTRODUCTION

Forest condition monitoring at the European scale is based on national grids of different densities and on the transnational grid of 16 x 16 km. This extensive monitoring approach (referred to as Level I) comprises annual crown condition assessments, a soil condition survey as well as analyses of the chemical contents of needles and leaves.

Crown condition assessments have been conducted annually since 1986 on the national grids and since 1987 on the transnational grid by an increasing number of countries. The forest soil condition survey has been implemented by about half of the countries on the transnational grid between 1991 and 1995. An optional survey of the chemical content of needles and leaves is going on (1991-1996).

The main benefits from the Level I monitoring are a more accurate knowledge of the spatial and temporal variation of forest condition with respect to crown condition, soil condition and the chemical contents of needles and leaves.

In order to also contribute to a better understanding of cause-effect relationships, a more intensive monitoring approach (Level II) has been implemented. This approach is based on a lower number of monitoring plots situated in selected forest ecosystems and having a higher monitoring intensity per plot. Besides crown condition assessments, soil and foliar analyses, also increment studies, deposition measurements and meteorological measurements are carried out on Level II.

The present report has been structured as follows:

Chapter 2 provides an overview of the objectives and the design of the above mentioned extensive monitoring activities (Level I), also addressing the scientific background and methodological details. This information is essential for the understanding and interpretation of results. In addition, general information on the intensive monitoring programme (Level II) is provided.

In Chapter 3 the results of the 1995 transnational and national surveys are presented. The transnational results (Chapter 3.1) reflect forest condition in Europe without regard to national borders and refer to correlations between defoliation and discolouration with site parameters. The national reports (Chapter 3.2) reflect forest condition in individual countries with emphasis on its interpretation in connection with the multitude of damaging agents, particularly air pollution. Both the transnational and the national survey results are interpreted together in Chapter 3.3, also paying special attention to the effects of air pollution.

In Chapter 4, conclusions are drawn from the survey results and their interpretation. Chapter 5 lists the references used for the survey methods and the former reports.

Annexes I and II contain maps, graphics and tables concerning the transnational and national results, respectively. Annex III provides a list of tree species with their botanical names and their names in the official UN/ECE and EU languages. Annex IV contains the addresses of the Members of the Programme Task Force, the National Focal Centres (NFCs) and other bodies of ICP Forests and the Community programme.

2. OBJECTIVES AND DESIGN OF THE MONITORING PROGRAMME

2.1 Extensive monitoring on the large-scale grid (Level I)

2.1.1 Crown condition surveys

The transnational and national crown condition surveys on Level I comprise the selection of sample trees and the assessment of defoliation, discolouration and a number of further tree and plot related parameters. The methodological details are described in the ICP Forests Manual (UN/ECE, 1994), in Commission Regulations (EEC) No. 1696/87 and its amendments of EU and in Council Regulation (EEC) No. 3528/86. The knowledge of these methods is indispensable for the reading of Chapter 2.1.1.5, which discusses the interpretability of the survey results in detail.

2.1.1.1 Selection of sample plots

Transnational survey

The objective of the transnational survey is the documentation of the spatial distribution and the development of forest condition on the European level. This is achieved by means of a large-scale monitoring of crown condition of forest trees in connection with 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.

The coordinates of the transnational grid were calculated and provided to the participating countries by the EC. If a country had already established plots, the existing ones were accepted, provided that the mean plot 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 less dense in parts of the boreal forests can be shown to be of negligible influence due to the homogeneity and the current condition of these forests.

National surveys

The national surveys aim at the documentation of the forest condition and its development in the respective country. Therefore, the national surveys are conducted on national grids. The densities of these national grids vary between 1x1 km and 32x32 km due to differences in the size of forest area, in the structure of forests and in forest policies. Any comparisons between the national surveys of different countries should be made with great care because of differences in species composition, site conditions and reference trees.

2.1.1.2 Selection of sample trees

On each sampling point of the national and transnational grids situated in forest, in an ideal situation at least 20 sample trees are selected according to standardised procedures. Predominant, dominant, and co-dominant trees (according to the system of KRAFT) of all species qualify as sample trees, provided that they have a minimum height of 60 cm and that they do not show significant mechanical damage. Trees removed by management operations, blown over by wind or having died must be replaced by newly selected trees. Due to the small percentage of removed trees, this replacement does not distort the survey results, as has been shown by a special evaluation (Forest Condition Report 1994).

2.1.1.3 Assessment parameters

Defoliation and discolouration

Defoliation of the sample trees of each plot are assessed in comparison to a reference tree of full foliage as well as discolouration. Alternatively, photo guides suitable for the region under investigation may be used when no reference tree can be found in the vicinity of the sample trees.

In principle, the transnational survey results for defoliation are reported in 5% steps and the national survey results for defoliation according to the traditional classification (Table 2.1.1.3.-1). Most countries also report their national results for defoliation in 10% steps. The assessment down to the nearest 5 or 10% permits studies of the annual variation of foliage with far greater accuracy than using the traditional system of only 5 classes of uneven width. Discolouration is reported both in the transnational and in the national surveys using the traditional classification.

Changes in defoliation and discolouration attributable to air pollution cannot be differentiated from those caused by other factors. Consequently, defoliation due to other factors is included in the assessment results, although known causes should be recorded. However, mechanical damage (e.g. windbreak, snowbreak) is ruled out as a cause as such trees are excluded from the sample anyhow.

Table 2.1.1.3-1: 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 % - < 100 %	severe
4	100 %	dead
Discolouration class	foliage discoloured	degree of discolouration
0	up to 10 %	none
1	> 10 - 25 %	slight
2	> 25 - 60 %	moderate
3	> 60 %	severe
4		dead

In the presentation of results a change is called "significant" if a statistical significance test was performed at a 95% probability level.

Additional parameters

On the plots of the transnational survey, additional parameters have to be assessed besides defoliation and discolouration. Within the transnational crown condition survey, for each plot the following plot and tree parameters should be reported:

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 identifiable damage, date of observation.

2.1.1.4 Evaluation and presentation of the survey results

The tree and plot parameters of the transnational survey are submitted in digital format via EC or directly to PCC West of ICP Forests for screening, storage and evaluation. The national survey results are submitted on paper to PCC West as country related mean values, classified according to species and age groups. These data sets are accompanied by national reports providing explanations and interpretations. The survey results are presented mainly in terms of the percentages of the tree sample falling into the traditional five defoliation or discolouration classes. This classification reflects to a certain extent the experience gathered in forest damage assessments in Central Europe between 1980 and 1983. At that time, any loss of foliage exceeding 10% was considered as abnormal, indicating impaired forest health. Assumptions based on physiological investigations of the vitality of differently defoliated trees led to the establishment of 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.

A certain natural range is taken into account by choosing a border of a defoliation up to 25% as "undamaged" (Chapter 2.1.1.5). A defoliation of >10-25% indicates a "warning-stage". Therefore, in the present report a distinction has often only been made between defoliation classes 0 and 1 (0-25% defoliation) on the one hand, and classes 2, 3 and 4 (defoliation > 25%) on the other hand.

Classes 2, 3 and 4 represent trees of 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 is considered as "undamaged".

The most important results have been tabulated separately for all countries having participated (called "total Europe") and for those 15 countries being EU-Member States in the survey year 1994. As Austria, Finland and Sweden became EU-Member States in 1995, they are included in the EU total from this year's report on. 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 in 11 languages as well as by their proper botanical names (Annex III).

2.1.1.5 Interpretability of the survey results

The survey results reflect the spatial distribution and temporal development of forest condition in Europe. Care must be taken, however, in the interpretation of these results in order to avoid wrong conclusions. This holds true particularly for the explanation of any potential causes of forest damage as well as to all regional and temporal comparisons of the survey results. Typical examples for 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. The following paragraphs reveal the limitations of the interpretability of the survey results.

Defoliation is assessed relative to a tree with full foliage. This reference tree could be either a healthy tree in the vicinity (of the same crown type) or a locally applicable photograph representing a tree with full foliage. The selection of proper reference trees, though within the responsibility of trained personnel familiar with the local habitus of the trees, is principally subject to bias. Besides this difficulty in intercalibration, the estimation of defoliation percentages is biased by itself. For these reasons any interpretation of defoliation assessments from different regions must account for the limited comparability of the assessment results.

As defoliation constitutes the loss of needles or leaves in comparison to that of a reference tree, the assessment results are not absolute crown density values, but relative quantities to be interpreted as deviations from the local standard. This means that e.g. a spruce tree of a certain defoliation percentage growing at high altitude will have a lower absolute crown density than a spruce tree at low altitude, to which the same defoliation percentage was assigned.

The crown condition even of a healthy tree shows a great variation, depending on a multitude of factors, such as crown morphology, needle and leaf size, needle retention as well as flowering and fruiting. The causes of this variation are mainly genotype, site conditions and tree age. The reference tree used to assess a particular plot should account for this.

Besides that, a multitude of damage factors, such as climatic stress, insect attack, fungi attack and air pollution damage may cause defoliation. However, a certain level of variation of defoliation in forest stands is natural. The average amount of foliage may vary substantially depending on the site conditions, especially according to water and nutrient availability. Moreover, forest trees regulate their amount of foliage according not only to moisture and nutrient availability, but also others, including abiotic (e.g. spring frost, thaw-freeze) or biotic (e.g. insect defoliation) stresses.

The level of variation in defoliation which should be considered as natural is unknown. It may be assumed that not only tree but also a stand may die because of natural factors. There are many examples of this in the international literature. The cause and effect relationships may be obvious in some cases, but remain incompletely known in many others. However, the more or less continuous increase of the proportion of severly damaged and dying trees of several species in a large area would clearly appear as abnormal.

Setting a precise **defoliation threshold** for separating a healthy from a damaged tree is difficult. A defoliation larger than 25% (defoliatiton classes 2, 3 and 4) is usually considered as damage. This threshold proves practical in that it makes sense for foresters: in most cases they will classify not necessarily a tree as damaged, but a stand with a rather large proportion of such trees. This threshold also is reasonable in relation to possible growth losses, although this may vary substantially according to the species. In summary, the defoliation treshold should be considered as a convenient indicator of forest condition, but of relative rather than absolute value.

Defoliation, as seen above, may be caused by a variety of factors. In the field surveys, these factors can only be identified and assessed to a limited extent; defoliation is therefore a rather **unspecific health indicator**. Any forest damage documented in the tables, graphics and maps of the present report should therfore be interpreted with care. This is especially true with respect to air pollution effects.

The severity of forest damage has been claimed to be underestimated as a result of the replacement of dead trees by living trees. However, detailed statistical analyses of the results of 10 monitoring years reveal that the number of dead trees has remained so small that their replacement has not influenced the results significantly. Of course, a statistical distortion of this kind could occur on sites of severe forest dieback at certain locations. However, the large-scale monitoring of forest condition on Level I does not reflect forest condition at the scale of small areas.

For the same reason 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.

Forest damage as observed during the last two decades is understood as a long term process. Therefore, 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.

2.1.2 Forest soil condition survey

2.1.2.1 Soil changes induced by atmospheric pollution

The purpose of the large scale transnational soil survey is the assessment of basic information on the chemical soil status and on the soil properties which determine its sensitivity to air pollution. For this purpose, soil sampling and analysis were carried out by the national focal centres (NFCs). In collaboration with the EC and the Flemish Institute for Forestry and Game Management, ICP Forests set up a Forest Soil Co-ordinating Centre (FSCC) at the University of Gent for the processing of the soil condition results. The results of the national surveys were to be submitted to FSCC before 31 December 1995. They are stored in a European database and will be presented in a "Report on the European forest soil condition" by the end of March 1997.

The ICP "Manual on methods and criteria for harmonised sampling, assessment, monitoring and analysis of the effects of air pollution on forests" describes reference methods for sampling and analysis of forest soils on the Level I observation plots. Details of national methods may, however, deviate from the reference methods.

Any addition of pollutants to soil, that is of those compounds that may exert adverse effects on soil functioning, can be defined as soil pollution. Principal soil functions are the plant growth function and the ecological function of soil, with its contribution to element cycling as an important aspect.

Because most soils have a certain buffering capacity, it usually takes some time before negative effects become apparent. The buffering capacity of soils can be described as the capacity to allow contents of compounds, once present at optimum level, to increase without actual occurrence of negative effects. Several potentially hazardous compounds, such as Cu and Zn, are also prerequisites for good soil functioning and show a positive effect at low concentration level (de Haan, 1994). The buffering capacity is a function of the nature of the pollutant and of many soil properties and system conditions occurring in practice.

A possible reason for the loss of vitality of the European forests is the persistent input of atmospheric pollutants. Beside the direct effect of gaseous pollutants ("dry deposition") and solutes ("wet deposition") on needles and leaves, air pollution might effect forests indirectly through changes of the soil (Matzner and Murach, 1995). The most important air pollutants are SO_2, NO_x, O_3 and NH_x. H^+ and H_2O_2 deposition from fog and low clouds may be considerable at high altitude sites.

2.1.2.2 Methods

The pedological characterisation is optional for Level I study plots. It includes at least one detailed profile description and is carried out before starting soil measurements. It provides background information on the soil in order to improve the interpretation of other data collected at the plot location. It is mandatory to classify the soil at the study plots according to the FAO Soil Legend (1988). Such a soil classification requires information on several items that are observed during the profile description. The profile description(s) is (are) carried out according to the FAO-guidelines for profile description (FAO, 1990) on a location that is representative for the actual sampling area.

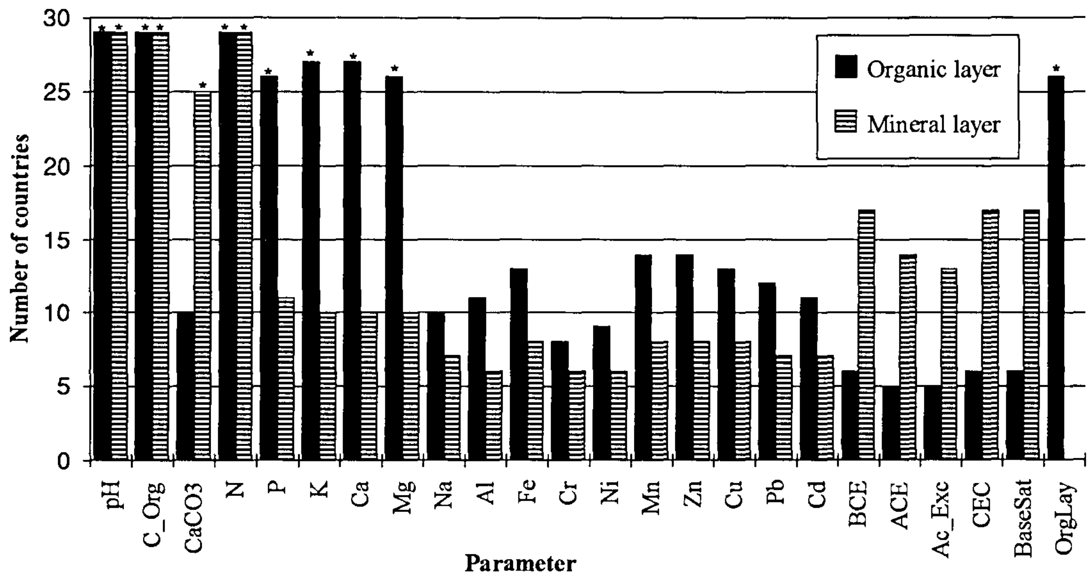
The actual sampling area is selected in a homogeneous part of the study plot. The sampled soil should be representative for the forest stand on the study plot. The organic top layer is sampled separately. A distinction is made between O- and H-horizons, defined in the FAO-guidelines for soil description (FAO, 1990).

After removal of the litter, the mineral soil is sampled following genetic horizons or by layers with predetermined depths. The method using predetermined depth layers is preferred because it facilitates comparison between soils. For every sampled layer or horizon, one representative composite sample or several samples are taken. The number of subsamples collected is reported.

The mandatory and optional parameters assessed and the number of countries having submitted the respective data so far are shown in Figure 2.1.2.2-1.

Figure 2.1.2.2-1: Data availability, presented by the number of countries that have measured each soil condition parameter.

The asterisks (*) identify mandatory parameters.



The forest soil condition results are submitted to FSCC in digital format. A file with plot information contains plot coordinates, altitude code and FAO soil unit. The chemical parameter data are submitted in separate files for mandatory and optional parameters, respectively. Supplementary information on parent material, soil texture class, bulk density and coarse fragments content is submitted on a voluntary basis in another file. Table 2.1.2.2-1 gives an overview about available data.

The first forest soil condition results have shown the necessity to relate the chemical soil properties to physical conditions, such as bulk density and particle size distribution. In order to determine absolute values of nutrient availability, information on physical soil properties is required, and should be foreseen as mandatory parameters in future soil surveys. Parent material and texture data are mainly used to differentiate soil groups.

Table 2.1.2.2-1: Availability of forest soil condition results from 22 countries that will be presented in the 1996 European report

Country	Number of soil plots	Soil unit	pH, C_Org, N		CaCO 3	P		K, Ca, Mg		Optional aqua regia extractions	cation exchange properties
			Org	Min	Min	Org	Min	Org	Min	Org	Min
Austria	131	1	1	1	1	1	1	1	1	Al, Fe, Cr, Ni, Mn, Zn, Cu, Pb, Cd	1
Belgium	31	1	1	1	1	1	0	1	0		(1)
Croatia	87	1	1	1	1	1	0	1	0	Fe, Mn, Zn	0
Czech Rep.	100	1	1	1	1	1	0	1	0		0
Denmark	25	1	1	1	1	1	1	1	1	Na	0
Finland	442	1	1	1	1	1	0	1	0	Na, Al, Fe, Cr, Ni, Mn, Zn, Cu, Pb, Cd	1
France	517	0	1	1	1	1	0	1	0	(Ni, Zn, Cu, Pb, Cd)	1
Germany	416	1	1	1	1	1	(1)	1	0	Al, Fe, Mn, Zn, Cu, Pb	(1)
Greece	15	1	1	1	1	1	0	1	0		0
Hungary	67	1	1	1	1	1	0	1	0	Al, Fe, Mn	1
Ireland	22	0	1	1	1	1	1	1	1		0
Italy	20	0	1	1	1	1	0	1	0		0
Lithuania	74	1	(1)	(1)	1	0	0	0	0	Fe, Cr, Ni, Mn, Zn, Cu, Pb, Cd	1
Luxembourg	4	1	1	1	1	1	0	1	0	Mn	1
Netherlands	11	1	1	1	1	1	1	1	1	Na, Al, Fe, Cr, Ni, Mn, Zn, Cu	1
Norway	440	1	1	1	1	0	0	0	0		1
Portugal	149	1	1	1	1	1	1	1	1	Na, Al, Fe, Cr, Ni, Mn, Zn, Cu, Pb, Cd	1
Slovak Rep.	111	1	1	1	1	1	0	1	1	Na, Al, Fe, Mn, Zn, Cu	1
Slovenia	34	1	1	1	1	1	0	1	0		1
Spain	464	1	1	1	1	1	0	1	0		0
Sweden	1249	(1)	1	1	1	0	0	0	0		1
Switzerland	48	1	1	1	1	1	1	1	1	Na, Al, Fe, Cr, Ni, Mn, Zn, Cu, Pb, Cd	1
United Kingdom	67	1	1	1	1	1	0	1	0	Na, Al, Fe, Cr, Ni, Mn, Zn, Cu, Pb, Cd	0

1: available parameter; (1): available for a selection of plots; 0: unavailable; Org: organic layer; Min: mineral layer).

2.1.3 Chemical analyses of needles and leaves

Foliar sampling and analysis are among the tools for assessing the effects of air pollution on forests. For many decades foliar analyses have been used in some European countries in local or regional investigations to show the influence of air pollution on the nutrient content, the nutrient balance and the accumulation of sulphur or fluorine in leaves or needles. Based on these data, guidelines or regulations were provided in several countries in order to use the possibilities of foliar analysis to demonstrate the impact of air pollution. More than 10 years have passed since some countries began to use foliar analysis also in connection with monitoring on the national level.

In the framework of ICP Forest the first relevant activities were started in 1992 at the 8th Task Force Meeting in Avignon. It gave a mandate to the Foliar Analysis Expert Panel to work out the following:

- sampling methods adapted to the different cases; number of trees, where and when to harvest the needles/leaves;
- a list of mandatory and advised elements to be analysed in the permanent plots of Level II and eventually of Level I if considered opportune by the expert panel;
- a list of acceptable mineralisation methods for each element;
- a list of acceptable determination methods compatible with mineralisation methods for each element;
- a proposal for guaranteeing the comparability of the results between laboratories;
- a proposed frequency for analysis in Level II permanent plots and also for Level I plots, if considered opportune by the expert panel;
- the format and the structure of the data transfer;
- the format and the structure of the report.

Besides this the Foliar Analysis Expert Panel should identify the main problems of interpretation of foliar analysis (threshold values for nutrient deficiencies or potential toxic effects). The experts participating in the panel were mandated to negotiate both the technical matters (sampling analysis) and the financial consequences of the proposals.

As one of its first activities, the Foliar Analysis Expert Panel developed a draft manual entitled „Sampling and Analysis of Needles and Leaves". It provided information on sampling and analysis procedures, including the following details:

Sampling: Frequency, date, number of trees to be sampled and analysed, selection of the sample trees, selection of leaves and needles to be sampled, orientation, quantity of material to be sampled, means of sampling, pretreatment before sending the samples to the laboratories for analysis.

Chemical analysis: Treatment before analysis, elements to be determined, digestion (or ashing) and analysis.

It was decided to make foliar analysis mandatory on the intensive monitoring plots (Level II) and should be performed at least every second year. A number of countries intend to include the Level I plots as well. The first common sampling in all participating countries was carried out in 1995, for deciduous species and larch during the summer and for other conifers in the following dormancy period. In general, the sampling is done on at least 5 predominant or dominant trees (Level II) in the vicinity of the soil sampling location. Trees must not be felled, and the sampling of branches can be done by pruning devices, climbing or shooting. After drying and grinding the samples will be analysed for the major elements N, P, K, Ca, Mg, and S.

The draft manual was adopted by the Task Force of ICP Forests as part of the 3rd edition of the ICP Forests Manual. Furthermore, the Task Force decided to carry out intercalibration tests on samples with unknown determination values in order to make the results of the individual laboratories comparable.

In the first intercalibration test laboratories from the following countries took part: Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Netherlands, Spain, Switzerland, and the United Kingdom. A number of other countries contributed their results later. In general, the intercalibration test showed fairly good results, but, as expected, they varied between the laboratories as well as with regard to the elements and the methods applied. Six of the laboratories showed excellent results for all elements in both samples. Evaluation of the results clearly showed which method of analysis for all individual elements gave poor results only. For this reason the meeting felt the neccessity to carry out the second intercalibration test with 39 laboratories from 25 countries. The finalisation of this test with the participating laboratories was planned for the end of 1995. A German laboratory agreed to elaborate a report on accuracy of the individual methods and to circulate it among the participants in spring of 1996.

Threshold values for an all-European assessment of the needle- and leaf-analytical data were determined. Since very different terms are being used for the same values or range of values in European countries, and in order to avoid misinterpretation or wrong conclusions, it was decided that, for the evaluation at **European level**, classifications of only 3 classes and without more specific names or descriptions should be determined. After that basic decision the classification values of the major nutrients for spruce, pine, beech and oak (which are the main tree species on the Level I and Level II plots in Europe) were determined (Table 2.1.3.1-1):

Table 2.1.3.1-1: Classification values of the nutrient status for main tree species

SPRUCE (mg/g)	N	P	K	Ca	Mg
lower value	12.0	1.0	3.5	1.5	0.6
upper value	17.0	2.0	9.0	6.0	1.5
PINE (mg/g)	N	P	K	Ca	Mg
lower value	12.0	1.0	3.5	1.5	0.6
upper value	17.0	2.0	10.0	4.0	1.5
BEECH (mg/g)	N	P	K	Ca	Mg
lower value	18.0	1.0	5.0	4.0	1.0
upper value	25.0	1.7	10.0	8.0	1.5
OAK (mg/g)	N	P	K	Ca	Mg
lower value	15.0	1.0	5.0	3.0	1.0
upper value	25.0	1.8	10.0	8.0	1.5

SULPHUR (mg/g)	Spruce	Pine	Beech	Oak
lower value	1.1	1.1	1.3	to be determined
upper value	1.8	1.8	2.0	

The sulphur values for oak still have to be determined. In this respect the results from the foliar analysis, notably those from the Mediterranean region in Spain, have to be taken into account as there are a lot of oak plots.

As a next step, the Foliar Analysis Expert Panel will concentrate on the determination of classification values of micronutrients which are optional on Level I and Level II plots. When determining these values the results of 1995/1996 samples should be taken into consideration. Apart from the determination of the classification values for micronutrients the results of the second intercalibration test and the draft report on the results of the Level I plots will be discussed.

2.2 Intensive monitoring (Level II)

In order to contribute to a better understanding of the impact of air pollution and other factors which may influence forest ecosystems, the large scale systematic sampling was extended by adding intensive and continuous monitoring of forest ecosystems. This second Level of monitoring is carried out on 770 permanent observation plots in 29 countries. 440 of these plots have been selected and installed in the European Union (Regulation (EC) N° 1091/94 and its amendment). This monitoring programme is a consequence of both Resolution S1 of the first Ministerial Conference on the Protection of Forests in Europe (Strasbourg, 1990) and of Resolution H1 of the second Ministerial Conference on the Protection of Forests in Europe (Helsinki, 1993).

This second level of monitoring is defined as "intensive monitoring of forest condition aimed at the recognition of factors and processes with special regard to the impact of air pollutants on the more common forest ecosystems in Europe". The intensive monitoring programme contains continuous and intensive surveys such as crown condition assessments, soil and foliar surveys, increment studies, deposition measurements and the observation of meteorological parameters over a period of at least 15 to 20 years. Several countries carry out additional activities and several groups of experts are working at specifying recommended methods for survey and analysis of some additional activities (vegetation, soil water and remote sensing). By the end of 1996 the first submission of the survey data is foreseen, and first results are expected to become available in 1997, but it will take at least 5 to 10 years before trends can be identified, as for instance increment is surveyed only every 5 years and soil only every 10 years.

The second edition of the report 'General information on the permanent observation plots in Europe (Level II)', which has been published in January 1996 contains more information on the intensive monitoring programme of the Member States of the European Union and eleven non-EU countries as was available by the end of 1995.

The evaluation of the data of the intensive monitoring programme are in first instance done at national level and, after submission, at European level. At national level the National Focal Centres (NFC) have been appointed for data management and evaluation. At European level a Consultant has been appointed to carry out the management of the data. To ensure correct procedures in data management, evaluation and interpretation a Scientific Advisory Group (SAG) has been formed, which consists of experts working in the related fields.

2.2.1 Establishment of the intensive monitoring plots

In most countries the selection and installation of plots has now been completed. The progress of this selection and installation is presented by introducing first the number of plots selected and secondly by the number of plots installed per participating country. Reference is made to Table 2.2.1.1-1.

2.2.1.1 Number of plots selected

Based on the agreed selection criteria, laid down in Commission Regulation (EC) N° 1091/94, the EU Member States made plans (in 1994) to select and install a certain number of plots. After acceptance of the relevant parts of the ICP Forest manual (Task Force meetings in Lillehammer and Prague, 1994 - 1995), also the non-EU countries started with the selection and installation process. For inclusion in this report of the intensive monitoring programme, the minimum size and the minimum set of surveys (crown, soil, foliar and increment on all plots and deposition on at least 10%) is used as a general rule to determine the actual number of plots in the intensive monitoring programme.

The actual situation is shown in Table 2.2.1.1-1. For the EU Member States, where the installation is complete, there are in total 440 plots for the intensive monitoring programme. For the non-EU countries the installation is not yet complete and of the 330 plots selected 203 plots have already been installed.

The grand total for the intensive monitoring programme in Europe, based on the information of the EU and the 14 non-EU countries, leads to a total of 770 plots. With the possible inclusion of remaining non-EU countries, which participate in the ICP Forests, this total could rise to 900 plots.

In the 29 participating countries, which have submitted information, the selection of the plots seems to be completed. Several other non-EU countries, which participate in the ICP Forests (e.g. Slovenia and Belarus), are expected to participate in the intensive monitoring programme in the near future.

Figure 2.2.1.1-1 shows the geographical distribution of all plots located in the EU Member States and non-EU Member States.

Table 2.2.1.1-1: Overview of the number of plots per country

Number of plots intensive monitoring				
EU Member States		Selected	Installed (31/10/'95)	Remarks
AU	Austria	20	20	
BL	Belgium-Flanders	12	12	
BL	Belgium-Wallonie	8	8	
DK	Denmark	16	16	
D	Germany	86	86	
EL	Greece	4	4	
ES	Spain	53	53	
FR	France	100	100	
IR	Ireland	15	15	
IT	Italy	20	20	
LX	Luxembourg	2	2	
NL	Netherlands	14	14	
PO	Portugal	4	4	
PO	Portugal-Azores	4	4	1 plot to be re-installed
SF	Finland	22	22	
SW	Sweden	50	50	
UK	United Kingdom	10	10	
	EU total	440	440	
Non-EU countries				
BR	Belarus	81	?	
BU	Bulgaria	2	?	
CH	Switzerland	20	11	to be completed in 1996
CR	Croatia	8	5	3 plots to be added?
CZ	Czech Republic	8	8	2 plots < 0.25 ha, 3 plots no age
EE	Estonia	6	6	all plots are < 0.25 ha
HU	Hungary	14	14	
LA	Latvia	4	2	to be completed in 1996
LI	Lithuania	9	9	
NO	Norway	17	17	
PL	Poland	122	122	
RO	Romania	24	?	
RU	Russia (St. Petersburg Region)	12	6	to be completed in 1996
SL	Slovak Republic	3	3	7 more plots will be installed
	Non-EU Total	330	203	
	Total	770	643	

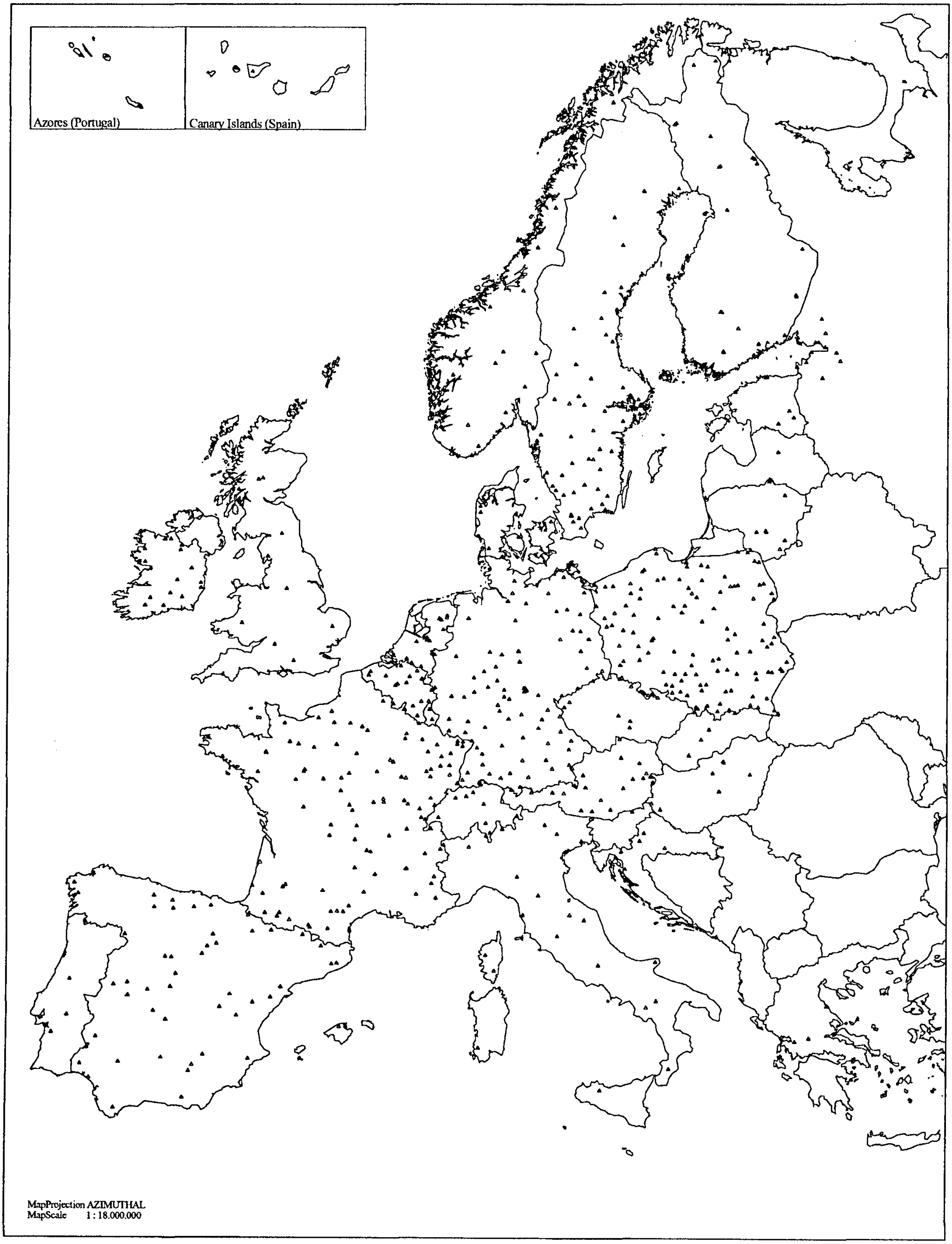


Figure 2.2.1.1-1: The location of the plots of the intensive monitoring

2.2.1.2 Monitoring activities

Level II comprises the following monitoring activties:

- crown condition assessment (at least once a year)
- chemical analysis of the contents of needle and leaves (at least every 2 years)
- soil analysis (every 10 years)
- increment studies (every 5 years)
- deposition measurements (on at least 10% of the plots)
- meteorology monitoring (in a test phase for one year, on an optional basis).

Details on the common methodologies for these surveys, such as sampling method, analysis procedures, data format for submission, etc. are stated in Regulations (EC) N° 1091/94 (Annex III - VII) and 690/95 (Annex VIII and IX) and in the Manual of ICP Forests.

In addition to the surveys of this programme many countries are executing a number of other surveys on their intensive monitoring plots. In the summer of 1995 a questionnaire has been sent out (by the chairman of the Scientific Advisory Group for the intensive monitoring) requesting the countries to indicate the surveys, the frequency of the surveys and the number of plots on which these surveys are (or will be) executed. Table 2.2.1.2-1 gives an overview on the execution of these surveys.

Table 2.2.1.2-1: Overview of the surveys carried out in the Intensive Monitoring Plots[1]

	Total EU		Non-EU countries		Total Europe	
Total plots	440		220		660	
Mandatory/Optional						
Crown Condition Ass.	440	100%	220	100%	660	100%
Soil	440	100%	220	100%	660	100%
Foliar	440	100%	216	98%	656	99%
Increment	439	100%	220	100%	659	100%
Atm. Deposition	288	65%	178	81%	466	71%
Meteorology	172	39%	47	21%	219	33%
Other surveys						
Phytopathology	211	48%	179	81%	390	59%
Gr. Vegetation	248	56%	217	99%	465	70%
Litterfall	266	60%	64	29%	330	50%
Soil solution	201	46%	18	8%	219	33%
Phenology	71	16%	36	16%	107	16%
Dendrochronology	135	31%	28	13%	163	25%
Insects	10	2%	139	63%	149	23%
Lichens and mosses	10	2%	53	24%	63	10%
Aerial Photo./Rem Sens	55	13%	0		55	8%
Mycorrhiza/fungi	10	2%	31	14%	41	6%

For the 440 plots of the EU Member States, deposition measurements are carried out on 288 plots (65%) and meteorology is monitored on 172 plots (39%). Besides the surveys of the agreed common programme phytopathology (211 plots), ground vegetation (248

[1] As information on the surveys in Belarus, Bulgaria and Romania was not available at the time of finalisation, the figures given here partly differ from above chapter 2.2.1.1.

plots), litterfall (266 plots), soil solution (201 plots) and phenology (71 plots) are or will be carried out.

When looking at the non-EU countries it is remarkable that almost all countries intend to carry out ground vegetation surveys and most of them also phytopathology. In total with the eleven non-EU countries the surveys indicated as mandatory in the Regulation (EC) N° 1091/94 will be carried out on 660 plots. The deposition measurements will be carried out on 465 plots (70 %) and the meteorological parameters will be monitored on 260 plots (45%). In addition, measurements will be carried out in the following areas: phytopathology (390 plots), ground vegetation (465 plots), litterfall (330 plots), soil solution (229 plots) and phenology (107 plots). It is therefore important to continue the harmonization of the assessment of soil solution and ground vegetation. For the assessment of phytopathology, litterfall and phenology the possibilities of harmonization should be reviewed.

On a limited scale several other investigations are carried out. Among the more common investigations are dendrochronology in 6 countries (163 plots), studies of lichens and/or mosses in 5 countries (63 plots), insects in 3 countries (149 plots) and mycorrhiza and/or fungi in 3 countries (41 plots). Aerial photography (or remote sensing) is carried out by 3 countries (55 plots), while some countries intend to carry out an even more in-depth study on soil physiology, soil water regimes, air quality, gas exchange, etc.

2.2.2 Thematic description of the plots

The data for the various parameters, which have been reported, has been evaluated. In this evaluation, an attempt was made to answer the following question: How are the selected plots distributed with regard to geography, species, age, altitude, etc.?
To enable an easy interpretation of the results, the results are presented in figures.

2.2.2.1 Main tree species

From 651 plots the main species has been reported. The top-5 main tree species in the plots are according to the information received:

1) *Pinus sylvestris* (205 plots)
2) *Picea abies* (162 plots),
3) *Fagus sylvatica* (84 plots),
4) *Quercus petraea* (36 plots) and
5) *Quercus robur* (34 plots).

This distribution is indicated in Figure 2.2.2.1-1.

Figure 2.2.2.1-1: Distribution of the main tree species in the plots of the intensive monitoring

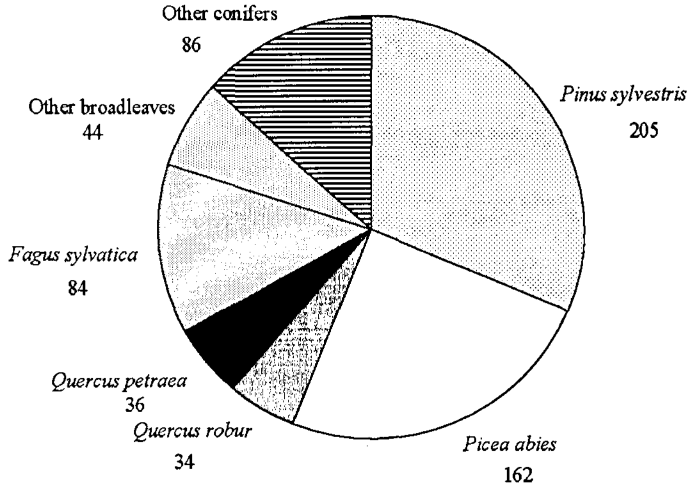
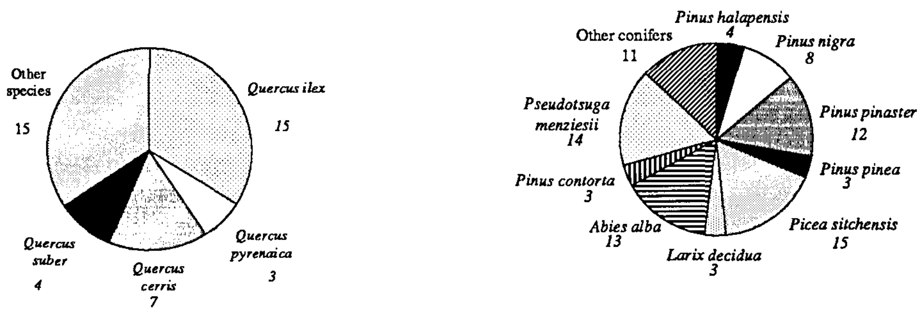


Figure 2.2.2.1-2: Distribution of "other broadleaves" and "other conifers" in the plots of the intensive monitoring

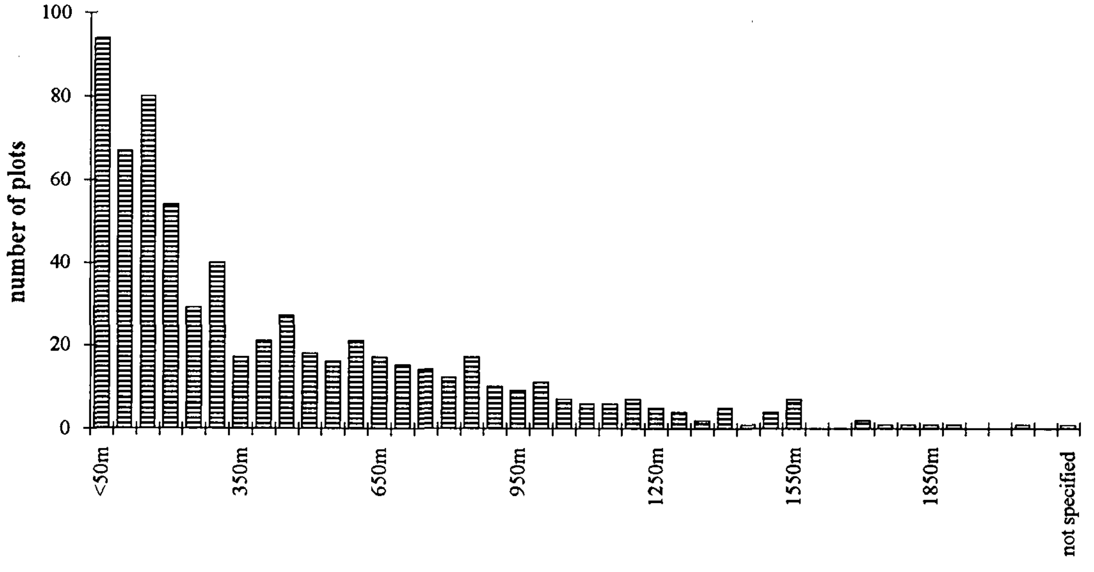


The two pie segments with "other broadleaves" and "other conifers" have been studied in more detail and the results are presented in the two smaller graphs in Figure 2.2.2.1-2. It shows that the rest groups are very heterogenous, that the larger species groups are *Quercus ilex* (15), *Picea sitchensis* (15) and *Pseudotsuga menziesii* (14), while many species are only represented in one or two plots.

2.2.2.2 Altitude

Altitude is known for 651 of the plots. In Figure 2.2.2.2-1 the distribution of the plots over the various altitudes is shown. Most of the selected plots are located in the lower altitudes and the number of plots slowly decreases with higher altitudes.

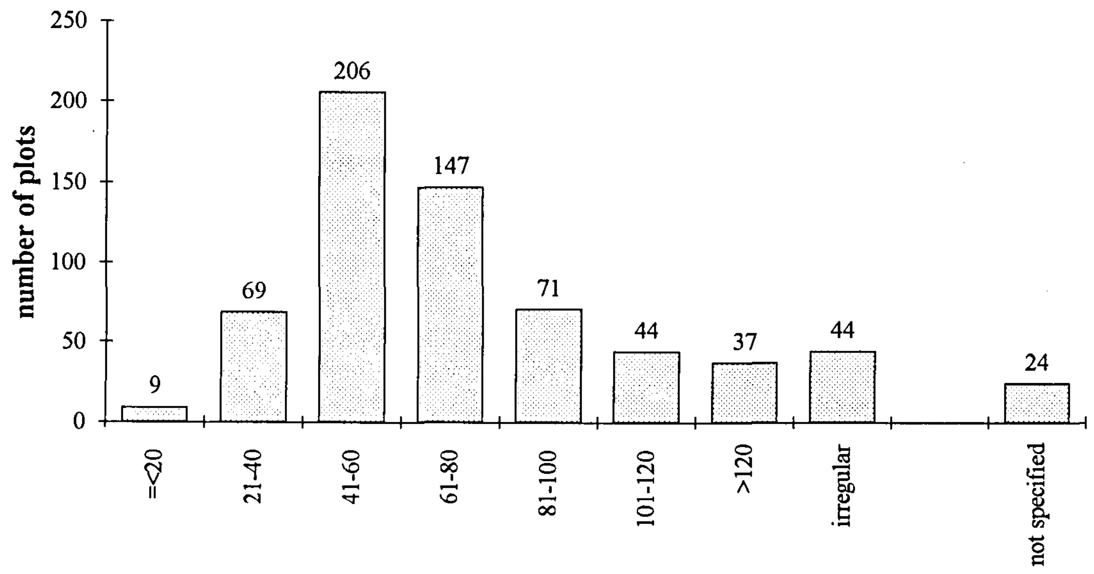
Figure 2.2.2.2-1: Distribution of the plots over altitude classes



2.2.2.3 Mean age

From most plots the mean age of the trees has been reported. In 24 plots the mean age is not specified yet. In Figure 2.2.2.3-1 the distribution of the plots over the age classes is presented. There are only nine plots of young stands (age class ≤20 years). There is a concentration of 206 plots in the class 41-60 years.

Figure 2.2.2.3-1: Distribution of the plots over age classes

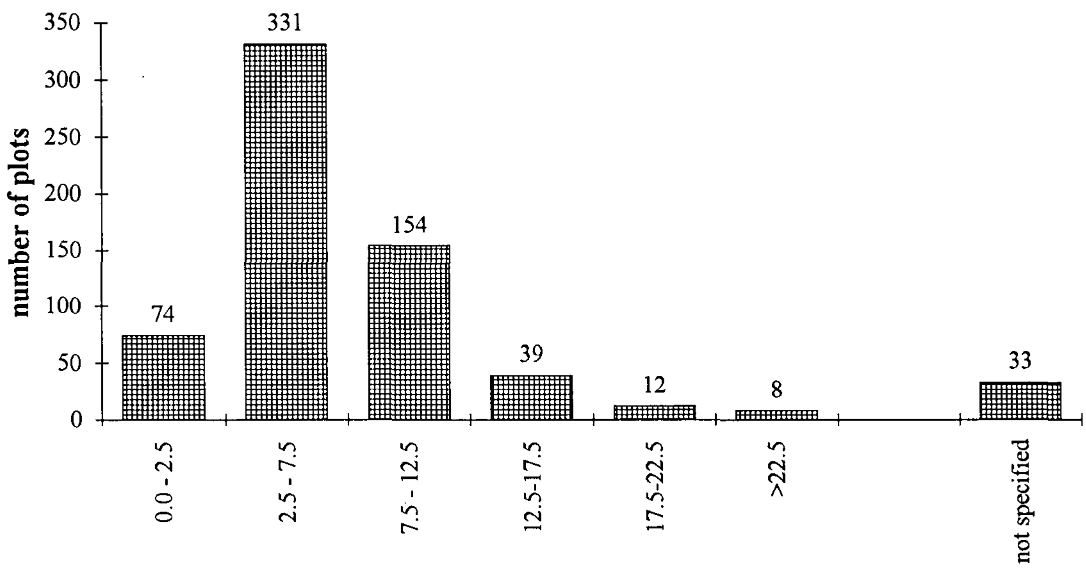


2.2.2.4 Yield estimate

For almost all plots the estimated yield (in cubic metres per hectare per year) has been received (95%). The yield estimates consist of an absolute and a relative yield estimate. The absolute yield estimate is the estimated average yield over the total life period of the stand.

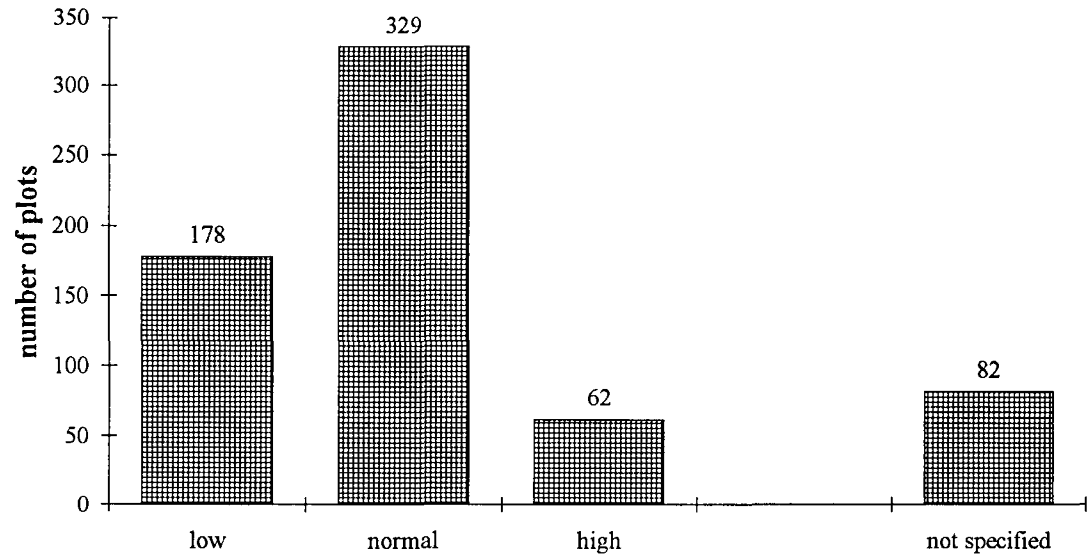
It has to be understood that these figures are based on estimates in the field. In a later stage when the increment studies have been completed, more detailed information will become available. In Figure 2.2.2.4-1 the distribution of the plots per yield class is shown.

Figure 2.2.2.4-1: Distribution of the plots over the estimated yield classes



Participating countries were asked to indicate whether the estimated yield was considered as being low, normal or high for these species under these plot conditions. For most plots information was received (85%). In Figure 2.2.2.4-2 the distribution of the plots with the relative yields is indicated. It shows that most plots are considered normal.

Figure 2.2.2.4-2: Distribution of the plots over the relative yield classes

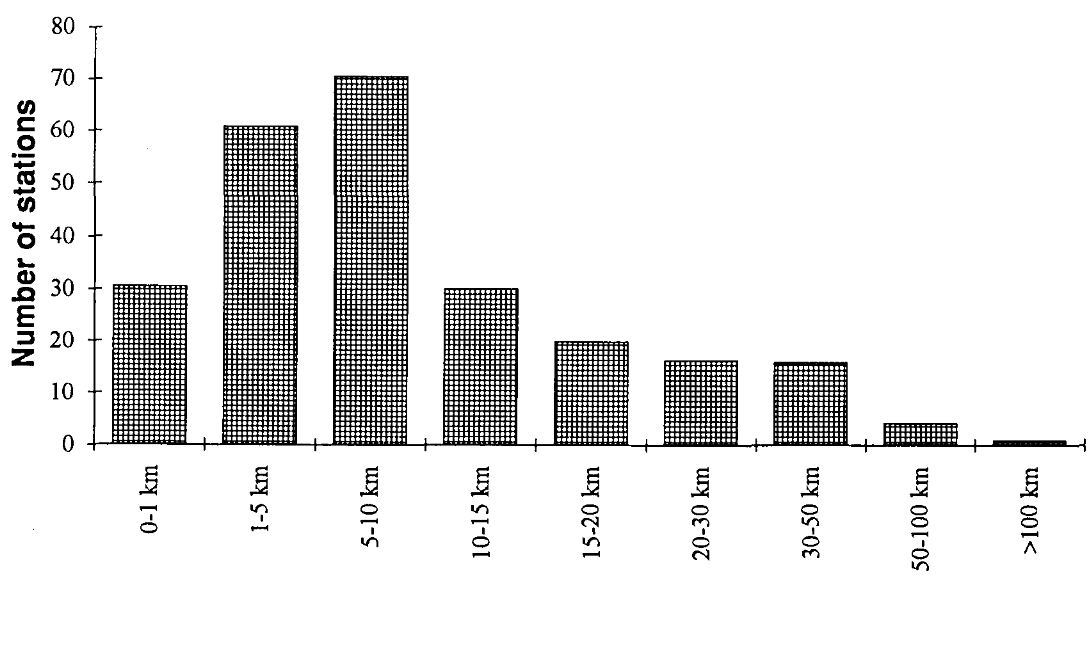


2.2.2.5 Distance to nearby monitoring or meteorological station

Ideally the plots should have been selected nearby an existing meteorological or other monitoring station. From 248 plots descriptions with information of nearby stations have been received. In most cases the nearby station was a monitor station, but also Integrated Monitoring Plots, and other research plots were mentioned. Based on the coordinates supplied for these stations the distance has been calculated.

In Figure 2.2.2.5-1 the distribution of the distance between the plot and the nearest station(s) is shown. It can be seen that the majority is located within 10 km of the plot.

Figure 2.2.2.5-1: The distribution of the distance between plot and nearby stations



2.2.3 Data collection and evaluation

By the end of 1996, the results of the first surveys will become available at the European Level. In first instance these data will be collected, validated, evaluated and interpreted at local or national level by the appointed National Focal Centre (NFC). By 31 December 1996, the data will be submitted to the Forest Intensive Monitoring Coordinating Institute (FIMCI). At the beginning of 1997 the validation, evaluation and interpretation at European level will be started. At European level a strategy for the evaluation of the data will need to be developed during 1996. This will be done by FIMCI in close collaboration with the Scientific Advisory Group (SAG) and the NFCs.

After 1996, the data from additional surveys will be submitted yearly. Procedures and deadlines for the submission will have to be further elaborated in close collaboration with the SAG and the NFCs. Amendments to the data requirements, methods, forms etc. which will have to be discussed and agreed upon in the respective expert panels or working groups and SAG, will be presented to the Standing Forestry Committee of the EC and the Task Force of the ICP Forest for decision.

Well defined conditions for data handling also permit external institutes to obtain a part of the database for specified evaluations. The coordination of this external evaluation with the internal evaluation, the evaluation strategy and the interpretation of the results will also be part of the work of FIMCI, who will carry this out in close collaboration with the SAG.

3. RESULTS OF THE 1995 SURVEYS

3.1 Transnational survey

3.1.1 The sample trees and plots in 1995

In 1995, the extension of the transnational grid continued. The actual database is now more comprehensive than ever before, comprising 117 305 trees assessed on 5 388 plots. This is more than four and a half times as large as the database of the starting year 1987. This extension is mainly caused by the growing number of non-EU countries participating in the survey since 1990. However, it is also a consequence of the completion of the grid within EU-Member States, such as in Finland and Sweden in 1995. With one non-EU country more than in 1994 (Russian Federation), the number of participating countries amounted to 30, which comprised all 15 EU-Member States and 15 non-EU countries, and which was the largest number of countries ever.

Besides the above mentioned 5 388 plots, 8 plots were surveyed on the Azores and 12 plots on the Canary Islands. These plots appear in the relevant maps of the present report, although they were not included in the total plot sample for the transnational evaluation.

The plot and tree samples of the actual database are listed in Tables 3.1.1-1 and 3.1.1-2. The actual database of each year accounts for rearward consistency checks of the data, which are performed every year. As a consequence, data for previous years in Tables 3.1.1-1 and 3.1.1-2 do not necessarily coincide with respective data in previous reports.

In 1995 a particularly comprehensive consistency check was carried out in close cooperation with the NFCs. Both plot and tree related data of the entire database from 1987 to 1995 were examined with respect to coding for 1987 to 1995 and consistency. All inconstistencies found were reported to the NFCs for inspection and clarification. Based on the replies of the NFCs, the inconsistencies were removed. A detailed description of the actual database, along with a description of the plausibility routines, is provided in a special Consistency Report which is available from PCC West.

A share of 59.8% of the 1995 tree sample accounted for **coniferous species** and a share of 40.2% for **broadleaved species**. The spatial distribution of the coniferous, the broadleaved and the maquis plots over the area surveyed is documented in Annex I-1. Each plot was assigned to the species group which comprised the majority of trees on the plot. The respective partition of the plot sample is 63.5% coniferous plots, 36.2% broadleaved plots and 0.3% maquis plots. As compared with the 1994 plot sample (60.6% coniferous, 39.1% broadleaved and 0.3% maquis plots, this is a shift towards the coniferous plots due to the completion of the grid in Finland and Sweden.

The 1995 tree sample comprised 114 **species**. As in previous years, the high number of species assessed yielded very low shares for most of the species (Annex I-2). *Pinus sylvestris* with 26.9% and *Picea abies* with 21.1% of all trees accounted for nearly half of the total tree sample. Besides *Pinus sylvestris* and *Picea abies*, the most frequent species were *Fagus sylvatica* (9.1%), *Quercus robur* (3.9%), *Quercus pubescens (2.8%), Quercus petraea* (3.1%), *Pinus pinaster* (2.9%) and *Quercus ilex* (2.6%).

Table 3.1.1-3 shows the number of plots per country and the number of plots per country on which the plot variables **water availability, humus type, altitude, aspect, mean age** and **soil type** were assessed. In the EU-Member States age, altitude and aspect were reported for 100.0% of the plots. Water availability and humus type were reported for 82.6% and 98.0%, respectively. As regards soil type, a far larger percentage than in previous years was reported because of the completion of the current soil survey on Level I in 1995. This dataset, however, is currently subjected to plausibility tests at FSCC. The respective percentages for non-EU countries are still slightly smaller, but have been increasing since the 1993 survey.

Table 3.1.1.-1: Number of sample plots from 1987 to 1995 according to the actual database

Country	Number of sample plots								
	1987	1988	1989	1990	1991	1992	1993	1994	1995
Austria				72	79	77	76	76	76
Belgium	11	33	33	29	29	29	29	29	29
Denmark			25	25	25	25	25	25	24
Finland					359	413	405	382	455
France	72	228	509	514	513	505	506	534	543
Germany	300	300	298	410	411	414	412	417	417
Greece		84	104	101	101	98	96	96	95
Ireland	22	22	22	22	22	22	22	21	21
Italy	172	208	206	206	208	204	214	211	209
Luxembourg	4	4	4	4	4	4	4	4	4
Netherlands	14	14	14	14	14	14	13	13	13
Portugal	86	154	152	152	151	149	143	147	141
Spain	322	388	457	447	436	462	460	444	454
Sweden			60	38	45	67	59	340	726
United Kingdom	73	74	74	74	74	72	69	66	63
EU	1076	1509	1958	2108	2471	2555	2533	2805	3270
Bulgaria								109	120
Croatia							84	88	82
Czech Republic		79		87		146	175	212	199
Estonia							89	90	90
Hungary				67	66	65	65	62	63
Latvia								90	94
Lithuania						73	74	73	73
Rep. of Moldova							12	12	11
Norway						387	390	384	386
Poland				474	476	476	476	441	432
Romania						215	167	199	243
Russian Fed.								7	134
Slovak Republic						111	111	111	111
Slovenia							34	34	33
Switzerland				45	45	45	45	45	47
Total Europe	1076	1588	1958	2781	3058	4073	4255	4762	5388

Although all of the above parameters were evaluated with respect to defoliation and discolouration, the present report only refers to the evaluations for mean age, water availability and altitude. The analysis of the other parameters did not lead to conclusive results. Nevertheless, as a series of these parameters may become important for future trend analyses, they should be continued to assess in the future.

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)** was defined which consists of only those sample trees observed in 1994 and 1995. This subsample contained 94 093 trees or 80.2% of the grand total of trees.

A similar evaluation was made for the period from 1988-1995 on 12 of the most common tree species in the total tree sample. The respective subsample comprised 19 165 trees or 16.4% of the grand total.

Table 3.1.1.-2: Number of sample trees from 1987 to 1995 according to the actual database

Country	Number of sample trees								
	1987	1988	1989	1990	1991	1992	1993	1994	1995
Austria				2132	2244	2167	2121	2107	2101
Belgium	264	792	791	684	686	673	685	684	678
Denmark			600	600	600	600	600	600	576
Finland					3899	4545	4427	4261	8754
France	1446	4464	10170	10280	10255	10093	10118	10672	10851
Germany	7924	7943	7883	10588	10662	10767	10729	10866	10907
Greece		1980	2463	2392	2392	2320	2272	2272	2248
Ireland	535	461	462	458	458	460	462	441	441
Italy	4570	5579	5695	5759	5799	5700	5941	5849	5761
Luxembourg	96	96	96	96	96	95	95	93	96
Netherlands	280	280	278	279	280	280	260	260	257
Portugal	2274	4620	4569	4563	4585	4508	4308	4414	4230
Spain	5905	9313	11073	10791	10557	11088	11040	10655	10896
Sweden			234	146	265	300	312	3991	10314
United Kingdom	1750	1775	1776	1776	1770	1728	1656	1584	1512
EU	25044	37303	46090	50544	54548	55324	55026	58749	69622
Bulgaria								4370	4812
Croatia							2016	2150	1970
Czech Republic		1975		2175		3635	4352	5272	4935
Estonia							2136	2159	2160
Hungary				1351	1371	1348	1361	1322	1342
Latvia								2191	2262
Lithuania						1768	1843	1760	1777
Rep. of Moldova							288	288	263
Norway						4001	4016	3942	3905
Poland				9476	9520	9520	9520	8820	8640
Romania						5155	4004	4776	5736
Russian Fed.								183	3180
Slovak Republic						5251	5144	5115	5091
Slovenia							792	815	786
Switzerland				479	487	488	500	509	824
Total Europe	25044	39278	46090	64025	65926	86490	90998	102421	117305

Table 3.1.1-3: Number of sample plots and plots per plot variable

Country	Number of plots	Number of plots per plot variable				
		Water	Humus	Altitude	Aspect	Age
Austria	76	76	76	76	76	76
Belgium	29	29	29	29	29	29
Denmark	24	24	24	24	24	24
Finland	455	455	454	455	455	455
France	543	543	543	543	543	543
Germany	417	417	417	417	417	417
Greece	95	95	93	95	95	95
Ireland	21	21	21	21	21	21
Italy	209	209	209	209	209	209
Luxembourg	4	4	4	4	4	4
Netherlands	13	13	13	13	13	13
Portugal	141	141	141	141	141	141
Spain	454	454	454	454	454	454
Sweden	726	221	726	726	726	726
United Kingdom	63			63	63	63
EU	3270	2702	3204	3270	3270	3270
Percent of EU plot sample		82.6	98.0	100.0	100.0	100.0
Bulgaria	120	120		120	120	120
Croatia	82	82	75	80	80	78
Czech Republic	199	199	100	199	199	
Estonia	90	90	90	90	90	90
Hungary	63			63		63
Latvia	94	94	94	94	94	94
Lithuania	73	73		73	73	73
Rep. of Moldova	11	11	11	11	11	11
Norway	386		364	386	386	386
Poland	432			432	432	432
Romania	243	243	243	243	243	242
Russian Fed.	134	134	127	134	134	134
Slovak Republic	111		111	111	111	111
Slovenia	33	33	33	33	33	33
Switzerland	47			47	47	47
Total Europe	5388	3781	4452	5386	5323	5184
Percent of total plot sample		70.2	82.6	99.9	98.8	96.2

3.1.2 Defoliation and discolouration

Of the 117 305 sample trees of the 1995 survey, 25.3% were rated as damaged, i.e. had a **defoliation** of more than 25% (defoliation classes 2-4). The conifers had nearly the same proportion of damaged trees (25.5%) as the broadleaves (25.0%). Table 3.1.2-1 shows the results in greater detail. **Discolouration** was reported for only 111 805 trees because some countries (mostly non-EU Member States) did not assess discolouration on all sample trees. 10.2% of this tree sample had a discolouration of more than 10% (Table 3.1.2-2).

Of the total tree sample, **defoliation** among the **broadleaves** was highest for *Quercus* spp. (30.9% damaged trees). The lowest defoliation was found for *Castanea sativa* with 16.4%

and *Eucalyptus* spp. with 7.7% damaged trees. Of the **conifers**, *Abies* spp. had the highest percentage of damaged trees (31.6%), whereas the lowest share of damaged trees was recorded for *Larix* spp. (21.2%) (Annex I-3).

Discolouration of the **broadleaves** was highest for *Castanea sativa* and *Quercus* spp. (17.3% and 15.3%, respectively, of the trees discoloured, i.e. showing discolouration greater than 10%). *Betula* spp. had the lowest share of discoloured trees (3.4%). Among the **conifers** the interspecific variation was smaller, with *Abies* spp. showing the highest percentage of discoloured trees (18.3%). The lowest discolouration was found in *Larix* spp. with 5.2% of the trees being discoloured (Annex I-4).

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

	Species type	Defoliation							No. trees
		0-10%	>10-25%	0-25%	>25-60%	>60%	dead	>25%	
EU	Broadleaves	45.3	34.5	79.8	17.4	2.1	0.7	20.2	29032
	Conifers	53.1	31.5	84.6	13.4	1.6	0.4	15.4	40590
	All species	49.9	32.8	82.7	15.0	1.8	0.5	17.3	69622
Total Europe	Broadleaves	40.1	34.9	75.0	21.6	2.4	1.0	25.0	47120
	Conifers	39.9	34.6	74.5	22.7	2.0	0.8	25.5	70185
	All species	40.0	34.7	74.7	22.2	2.2	0.9	25.3	117305

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	89.9	7.2	1.7	0.4	0.8	10.1	29012
	Conifers	90.7	7.1	1.6	0.3	0.3	9.3	40556
	All species	90.3	7.1	1.7	0.4	0.5	9.7	69568
Total Europe	Broadleaves	88.7	8.2	2.1	0.4	0.6	11.3	46169
	Conifers	90.3	7.3	1.8	0.3	0.3	9.7	65636
	All species	89.8	7.6	1.9	0.3	0.4	10.2	111805

The distribution of the shares of damaged trees per plot over the survey area is shown in Figure 3.1.2-1. The pie diagram reveals that on 48.8% of the plots the share of damaged trees is 10% or lower. These plots are mainly located in south-western Europe, the eastern part of the Alps, Scandinavia and the Baltic Region. The share of damaged trees ranges from 51%-75% on 9.5% of the plots and from 76%-100% on another 9.5%. This means that on 19.0% of all plots more than half of the trees are damaged. The areas with the highest proportion of damaged trees are located in central Europe. Maps of the distribution of mean plot defoliation and discolouration are shown in Annexes I-5 and I-6. The mean plot defoliation (Annex I-5) is classified according to the five defoliation classes. On 29.6% of the plots the mean defoliation is larger than 25% (classes 2-4 with 28.6%, 0.9% and 0.1%, respectively). These plots are particularly frequent in central Europe.

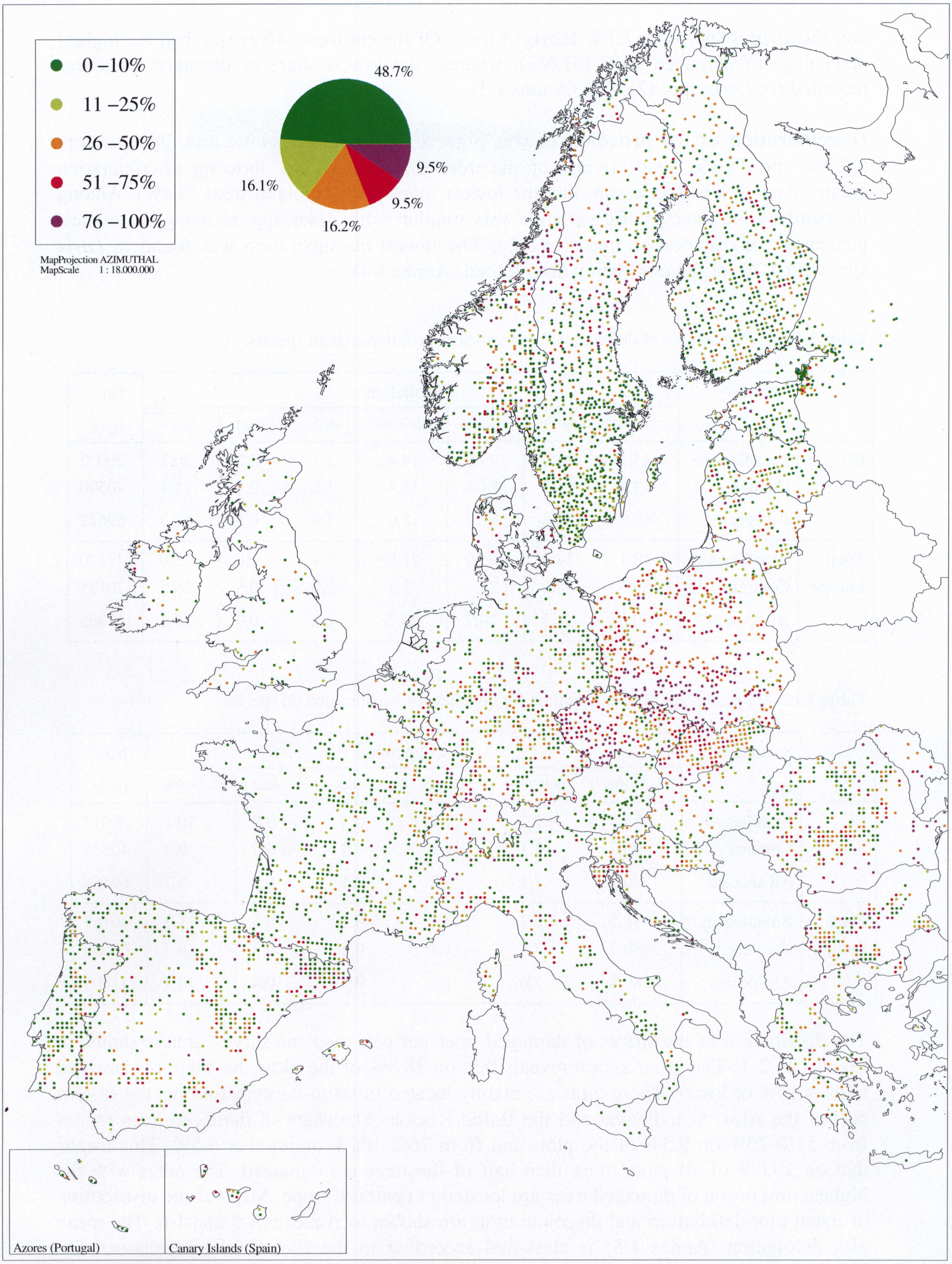


Figure 3.1.2-1: Percentage of trees damaged in 1995. For proper interpretation of the map see Chapter 2.1.1.5

3.1.3 Defoliation and discolouration by climatic region

3.1.3.1 Classification

As in previous reports, the total 1995 plot sample has been stratified according to the climatic classification introduced with the 1993 report. This classification was derived from the one by the Commission of the European Communities (1985) and the one by WALTER-HARNICKELL-MÜLLER-DOMBOIS (1975). Of these two classifications, several smaller regions were 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 10 climatic regions match the most important forest vegetation types. The percentages of the plots they comprised in 1995 are shown in Table 3.1.3.1-1. Figure 3.1.3.1-1 shows the distribution of all plots of the 1995 survey over the climatic regions.

Table 3.1.3.1-1: Distribution of the 1995 plot sample over the climatic regions

Climatic regions	Number of plots	Percentage of plots
Boreal	960	17.8%
Boreal (temperate)	657	12.2%
Atlantic (north)	313	5.8%
Atlantic (south)	274	5.1%
Sub-atlantic	1172	21.7%
Continental	242	4.5%
Mountainous (north)	256	4.8%
Mountainous (south)	663	12.3%
Mediterranean (higher)	336	6.2%
Mediterranean (lower)	515	9.6%
All regions	5388	100%

The **Boreal** region comprises Finland, the Leningrad Region of the Russian Federation, central and northern Sweden as well as small parts of south-eastern and northern 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. In 1995, the Boreal region represented 17.8% of the total sample plots.

The **Boreal (temperate)** region represents a large part of southern Sweden, a small part of south-eastern Norway, all of Estonia, Latvia, Lithuania as well as Kaliningrad Region and the south-western part of Leningrad Region of the Russian Federation. The Boreal (temperate) region 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. In 1995, it comprised 12.2% of the total plot sample.

The plots of the **Atlantic (north)** region cover all of the United Kingdom, Ireland, Denmark and the Netherlands. This region also includes the coast of southern Sweden, a small part of the coast of southernmost Norway, as well as the north-western 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. The Atlantic (north) region is dominated by *Fagus sylvatica*, *Pinus sylvestris* and *Picea abies*. In 1995, 5.8% of all sample plots were located within this region.

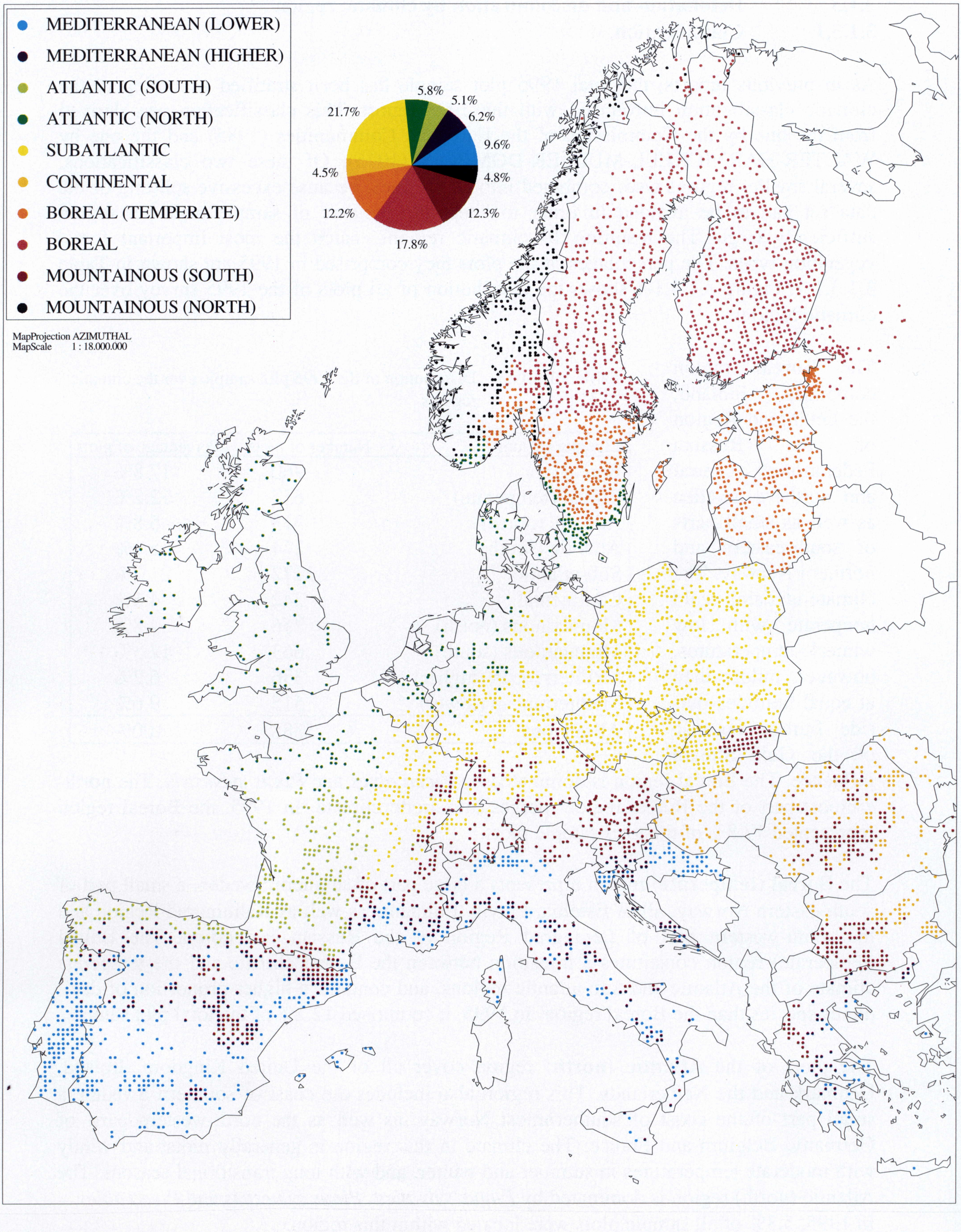


Figure 3.1.3.1-1: The climatic regions of the 1995 plot sample.

The **Atlantic (south)** region comprises central and south-western France, the northern and north-western coast of Spain and a small part in the north-west of Portugal. In comparison to 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 5.1% of the total 1995 plot sample.

The plots of the **Sub-atlantic** region cover total Poland and the total Czech Republic. Furthermore it comprises the largest part of Germany, the western part of the Slovak Republic, northern Switzerland, northern Austria, south-eastern Belgium, northeastern France and total Luxembourg. The climate in this region is typically temperate. It is characterized by larger differences between summer and winter temperatures, and by 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, containing 21.7% of all plots of the 1995 survey.

The **Continental** region consists of the total Republic of Moldova, large parts of Romania, the eastern and northern parts of Bulgaria and nearly all of Hungary. As compared with the Sub-atlantic 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. This region is the smallest one, containing only 4.5% of the total sample plots in 1995.

The **Mountainous (south)** regions comprise plots on several mountain ridges which are 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 in these areas are very complex, depending on altitude and exposition. The Mountainous (south) regions comprise the Alpine system (Pyrenees, Alps, Tatras, Carpathians and Balkan chains), several ridges in the Mediterranean countries and several highland areas. The dominant species are *Picea abies*, *Pinus sylvestris*, *Abies alba* and *Larix decidua*. Of the total 1995 plot sample, 12.3% belonged to the Mountainous (south) regions.

The **Mountainous (north)** region was introduced in order to account for peculiarities of the mountainous climate in northernmost Europe in comparison to that in the remaining parts of Europe. The plots of this region cover large parts of Norway (from the south-west to the north). Similar to the Mountainous (south) region, the Mountainous (north) region is characterized by steep climatic gradients. The plots of lower altitude on the Atlantic coast are influenced by more temperate climate due to the Gulf Stream. In 1995, the Mountainous (north) region contained 4.8% of all sample plots.

The plots of the **Mediterranean (higher)** region are located 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. In 1995, 6.2% of all plots were located in the Mediterranean (higher) region.

The **Mediterranean (lower)** region covers 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. Forest vegetation includes *Pinus halepensis*, *Pinus pinaster*, *Quercus ilex*, *Quercus suber* and *Castanea sativa*. The Mediterranean (lower) region in 1995 comprised 9.6% of the total plot sample.

3.1.3.2 Results

The shares of the trees in the individual defoliation and discolouration classes are listed in Tables 3.1.3.2-1 and 3.1.3.2-2, respectively, for broadleaves, conifers and all species in each climatic region. For all species, Figure 3.1.3.2-1 presents the same information graphically. These results should not be compared with those of previous reports because of annual changes in the tree samples. Changes in defoliation over time are calculated from special unbiased tree samples in Chapters 3.1.7 and 3.1.8.

With respect to **defoliation** of **all species** in the 10 climatic regions, the percentage of damaged trees was lowest in the Atlantic (south) region with 7.8% and highest in the Sub-atlantic region with 42.2%. The share of severely damaged trees (defoliation greater than 60%, without dead trees) was generally small and had its highest values in the Mountainous (north), the Continental and the Mediterranean (higher) region with 4.0%, 3.8% and 3.7%, respectively. The dead trees had their highest share in the Continental region with 2.2%. The share of damaged **conifers** was larger than that of the broadleaves in the Boreal, the Boreal (temperate), the Atlantic (north), the Sub-atlantic and the Continental regions. In the remaining 5 regions, **broadleaves** had a higher share of damaged trees than conifers. Details on the defoliation of the most important species are given in the following paragraphs and in Annex I-3.

The **Boreal** region was with 14.7% of damaged trees among the least damaged regions. This results from the high proportion (53.2%) of *Pinus sylvestris* trees, of which only 5.6% were classified as damaged. This low defoliation of the most abundant species in this region was partly balanced by *Picea abies* which accounted for 32.8% of all trees and of which 30.7% were damaged. All in all, conifers had a higher share of damaged trees (15.1%) than broadleaves (12.2%) represented by *Betula* spp. (12.1% of all sample trees in this region with 12.4% trees damaged).

14.9% of the trees were damaged in the **Boreal (temperate)** region. In contrast to the Boreal region, the dominating *Pinus sylvestris* trees (52.6% of all trees) were of relatively high defoliation, with 15.5% classified as damaged. *Picea abies* comprised 31.2% of all species with 15.0% damaged. The total result for the Boreal (temperate) region was dominated by conifers, which had a far higher number of sample trees (10 980) and a higher share of damaged trees (15.4%) than broadleaves (2 105 and 12.9%, respectively).

In the **Atlantic (north)** region 17.0% of the trees of all species were damaged. The most abundant tree species group in this region was *Picea* spp., comprising 29.0% of the trees of all species, with 16.7% of its trees rated as damaged. *Pinus* spp. comprised 20.7% of all species, with 15.2% of its trees damaged. 18.4% of all species accounted for *Quercus* spp., of which 15.2% were rated as damaged. *Fagus* spp. accounted for 14.6% of the tree sample, with 29.1% of its trees classified as damaged.

In the **Atlantic (south)** region as the one with the lowest share of damaged trees (7.8%), a large variety of conifers and broadleaves is represented, of which *Pinus pinaster* had the largest share (22.5%), followed by *Quercus robur* (15.9%) and *Quercus petraea* (8.9%). Among the more frequent species, the deciduous *Quercus* spp. had the largest share (10%) of damaged trees. All the other more abundant species showed relatively low defoliation.

In the **Sub-atlantic** region, both broadleaves and conifers had the highest shares of damaged trees (37.3% and 44.2%, respectively) of all regions, with broadleaves being clearly less defoliated than conifers. The most frequent species group was *Pinus* spp., comprising 37.1% of the sample trees in this region, with 43.8% of the trees classified as damaged. The second largest share of trees was represented by *Picea* spp., which represented 28.8% of all sample trees, with 46.0% of its trees rated as damaged. The highest percentage of damaged trees was found for *Abies* spp. with 46.3% which, however, represented only 2.4% of the sample trees of the Sub-atlantic region. The deciduous *Quercus* spp. had a share of damaged trees of 43.8%, however, this species group was only represented with 9.5%.

The second highest percentage of damaged trees among all climatic regions was found with 34.7% in the **Continental** region. Both in broadleaves and in conifers the shares of damaged trees were relatively high (37.8% and 33.0%, respectively). Of the large variety of species represented in the Continental region, the most frequent one was *Quercus* spp. with 33.2%. *Quercus* spp. also showed the largest share of damaged trees among all species assessed in the Continental region, namely 43.6%, and had thus the most severe impact on the total result for this region.

The share of damaged trees in the **Mountainous (north)** region amounted to 26.0%. Broadleaves had a higher share of damaged trees (32.4%) than conifers (22.0%), but were of less influence for the total result because their number (970) was clearly smaller than that of the conifers (1 556). The broadleaves consisted solely of *Betula pubescens* (38.4% of all trees of the region with 32.3% of the trees damaged), whilst the conifers consisted of *Pinus sylvestris* (32.4% of all trees in the region, with 12.9% of the trees damaged) and of *Picea abies* (29.2% of all trees, with 32.0% damaged).

In the **Mountainous (south)** region the share of damaged trees was 24.1%. Similarly to the Mountainous (north) region, broadleaves had a slightly higher share of damaged trees (24.7%) than conifers (23.6%). The total result was mainly influenced by the conifers which dominated with 10 419 trees over the 7 454 broadleaved trees. Among the conifers *Picea* spp. was the dominating species (with 19.6% of its 4 912 trees damaged). *Pinus* spp. showed the highest share of damaged trees (29.7%). The relatively high share of damaged broadleaves was mainly due to deciduous *Quercus* spp. (41.6% of its 1 606 trees damaged).

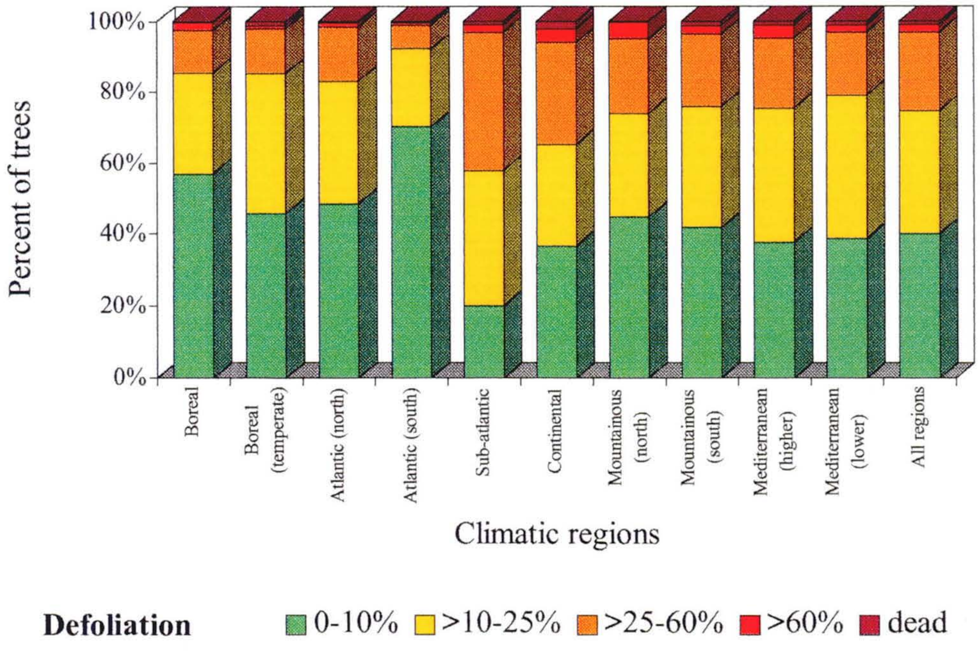
With 24.6% of its trees rated as damaged, the tree sample of the **Mediterranean (higher)** region was dominated by 4 949 broadleaved trees, of which 27.9% were damaged. For this relatively high share of damaged trees, 2 011 *Quercus* spp. trees with 28.3% of them being damaged were mainly responsible. Of the 3 268 conifers, 19.8% were damaged. The coniferous subsample was dominated by 2 578 *Pinus* spp. trees with 16.7% of them classified as damaged.

Table 3.1.3.2-1: 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	63.1	24.7	87.8	10.8	1.2	0.2	12.2	2115	1923
Conifers	56.0	28.9	84.9	12.5	2.5	0.1	15.1	13271	11340
All species	57.0	28.3	85.3	12.3	2.3	0.1	14.7	15386	13263
Boreal (temperate)									
Broadleaves	51.9	35.2	87.1	11.6	1.1	0.2	12.9	2105	653
Conifers	44.7	39.9	84.6	13.3	0.9	1.2	15.4	10980	3900
All species	46.0	39.1	85.1	13.0	0.9	1.0	14.9	13085	4553
Atlantic (north)									
Broadleaves	48.8	35.0	83.8	14.8	1.2	0.2	16.2	3140	3105
Conifers	48.3	33.9	82.2	16.2	1.1	0.5	17.8	3389	3321
All species	48.6	34.4	83.0	15.5	1.1	0.4	17.0	6529	6426
Atlantic (south)									
Broadleaves	66.6	24.4	91.0	7.7	0.9	0.4	9.0	3740	3740
Conifers	76.7	17.6	94.3	5.0	0.4	0.3	5.7	2055	2055
All species	70.2	22.0	92.2	6.7	0.7	0.4	7.8	5795	5795
Sub-atlantic									
Broadleaves	22.4	40.3	62.7	34.2	2.2	0.9	37.3	8342	4208
Conifers	19.1	36.7	55.8	41.2	2.2	0.8	44.2	19989	6984
All species	20.0	37.8	57.8	39.1	2.2	0.9	42.2	28331	11192
Continental									
Broadleaves	37.0	29.2	66.2	28.2	3.8	1.8	33.8	5276	
Conifers	34.8	25.8	60.6	31.3	3.6	4.5	39.4	1015	
All species	36.7	28.6	65.3	28.7	3.8	2.2	34.7	6291	
Mountainous (north)									
Broadleaves	37.0	30.6	67.6	27.8	4.5	0.1	32.4	970	
Conifers	49.9	28.1	78.0	16.8	5.1	0.1	22.0	1556	
All species	44.9	29.1	74.0	21.0	4.9	0.1	26.0	2526	
Mountainous (south)									
Broadleaves	39.8	35.5	75.3	20.5	2.8	1.4	24.7	7454	3130
Conifers	43.5	32.9	76.4	20.6	2.0	1.0	23.6	10419	5910
All species	41.9	34.0	75.9	20.6	2.3	1.2	24.1	17873	9040
Mediterra-nean (higher)									
Broadleaves	36.3	35.8	72.1	22.6	4.7	0.6	27.9	4949	4475
Conifers	39.9	40.3	80.2	16.0	2.3	1.5	19.8	3268	2921
All species	37.8	37.6	75.4	19.9	3.7	1.0	24.6	8217	7396
Mediterra-nean (lower)									
Broadleaves	38.6	39.5	78.1	18.7	1.8	1.4	21.9	9029	4208
Conifers	39.2	41.8	81.0	16.1	2.3	0.6	19.0	4243	4159
All species	38.8	40.2	79.0	17.9	2.0	1.1	21.0	13272	11957

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	99.5	0.4	99.9	0.0	0.1	0.0	0.1	2114	1922
Conifers	93.1	5.4	98.5	1.2	0.2	0.1	1.5	13255	11324
All species	94.0	4.7	98.7	1.0	0.2	0.1	1.3	15369	13246
Boreal (temperate)									
Broadleaves	97.4	2.2	99.6	0.2	0.1	0.1	0.4	2104	652
Conifers	94.1	4.8	98.9	0.8	0.2	0.1	1.1	10962	3882
All species	94.6	4.4	99.0	0.7	0.2	0.1	1.0	13066	4534
Atlantic (north)									
Broadleaves	87.4	8.7	96.1	3.2	0.5	0.2	3.9	3140	3105
Conifers	85.4	10.4	95.8	3.7	0.4	0.1	4.2	3389	3321
All species	86.3	9.6	95.9	3.5	0.5	0.1	4.1	6529	6426
Atlantic (south)									
Broadleaves	93.8	4.9	98.7	0.7	0.2	0.4	1.3	3740	3740
Conifers	90.6	8.2	98.8	0.9	0.0	0.3	1.2	2055	2055
All species	92.5	6.1	98.6	0.8	0.2	0.4	1.4	5795	5795
Sub-atlantic									
Broadleaves	93.6	4.8	98.4	1.2	0.2	0.2	1.6	7834	4191
Conifers	94.3	4.5	98.8	0.8	0.1	0.2	1.1	15545	6984
All species	94.2	4.6	98.8	0.9	0.1	0.2	1.2	23379	11175
Continental									
Broadleaves	84.6	11.7	96.3	3.4	0.1	0.2	3.7	4936	
Conifers	86.6	7.1	93.7	6.1	0.1	0.1	6.3	987	
All species	85.0	10.9	95.9	3.8	0.1	0.2	4.1	5923	
Mountainous (north)									
Broadleaves	96.3	3.1	99.4	0.2	0.4	0.0	0.6	970	
Conifers	92.0	4.6	96.6	2.2	1.1	0.1	3.4	1556	
All species	93.8	4.0	97.8	1.4	0.8	0.0	2.2	2526	
Mountainous (south)									
Broadleaves	87.7	9.1	96.8	2.1	0.2	0.9	3.2	7354	3130
Conifers	86.3	10.4	96.7	2.9	0.1	0.3	3.3	10376	5910
All species	86.8	9.9	96.7	2.6	0.2	0.5	3.3	17730	9040
Mediterra-nean (higher)									
Broadleaves	84.0	10.3	94.3	3.8	0.8	1.1	5.7	4948	4474
Conifers	83.2	11.4	94.6	3.6	0.3	1.5	5.4	3268	2921
All species	83.7	10.8	94.5	3.7	0.6	1.2	5.5	8216	7395
Mediterra-nean (lower)									
Broadleaves	83.4	12.2	95.6	2.4	0.6	1.4	4.4	9029	7798
Conifers	78.0	16.7	94.7	3.4	1.2	0.7	5.3	4243	4159
All species	81.7	13.6	95.3	2.7	0.8	1.2	4.7	13272	11957



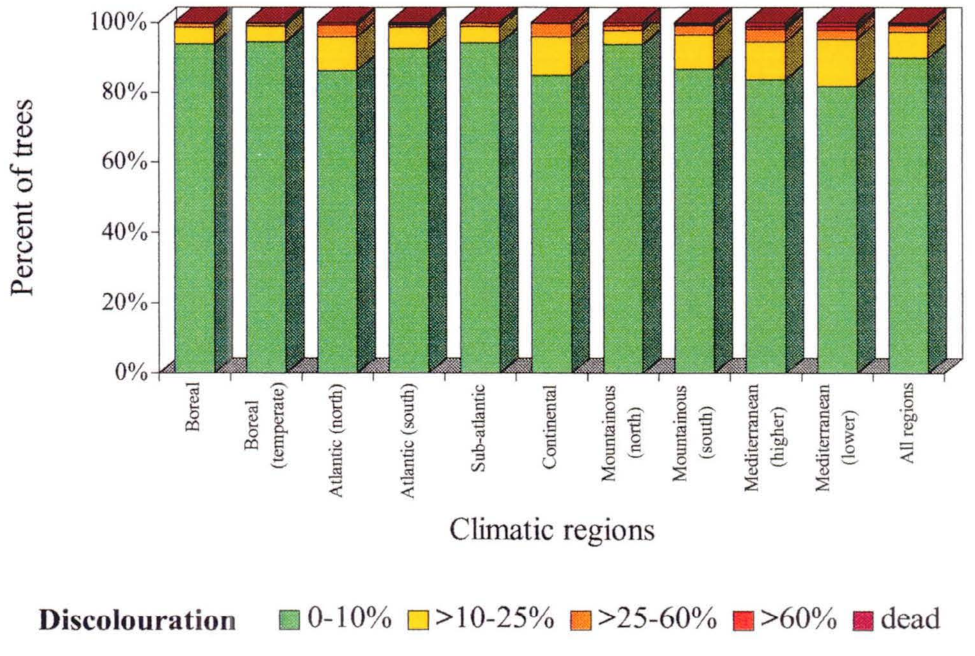


Figure 3.1.3.2-1: Defoliation and discolouration by climatic region

In the **Mediterranean (lower)** region the percentage of damaged trees amounted to 21.0%. The sizes of the broadleaved subsample (9 029 trees) and the coniferous subsample (4 243 trees) were very different. Their shares of damaged trees, however, differed only slightly (21.9% and 19.0%, respectively). The result of the broadleaved subsample was determined by *Quercus ilex* (1 995 trees, 29.5% damaged), *Quercus* spp. (1472 trees, 29.1% damaged) and *Quercus* suber (1 432 trees, 26.4% damaged). The result of the coniferous subsample was mainly influenced by 3 758 *Pinus* spp. trees with 18.4% of them damaged.

Detailed data on **discolouration** for species groups are given in Annex I-4. The highest discolouration was found in the Mediterranean (higher), the Mediterranean (lower), the Atlantic (north) and the Continental regions, with 5.5%, 4.7% and for the latter two species 4.1% of all trees, respectively, being discoloured, i.e. having a discolouration greater than 10%. The lowest proportion of discoloured trees occurred in the Boreal (temperate) region (1.0%). In all regions but the Atlantic (south), the Sub-atlantic and the Mediterranean (higher) regions, the discolouration of conifers was greater than that of broadleaves.

3.1.4 Defoliation and discolouration by mean age

For 7 classes of different mean stand age and for a class of irregular age composition the percentages of trees in each **defoliation** and **discolouration** class, respectively, are given in Tables 3.1.4-1 and 3.1.4-2., for both the EU-Member States and for total Europe. For total Europe, the respective results are also presented graphically in Figure 3.1.4-1.

The strong positive correlation between age and defoliation is confirmed. It is strongly suspected that this reflects inherent properties associated with ageing. In the sample for total Europe, the share of not defoliated trees (defoliation class 0) decreases rapidly from 62.7% at ages 0-20 to 31.3% at ages 81-100.

The share of damaged trees increases gradually from 14.1% at ages 0-20 to 31.4% at ages greater than 120. This increase is more pronounced at younger ages and becomes less evident at higher ages.

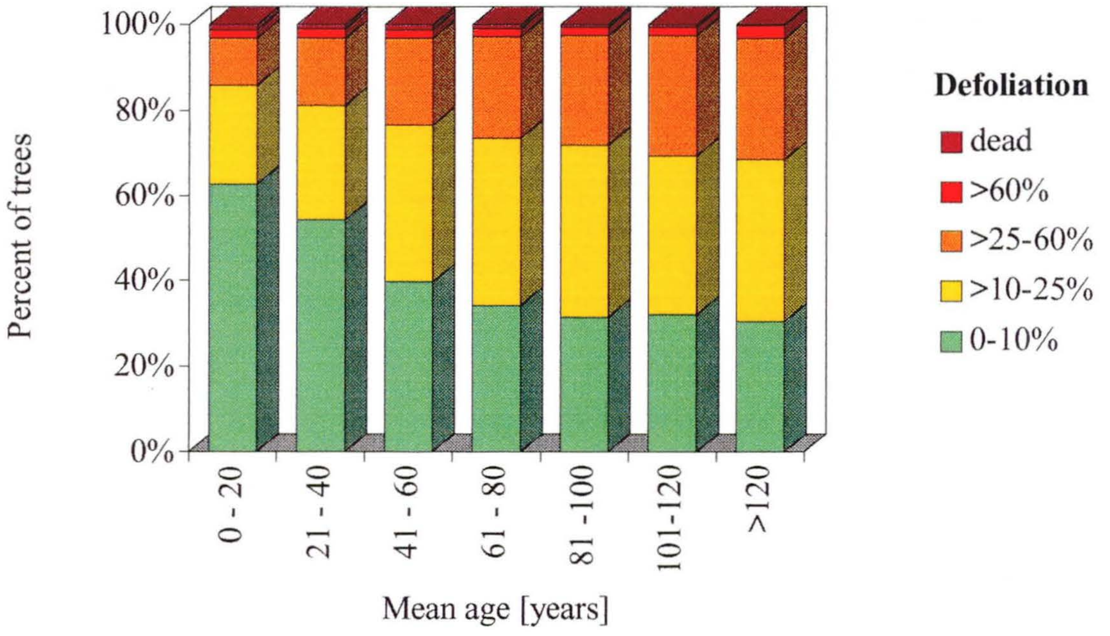
The shares of trees in different discolouration classes do not vary greatly with age. The younger trees (0-40 years) and the older trees (81- >120 years) seem to have a slightly larger discolouration than the trees between 41 and 80 years.

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

	Mean age [years]	Defoliation 0-10%	>10-25%	0-25%	>25-60%	>60%	dead	>25%	No. of trees
EU	0 - 20	64.0	23.4	87.4	9.8	1.6	1.2	12.6	8934
	21 - 40	60.8	25.7	86.5	11.2	1.8	0.5	13.5	15932
	41 - 60	51.7	34.3	86.0	12.1	1.5	0.4	14.0	11369
	61 - 80	48.6	37.9	86.5	12.2	1.0	0.3	13.5	9213
	81 -100	40.0	40.9	80.9	17.5	1.1	0.5	19.1	7833
	101-120	34.3	37.6	71.9	26.2	1.4	0.5	28.1	4379
	>120	31.9	38.0	69.9	27.2	2.8	0.1	30.1	4934
	Irregular	38.6	36.1	74.7	20.6	4.3	0.4	25.3	7028
	Total	49.9	32.8	82.7	15.0	1.8	0.5	17.3	69622
Total Europe	0 - 20	62.7	23.2	85.9	11.0	2.0	1.1	14.1	10270
	21 - 40	54.1	27.0	81.1	15.8	2.1	1.0	18.9	22744
	41 - 60	39.6	37.0	76.6	20.3	2.0	1.1	23.4	22728
	61 - 80	34.2	39.3	74.5	23.7	1.8	1.0	25.5	19667
	81 -100	31.3	40.6	71.9	25.5	2.0	0.6	28.1	14823
	101-120	32.0	37.4	69.4	28.1	1.9	0.6	30.6	7183
	>120	30.4	38.2	68.6	28.1	3.0	0.3	31.4	7251
	Irregular	38.0	36.1	74.1	21.4	4.2	0.3	25.9	7584
	Total	41.4	34.6	76.0	20.9	2.2	0.9	24.0	112250

Table 3.1.4-2: Percentages of discolouration of all species by mean age

	Mean age [years]	Discolouration 0-10%	>10-25%	>25-60%	>60%	dead	>10%	No. of trees
EU	0 - 20	87.8	8.4	2.5	0.2	1.1	12.2	8934
	21 - 40	89.8	7.2	1.7	0.5	0.8	10.2	15931
	41 - 60	90.6	7.1	1.7	0.3	0.3	9.4	11369
	61 - 80	93.0	5.3	1.1	0.4	0.2	7.0	9195
	81 -100	91.4	7.3	0.9	0.2	0.2	8.6	7820
	101-120	91.8	5.7	1.8	0.2	0.5	8.2	4376
	>120	92.3	5.6	1.9	0.2	0.0	7.7	4934
	Irregular	87.1	9.7	2.0	0.8	0.4	12.9	7009
	Total	90.3	7.1	1.7	0.4	0.5	9.7	69568
Total Europe	0 - 20	87.6	8.6	2.6	0.2	1.0	12.4	10238
	21 - 40	87.6	8.5	2.9	0.4	0.6	12.4	22574
	41 - 60	90.4	7.0	1.9	0.3	0.4	9.6	22648
	61 - 80	93.2	5.4	1.0	0.2	0.2	6.8	19604
	81 -100	90.0	8.5	1.1	0.2	0.2	10.0	14772
	101-120	91.2	6.6	1.6	0.2	0.4	8.8	7140
	>120	90.9	7.1	1.6	0.3	0.1	9.1	7168
	Irregular	85.7	10.9	2.2	0.8	0.4	14.3	7565
	Total	89.8	7.6	1.9	0.3	0.4	10.2	111709



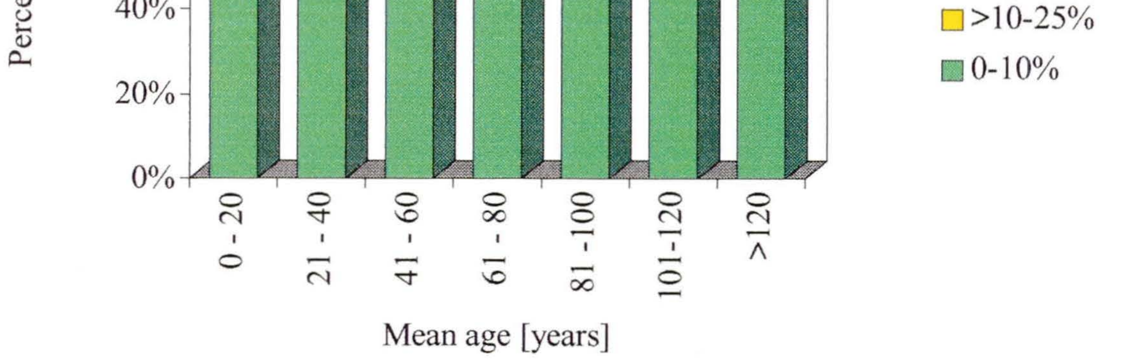


Figure 3.1.4-1: Percentages of trees of different defoliation and discolouration classes per age class

3.1.5 Defoliation and discolouration by water availability

At the date of observation water availability is determined. In 1995 it has been reported for 3 781 plots or 70.2% of the total plot sample (1994: 2 928, 61.6%) by means of a simple classification. Table 3.1.5-1 shows the percentages of plots of different mean plot defoliation and discolouration classified according to sites with insufficient, sufficient and excessive water availability. The overwhelming majority (83.4%) of the plots had sufficient water availability.

The results show that the share of damaged plots (with mean plot defoliation greater than 25%) was clearly lowest on sites of sufficient water availability (24.8%). On sites of insufficient and excessive water availability, the share of damaged plots was 29.4% and 26.6 %, respectively.

The highest share of discoloured plots (with mean plot discolouration greater than 10%) was found on sites of insufficient water availability (9.0%), whilst the respective shares on sites of sufficient and excessive water availability were 4.2% and 2.8%, respectively. These figures for discolouration, however, are hardly interpretable due to the very small amounts of discoloured plots.

Table 3.1.5-1: Percentages of plots of different mean plot defoliation and discolouration by water availability

Water availability	Plot defoliation		Plot discolouration		Sample plots	
	0-25%	>25%	0-10%	>10%	Number	%
Insufficient	70.6	29.4	91.0	9.0	469	12.4
Sufficient	75.2	24.8	95.8	4.2	3154	83.4
Excessive	73.4	26.6	97.2	2.8	158	4.2
Total	74.5	25.5	95.7	4.8	3781	100.0

3.1.6 Defoliation by altitude

In 1995, altitude was reported for almost the total plot sample. Table 3.1.6-1 and Figure 3.1.6.-1 show the percentages of plots of different mean plot defoliation by altitude (250 m class width).

The share of defoliated plots increases from 25.4% at 0-250 m altitude to 38.5% at 501-750 m altitude as its maximum. Then, with increasing altitude, the share of defoliated plots decreases to its minimum of 12.9% at altitudes of 1501-1750 m. Therefore it has to be considered that about half of the plots are located at 0-250 m altitude and less than 10% of the plots are situated above the 1000 m altitude.

Table 3.1.6-1: Percentages of plots of different mean plot defoliation by altitude

Altitude [m]	Plot defoliation							No. of plots
	0-10%	>10-25%	0-25%	>25-60%	>60%	dead	>25%	
0 - 250	26.7	47.9	74.6	24.7	0.6	0.1	25.4	2656
251 - 500	23.7	41.1	64.8	33.8	1.3	0.1	35.2	1179
501 - 750	22.3	39.2	61.5	37.1	1.4	0.0	38.5	699
751 - 1000	22.9	45.1	68.0	31.2	0.8	0.0	32.0	397
1001 - 1250	26.2	47.1	73.3	25.8	0.9	0.0	26.7	229
1251 - 1500	27.7	48.9	76.6	22.7	0.7	0.0	23.4	141
1501 - 1750	36.5	50.6	87.1	12.9	0.0	0.0	12.9	85
Total	25.4	45.0	70.4	28.6	0.9	0.1	29.6	5386

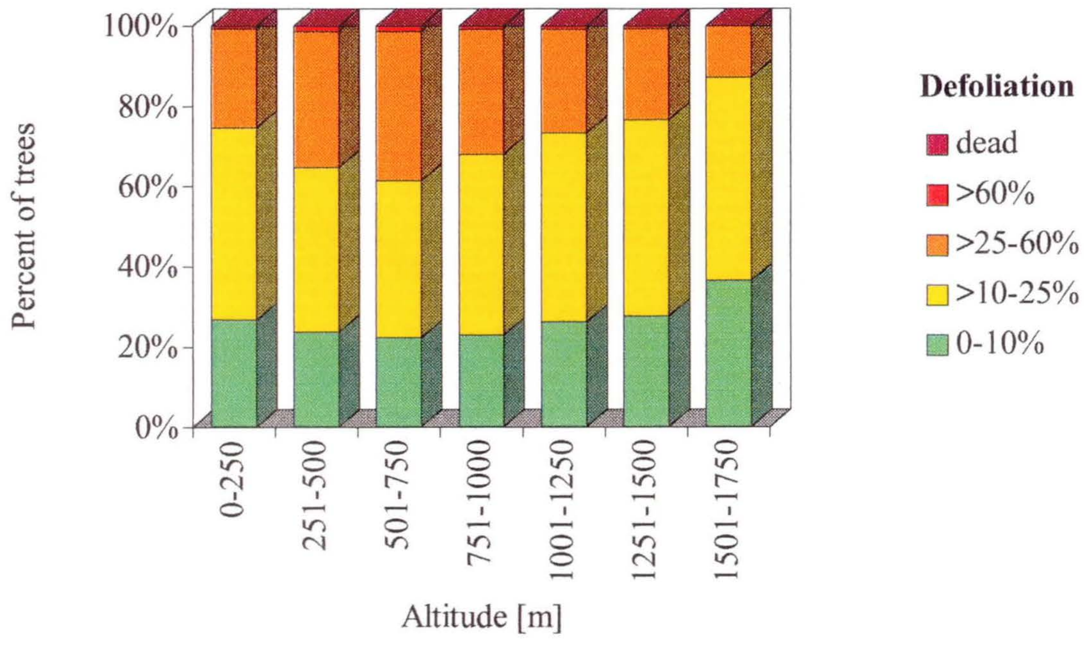


Figure 3.1.6-1: Percentages of plots of different mean plot defoliation by altitude

3.1.7 Changes in defoliation and discolouration from 1994-1995

3.1.7.1 The Common Sample Trees

For an unbiased comparison of the 1994 and 1995 survey results, a subsample called **Common Sample Trees (CSTs)** is defined. The CSTs contain all trees that are common to both surveys. For 1994 and 1995, this common sample consists of 94 093 trees, representing 92.0% of the total tree sample of 1994 and 80.2% of the total tree sample of 1995. This is 12 088 trees or 12.8% more than in the 1994 survey. The reason for this increase in the number of CSTs is the participation of Bulgaria, Latvia and Russia in the transnational forest condition assessment since 1994.

Again, the CSTs of 1994 and 1995 was the largest ever. The increasing number of CSTs improves the reliability of the calculation of changes in defoliation and discolouration and indicates a growing consistency of the datasets in the participating countries. Table 3.1.7.1-1 shows the percentages of trees in the different defoliation and discolouration classes for the CSTs of 1994 and 1995, both for total Europe and for the EU-Member States.

In total Europe, the shares of damaged trees of the CSTs were 25.2% in 1994 and 26.8% in 1995, indicating an increase in forest damage since 1994. The deterioration was most obvious in class 2, the share of which increased from 22.7% to 23.7%. The share of dead trees increased from 0.4% to 0.9%, indicating a mortality of 0.5%. The mortality is slightly lower than last year (0.8%).

The deterioration of forest condition was even more pronounced if only the EU-Member States are considered. In the EU-Member States, the share of damaged CSTs increased from 15.5% in 1994 to 18.1% in 1995.

Table 3.1.7.1-1: Percentages of the Common Sample Trees in different defoliation and discolouration classes in 1994 and 1995

	Total Europe		EU	
	1994	1995	1994	1995
Defoliation				
0 - 10 %	40.0	37.6	51.2	47.6
> 10 - 25 %	34.8	35.6	33.3	34.3
0 - 25 %	74.8	73.2	84.5	81.9
> 25 - 60 %	22.7	23.7	13.9	15.9
> 60 %	2.1	2.2	1.5	1.6
dead	0.4	0.9	0.1	0.6
> 25 %	25.2	26.8	15.5	18.1
No. of trees	94 093	94 093	55 422	55 422
Discolouration				
0 - 10 %	88.6	89.6	89.5	89.2
> 10 - 25 %	8.4	7.6	8.2	8.0
> 25 - 60 %	2.1	2.0	1.7	1.8
> 60 %	0.5	0.3	0.5	0.4
dead	0.4	0.5	0.1	0.6
> 10 %	11.4	10.4	10.5	10.8
No. of trees	90 774	90 774	55 396	55 396

The deterioration in forest condition at a large scale between 1994 and 1995 is also documented by the maps in Annexes I-7 and I-8. These maps were prepared on the basis of the mean defoliation of the CSTs on each plot. The pie diagram in Annex I-7 shows that the percentage of plots changing from undamaged to damaged is larger than the one changing from damaged to undamaged (7.2% and 5.3%, respectively). Defoliation class was not changed in 87.5% of the plots. In Annex I-8, the pie diagram reveals that 11.1% of the plots showed a significant decrease of mean defoliation, whereas 16.8% of the plots showed a significant deterioration, indicating a slightly worse forest condition than in 1994. There were no significant changes in defoliation in 72.1% of the plots.

The changes in plot defoliation represented in the map in Annex I-8 are statistically proved by significance tests. 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 in the plot. The map in Annex I-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.

Annexes I-7 and I-8 reveal only small changes at the large scale. However, larger changes are to be found at the regional scale. Chapter 3.1.7.2 provides statistical tests of the changes in plot defoliation in the various climatic regions.

As to **discolouration**, the proportion of trees affected decreased slightly from 1994 to 1995 in both the total tree sample and the CSTs. The slight decrease of discoloured trees in the total tree sample was higher than in the Common Sample.

3.1.7.2 Changes in defoliation and discolouration by climatic region

The percentages of damaged trees and mean plot defoliation were used to quantify the changes in defoliation of the CSTs from 1994 to 1995 for each climatic region. Because of the small differences in both figures between these two years, statistical significance tests were performed. Table 3.1.7.2-1 presents the results of these tests. Differences marked with asterisks are statistically significant at the 95% probability level. The changes in the percentage of trees in defoliation classes are visualized in Figure 3.1.7.2-1. The following descriptions refer to the changes in the percentage of trees damaged and differences in mean defoliation between 1994 and 1995.

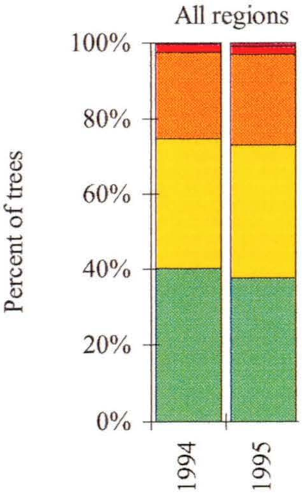
Regarding differences in **mean defoliation** significant changes were found for the total CSTs of all regions and for each climatic region as well. Except for the Boreal (temperate) region the mean defoliation increased significantly from 1994 to 1995. However, in no case did the change reach the 5% mark. The most pronounced worsening of crown condition, in terms of the **percentage of damaged trees**, occurred in the Mediterranean (lower) region (6.8 percent points), followed by the Mediterranean (higher) region (4.3 percent points). The situation in the Sub-Atlantic and the Continental regions appears to be stable as the changes there lie below 1 percent point and are not significant. The Boreal (temperate) region is the only one showing improved forest condition, the share of damaged trees decreasing significantly by 3.7 percent points.

The changes in **the percentages of discoloured trees** in each climatic region are presented in Table 3.1.7.2-2 and visualized in Figure 3.1.7.2-2. In contrast to defoliation the percentage of discoloured trees decreased in most of the climatic regions. The most noticeable improvement was a decrease of discoloured trees by 3.1 percent points that occurred in the Continental region. A positive development in terms of discolouration can also be seen with trees of the Boreal region where the percentage of discoloured trees fell significantly by 2.2 percent points. This improvement is comparable with the Sub-Atlantic region. Decreasing percentages of discoloured trees were also found in the Boreal (temperate) and Atlantic (north) regions (-1.8 and -1.4 percent points, respectively). A deterioration of forest condition in terms of discolouration occurred in the Atlantic (south), Mountainous (north) and both Mediterranean climatic regions. However, in all these regions the changes lie below 1 percent point and are not statistically significant.

Table 3.1.7.2-1: Changes in the percentages of damaged trees ($\Delta\ p$) and mean defoliation ($\Delta\ d$) of the CSTs from 1994 to 1995

Climatic region	No. of CSTs n	Percentage of damaged trees p_{94}	p_{95}	$\Delta\ p$	Mean defoliation d_{94}	d_{95}	$\Delta\ d$
Boreal	5413	10.4	12.7	2.3 *	13.0	13.8	0.8 *
Boreal (temperate)	8428	21.3	17.6	-3.7 *	19.1	18.5	-0.6 *
Atlantic (north)	5567	16.3	18.5	2.2 *	15.9	17.1	1.2 *
Atlantic (south)	5321	6.1	7.6	1.5 *	9.1	10.4	1.3 *
Sub-atlantic	25935	42.2	42.1	-0.1	25.8	25.9	0.1 *
Continental	4487	36.5	37.0	0.5	24.4	25.5	1.1 *
Mountainous (north)	2458	24.6	26.2	1.6	19.2	19.9	0.7 *
Mountainous (south)	16122	21.7	23.3	1.6 *	18.0	19.2	1.2 *
Mediterr. (lower)	12574	14.5	21.3	6.8 *	15.3	19.4	4.1 *
Mediterr. (higher)	7788	20.8	25.1	4.3 *	18.7	20.6	1.9 *
All regions	94093	25.2	26.8	1.6 *	19.4	20.5	1.1 *

* significant at the 95% probability level



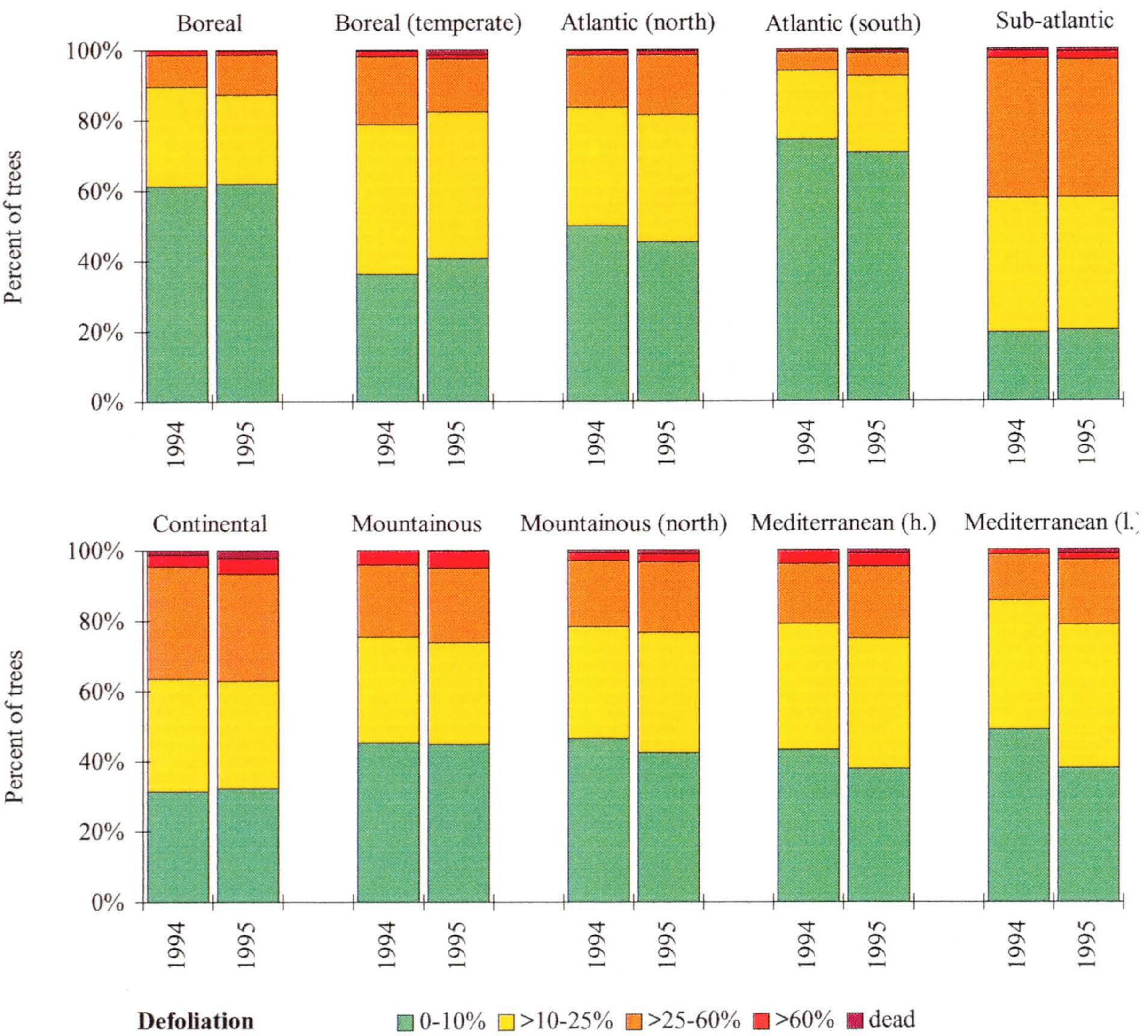
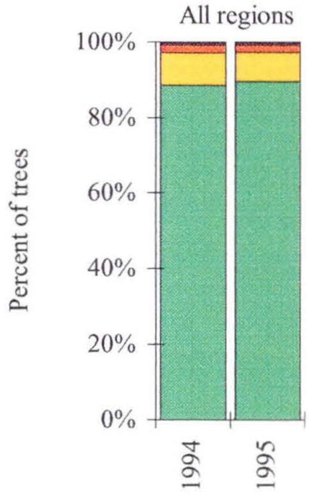


Figure 3.1.7.2-1: Percentages of defoliation of the Common Sample Trees in 1994 and 1995 for each of 10 climatic regions and for the total sample of CSTs

Table 3.1.7.2-2: Changes in the percentages of discoloured trees (Δ *p*) of the CSTs from 1994 to 1995

Climatic region	No. of CSTs n	Percentage of discoloured trees p_{94}	p_{95}	Δp
Boreal	5413	5.7	3.5	-2.2 *
Boreal (temperate)	8428	4.8	3.1	-1.7 *
Atlantic (north)	5567	13.4	14.8	-1.4 *
Atlantic (south)	5321	6.7	7.5	0.8
Sub-atlantic	25935	8.2	5.9	-2.3 *
Continental	4487	19.6	16.5	-3.1 *
Mountainous (north)	2458	5.5	6.4	0.9
Mountainous (south)	16122	13.9	13.0	-0.9 *
Mediterr. (lower)	12574	17.0	17.8	0.8
Mediterr. (higher)	7788	16.1	16.2	0.1
All regions	94093	11.4	10.5	0.9 *

* significant at the 95% probability level



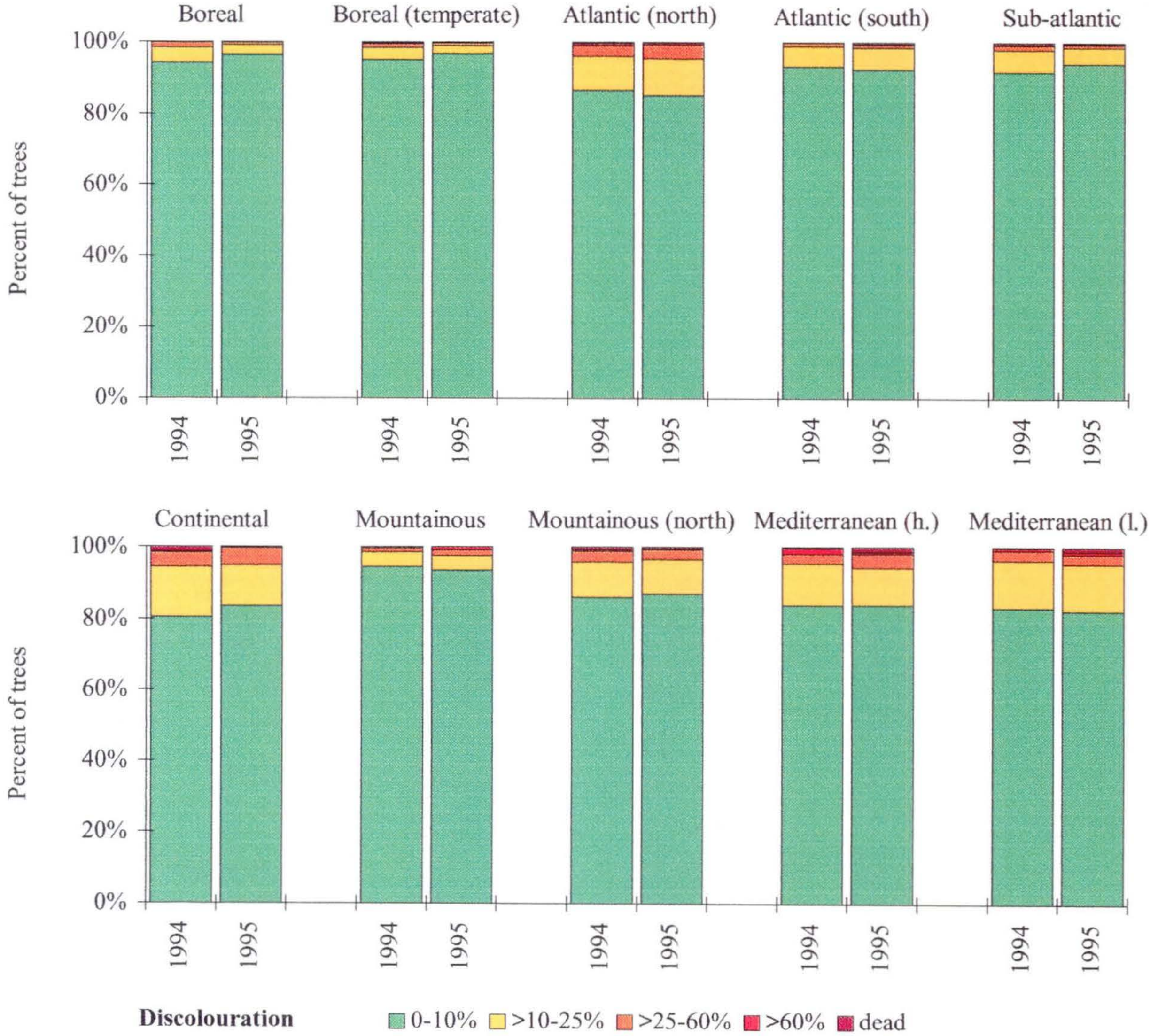


Figure 3.1.7.2-2: Percentages of discolouration of the Common Sample Trees in 1994 and 1995 for each of 10 climatic regions and for the total sample of CSTs

3.1.7.3 Changes in defoliation and discolouration by species group

The differences in defoliation and discolouration between the CSTs in 1994 and 1995 according to species groups are shown in Table 3.1.7.3-1.

The CSTs as a whole showed a significant worsening in **defoliation**. The share of damaged CSTs increased from 25.2% in 1994 to 26.8% in 1995. In the coniferous CSTs the respective proportion increased slightly, namely from 26.7% to 27.3%. In the broadleaved CSTs the proportion of trees defoliated more than 25% rose from 23.2% to 26.2%.

Some of the species among the **broadleaved CSTs** showed a remarkable deterioration, as expressed by the shares of damaged trees. The crown condition of *Quercus ilex, Quercus suber* and *Eucalyptus* spp. deteriorated notably. The share of damaged *Quercus ilex* trees rose from 13.1% to 29.5%. The respective proportion of *Quercus suber* increased from 14.2% to 25.5%. The proportion of damaged *Eucalyptus* spp. increased from 3.2% to 8.0%. However, this species still has shown the lowest damage patterns in the Mediterranean area. A decrease in defoliation only occurred among *Castanea sativa*, the damaged share of which diminished from 17.5% to 15.2%. The proportion of damaged *Betula* spp. remains the same, namely 22.0%.

As in the previous years, the rapid changes in vitality among the principal Mediterranean species *Quercus ilex, Quercus suber* and *Eucalyptus* spp. should be interpreted in connection with typical detrimental events in the Mediterranean region, such as drought and fire, especially if only small percentages of trees are affected. Though large, these changes have less influence on the result for the total broadleaves, due to the low numbers of CSTs among these species groups.

The deciduous *Quercus* spp., with 12 080 trees, represented the largest number of broadleaved CSTs. Consequently, their only little increase in the proportion of damaged trees from 30.3% to 30.9% diminished the increase for the broadleaved CSTs, but has great influence on their high damage percentage. Also of influence were *Fagus* spp. (9 439 trees) and other broadleaves (7 263 trees) with an increase in damaged trees from 19.7% to 22.8% and 26.8% to 28.5%, respectively.

The species groups of the **coniferous CSTs** experienced mostly slight changes in defoliation from 1994 to 1995, except other conifers (only 893 trees), whose share of damaged trees increased notably from 21.2% to 29.0%, and *Larix* spp., which showed an increase from 16.0% to 19.5%. *Abies* spp. showed a slight decrease, but nevertheless with the highest percentage of damaged trees in 1994 and 1995, both among the conifers and the broadleaves. However, with 2 207 trees, *Abies* spp. had only little influence on the total coniferous result, which is dominated mainly by *Pinus* spp. with 30 482 trees and *Picea* spp. with 18 651 trees. *Pinus* spp. showed no change since 1994 in the proportion of damaged trees (25.7%). For *Picea* spp., a slight increase in the share of damaged trees from 28.5% to 29.8% was found. The proportion of damaged coniferous CSTs increased from 26.7% to 27.3% mainly as a result of the deterioration of these most comprehensive species groups.

In the conifers and in the broadleaves there was an overall lower **discolouration** in 1995 than in 1994. As in the previous year, some species groups deteriorated over the period (1994-1995), but the most improved, especially in the conifers.

Among the **broadleaved CSTs**, the share of discoloured *Quercus ilex* (discolouration classes 1-4) increased from 6.4% to 9.1%. In contrast, the respective proportion of *Quercus* (dec.) spp. decreased from 17.6% to 14.7%. Further obvious increases in discolouration occurred in *Eucalyptus* spp. (from 9.3% to 11.7%). Other notable decreases in discolouration were found in other broadleaves (from 12.9% to 11.1%) and *Castanea sativa* (from 19.0% to 17.9%), which, however, comprise only small numbers of CSTs. The total result of the broadleaved CSTs, was dominated by the improvement of deciduous *Quercus* spp. and the small changes of *Fagus* spp., which accounted for more than half of the broadleaved CSTs with 12 080 and 9 439 trees, respectively.

The discolouration among the **coniferous CSTs** improved for the total and for all species groups, with exception of other conifers, which increased from 9.4% to 21.7%. *Abies* spp. decreased notably from 21.7 % to 18.6%.

Table 3.1.7.3-1: Percentages of the Common Sample Trees in different defoliation and discol- ouration classes in 1994 and 1995 by species group

Species Group	Defoliation						Discolouration		No. of trees
	0-10%		>10-25%		>25%		>10%		
	1994	1995	1994	1995	1994	1995	1994	1995	
Castanea sativa	68.4	60.5	14.1	24.3	17.5	15.2	19.0	17.9	1331
Eucalyptus spp.	81.4	73.8	15.4	18.2	3.2	8.0	9.3	11.7	984
Fagus spp.	44.4	39.4	35.9	37.8	19.7	22.8	9.9	10.4	9439
Quercus (dec.) spp.	34.5	33.1	35.2	36.0	30.3	30.9	17.6	14.7	12080
Quercus ilex	33.4	20.2	53.5	50.3	13.1	29.5	6.4	9.1	2975
Quercus suber	41.3	22.3	44.5	52.2	14.2	25.5	6.8	7.1	1516
Betula spp.	43.6	46.0	34.4	32.0	22.0	22.0	3.9	4.1	3790
Carpinus spp.	43.5	41.5	32.5	33.6	24.0	24.9	12.2	11.7	1534
Other broadleaves	43.3	40.4	29.9	31.1	26.8	28.5	12.9	11.1	7263
Total broadleaves	42.0	37.9	34.8	35.9	23.2	26.2	12.1	11.3	40912
Abies spp.	40.3	38.4	27.6	29.7	32.1	31.9	21.7	18.6	2207
Larix spp.	56.8	54.6	27.2	25.9	16.0	19.5	7.4	5.1	948
Picea spp.	39.1	39.2	32.4	31.0	28.5	29.8	8.1	6.6	18651
Pinus spp.	37.3	35.7	37.0	38.6	25.7	25.7	11.5	10.6	30482
Other conifers	45.1	37.0	33.7	34.0	21.2	29.0	9.4	21.7	893
Total conifers	38.6	37.4	34.7	35.3	26.7	27.3	10.8	9.8	53181
Total	40.0	37.6	34.8	35.6	25.2	26.8	11.4	10.4	94093

3.1.8 Changes in defoliation since 1988

A separate sample of trees common to the years 1988-1995 was defined in order to study the trends in forest condition over a longer period (similar to the Common Sample Trees (CSTs) of 1994 and 1995 in Chapter 3.1.7). Commencing this time series in 1987 would have resulted into a far lower number of common trees. Of the total tree sample, 27 933 trees common to all surveys from 1988 to 1995 were found.

The evaluation was carried out specieswise both for the total number of common trees and for the individual regions. Only the ten most common species, each of which comprised more than 800 common trees were evaluated, supplemented by *Abies alba* and *Picea sitchensis*. These 2 species had lower tree numbers and were not to be included according to their importance in particular regions, especially in the Mountainous (south) and in the Atlantic (north) region. As in the previous surveys, no evaluation was made for those regions in which the number of trees of a certain species was lower than 100. No common trees since 1988 existed in the Boreal, the Boreal (temperate) and the Continental region.

For the period from 1988-1995 19 165 trees were selected according to the selection criteria described above. The 12 species, their numbers of trees in each of the remaining 6 climatic regions as well as their total number for the 6 regions are listed in Table 3.1.8-1. The defoliation for each of the 12 species is tabulated for each region in Annex I-9.

The development of the defoliation for 12 selected tree species is described in detail in the following chapters 3.1.8.1 - 3.1.8.12. Special emphasis is laid on the proportions of trees in defoliation classes 2-4, which have been called "damaged". The development of defoliation over time is displayed by graphics for all trees and those regions with at least 100 trees of the respective species.

Table 3.1.8-1: Numbers of trees common to the surveys from 1988 to 1995, by species and climatic region. Tree numbers in brackets are lower than 100 and represent samples too small for regional evaluations.
Due to corrections of the Forest Condition database made in 1994, especially in the species codes, numbers of trees in some species groups and in the total of the CSTs of 1988-1995 (in comparison to 1988-1994) increased.

Species	Atlantic (north)	Atlantic (south)	Sub-atlantic	Moun-tainous (south)	Mediterr. (lower)	Mediterr. (higher)	No. of trees	[%]
Picea abies	438	(29)	1610	1208	(88)	(1)	3374	17.6
Pinus sylvestris	559	107	997	674	116	588	3041	15.9
Fagus sylvatica	380	111	916	459	388	346	2600	13.6
Quercus ilex	(0)	(24)	(0)	105	1210	584	1923	10.0
Pinus pinaster	(0)	279	(0)	(74)	1130	272	1755	9.2
Pinus halepensis	(0)	(0)	(0)	(8)	1010	241	1259	6.6
Quercus suber	(0)	(3)	(0)	(0)	1214	(32)	1249	6.5
Pinus nigra	(20)	(6)	(40)	285	256	642	1249	6.5
Quercus robur	291	188	294	121	(29)	(52)	975	5.1
Quercus petraea	(39)	(75)	492	147	(61)	113	927	4.8
Abies alba	(21)	(8)	230	281	(13)	(26)	579	3.0
Picea sitchensis	231	(0)	(3)	(0)	(0)	(0)	234	1.2
							19165	100.0

Figure 3.1.8-1a shows the development of the defoliation of the total common tree sample (27 933 trees). The share of trees defoliated more than 25% continuously increased from 8.2% in 1988 to 17.3% in 1992. After a small decrease to 15.6% in 1993, the respective share reached its highest level in 1995 with 22.2%.

The development of defoliation for the different climatic regions are presented in Figure 3.1.8-1b. Table 3.1.8-2 shows numerical details.

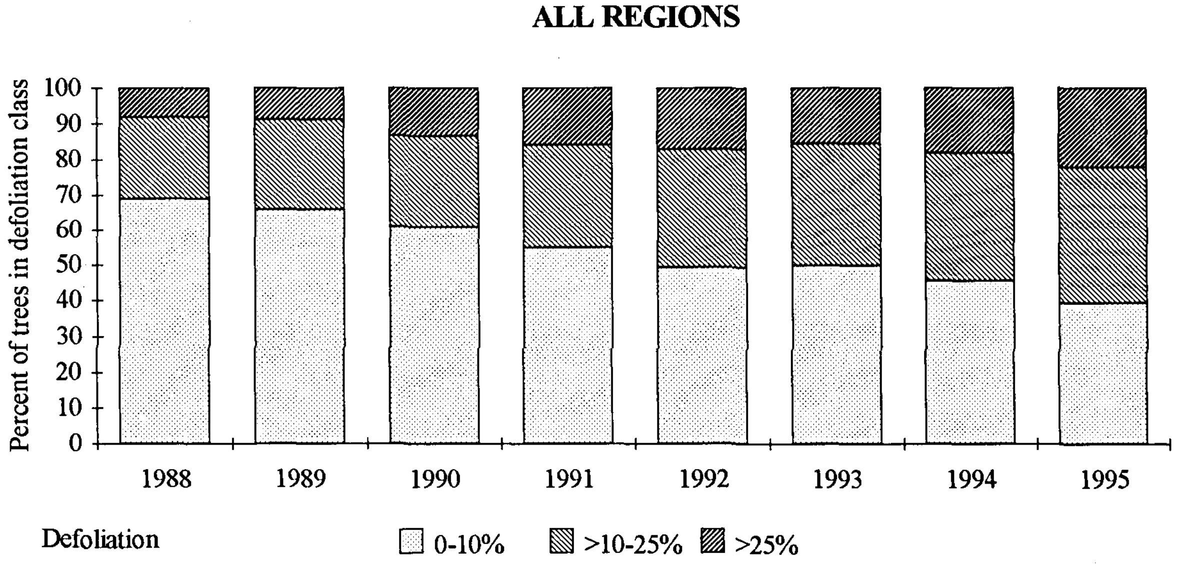


Figure 3.1.8-1a: Defoliation of all Common Sample Trees from 1988-1995

Table 3.1.8-2: Defoliation of all Common Sample Trees and for the different climatic regions from 1988-1995

All species

ATLANTIC (NORTH)	0-10%	11-25%	>25%
1988	59.4	30.6	10.0
1989	47.8	36.5	15.7
1990	49.2	34.2	16.6
1991	46.7	34.6	18.7
1992	43.2	37.9	18.9
1993	40.0	36.2	23.8
1994	39.3	36.3	24.4
1995	36.7	37.7	25.6

ATLANTIC (SOUTH)	0-10%	11-25%	>25%
1988	85.2	11.1	3.7
1989	83.3	11.2	5.5
1990	76.7	13.3	10.0
1991	73.9	15.1	11.0
1992	76.7	16.6	6.7
1993	72.6	19.4	8.0
1994	72.0	22.5	5.5
1995	65.7	25.4	8.9

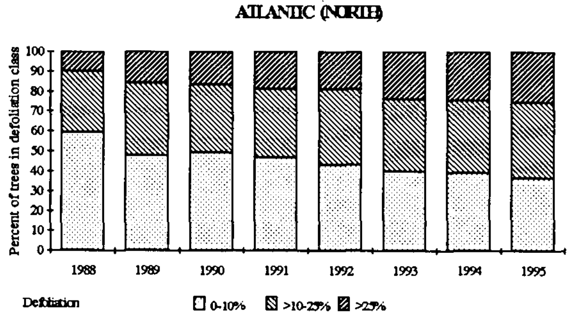
SUB-ATLANTIC	0-10%	11-25%	>25%
1988	53.6	33.1	13.3
1989	51.8	34.9	13.3
1990	50.0	34.5	15.5
1991	43.6	35.2	21.2
1992	39.9	38.3	21.8
1993	44.1	34.9	21.0
1994	36.1	39.6	24.3
1995	36.5	38.3	25.2

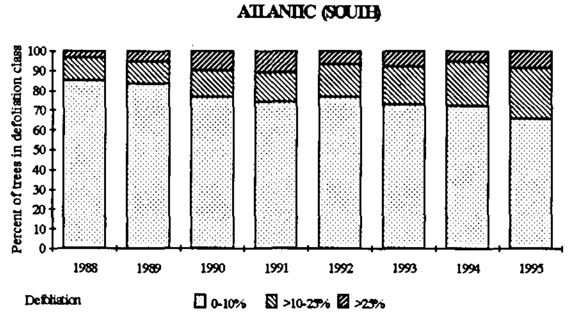
MOUNTAIN-OUS (SOUTH)	0-10%	11-25%	>25%
1988	62.3	27.2	10.5
1989	63.6	25.7	10.7
1990	58.9	28.1	13.0
1991	56.7	28.4	14.9
1992	50.2	32.3	17.5
1993	49.9	33.1	17.0
1994	47.1	32.4	20.5
1995	45.2	35.4	19.4

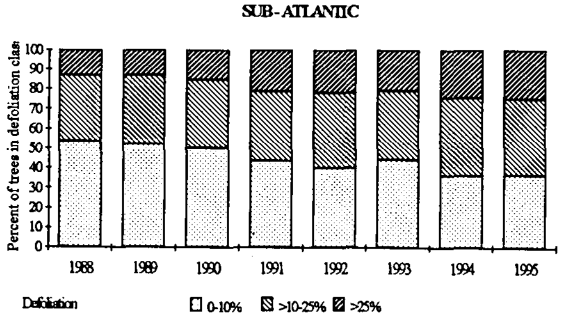
MEDITERR. (LOWER)	0-10%	11-25%	>25%
1988	79.6	16.1	4.3
1989	75.0	20.9	4.1
1990	65.5	20.3	14.2
1991	57.7	26.7	15.6
1992	50.9	33.2	15.9
1993	54.2	36.6	9.2
1994	49.4	38.4	12.2
1995	35.7	44.0	20.3

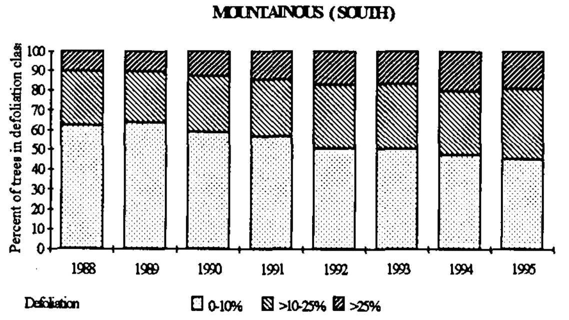
MEDITERR. (HIGHER)	0-10%	11-25%	>25%
1988	72.0	20.1	7.9
1989	71.4	20.6	8.0
1990	67.2	22.6	10.2
1991	59.3	28.3	12.4
1992	50.4	32.6	17.0
1993	46.6	36.1	17.3
1994	42.9	36.2	20.9
1995	35.8	36.9	27.3

ALL REGIONS	0-10%	11-25%	>25%
1988	68.9	22.9	8.2
1989	65.9	25.2	8.9
1990	60.9	25.6	13.5
1991	55.0	29.0	16.0
1992	49.3	33.4	17.3
1993	49.8	34.6	15.6
1994	45.6	36.1	18.3
1995	39.3	38.5	22.2









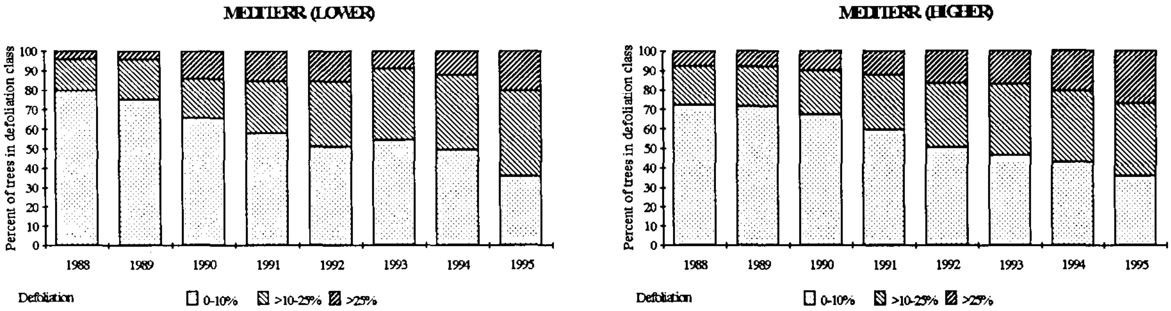


Figure 3.1.8-1b: Defoliation of the Common Sample Trees from 1988-1995

3.1.8.1 Picea abies

Picea abies represented the largest share of all common trees since 1988. It is the species with the highest number of common trees in the Sub-Atlantic and the Mountainous (south) region. A smaller amount of trees was evaluated in the Atlantic (north) region.

Considering the sample of all regions, the proportion of damaged common *Picea abies* trees has increased gradually from 1988 to 1992. After a slight improvement in 1993 an increase from 21.4% to 25.6% occurred in 1994. In 1995 the value decreased again to the state of 1992. According to the largest shares of common *Picea abies* trees this result is similar to those for the Sub-atlantic and Mountainous (south) regions.

The share of trees damaged in the Atlantic (north) region showed a rather constant level of defoliation from 1988 to 1992. In 1993, there was a remarkable increase in the proportion of damaged trees in contrast to the other regions evaluated. This increase continued from 29.5% to 33.6% in 1994 and decreased again in 1995 (30.4%). However, this region still showed the highest percentage of damaged *Picea abies* trees of the 3 regions evaluated.

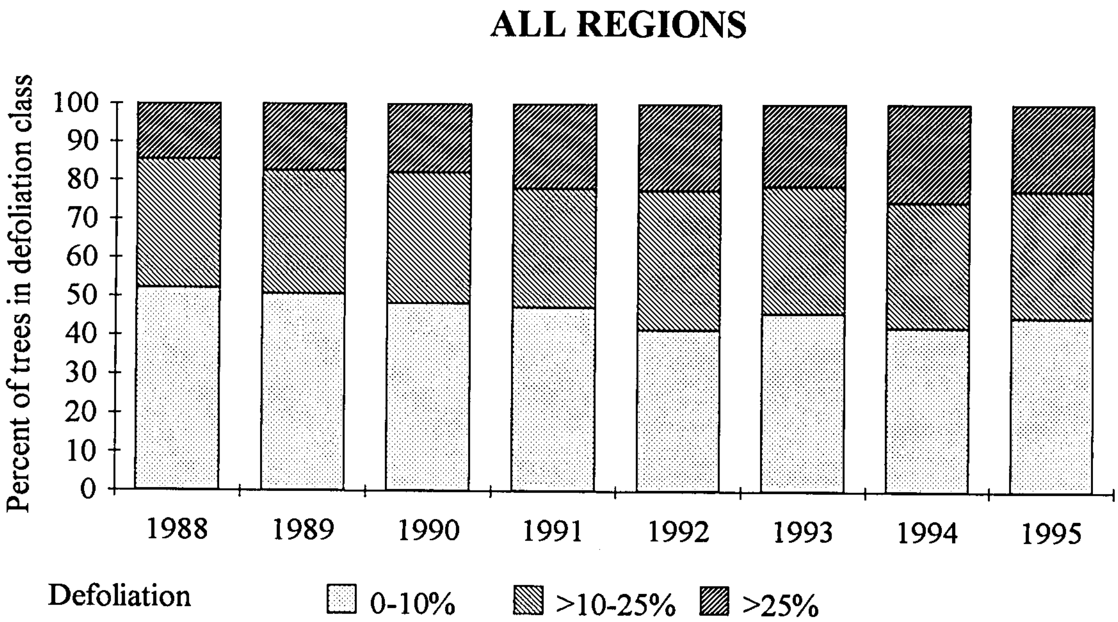


Figure 3.1.8.1-1a: Defoliation of *Picea abies* from 1988-1995

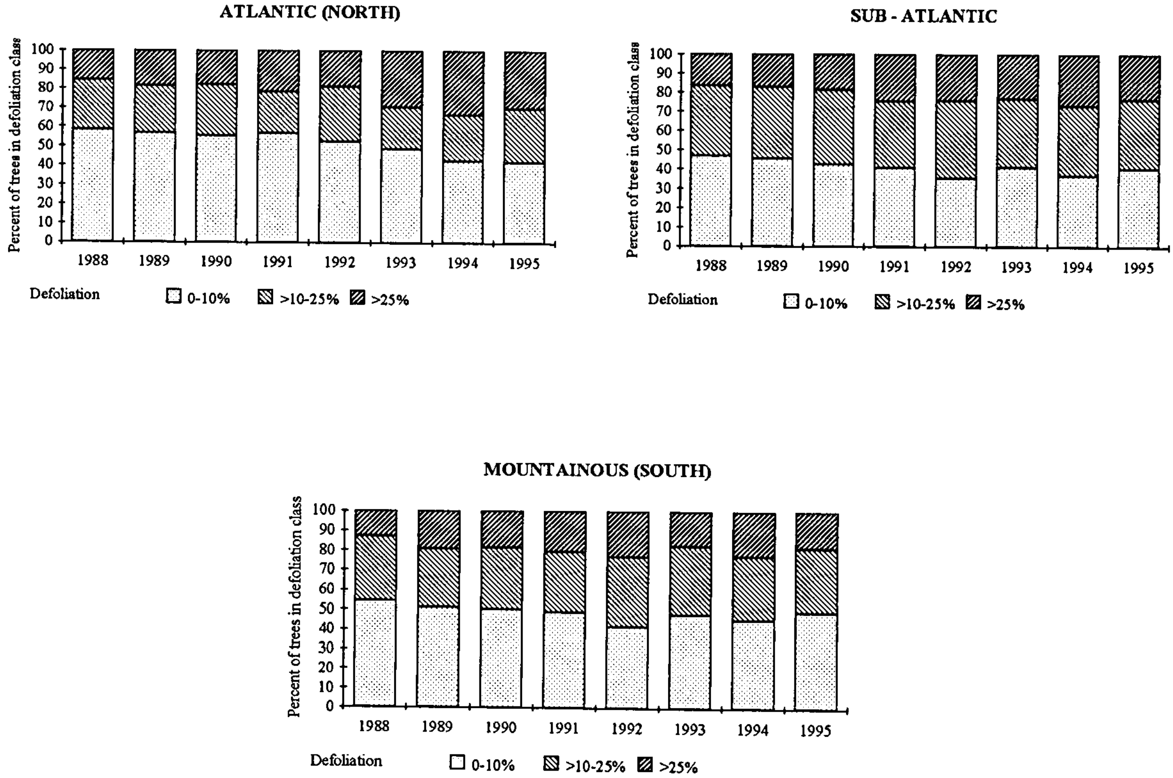


Figure 3.1.8.1-1b: Defoliation of *Picea abies* from 1988-1995

3.1.8.2 Pinus sylvestris

Pinus sylvestris, which was evaluated in all climatic regions has its largest proportion in the Sub-Atlantic region. This species represented the second largest share of the common sample.

The proportion of damaged common *Pinus sylvestris* trees in the total sample, which comprises all regions, increased gradually from 7.9% in 1988 to its highest value of 21.0% in 1994. In 1995 it decreased to nearly the state of 1993 (15.6%). Among the various climatic regions great differences in the development of defoliation were found, however, with exception of the Atlantic (south) and the Mediterranean (higher), in all regions the share of damaged trees increased until 1994 and decreased again in 1995. In the Mediterranean (higher) region the increase continued until 1995 and in the Atlantic (south) the percentage of damaged trees were waving for the last 8 years.

The increase in the share of damaged trees was most obvious in the Sub-Atlantic, Mountainous (south) and Mediterranean (lower) regions. In the Sub-Atlantic region, the respective share was highest during the total period of observation. It increased gradually from 11.4% in 1988 to 24.6% in 1991. After a decrease in 1992 it increased again from 19.4% in 1993 to 29.8% in 1994. In 1995 it increased again (22.7%). In the Mountainous (south) region the share of damaged trees rose clearly from 3.0% in 1989 to 23.6% in 1994 and decreased sharply in 1995 (11.9%). In the Mediterranean (lower) region, a continuous increase started in 1989 from 0.9% to the maximum of 19.0% in 1994. It decreased strongly in 1995 to 6.9%.

In the Mediterranean (higher) region the share of damaged trees remained at a relatively low level in comparison to the other regions, but it increased steadily from 5.8% in 1989 to 17.5% in 1995. Therefore it is the only region where *Pinus sylvestris* showed continuous worsening until 1995.

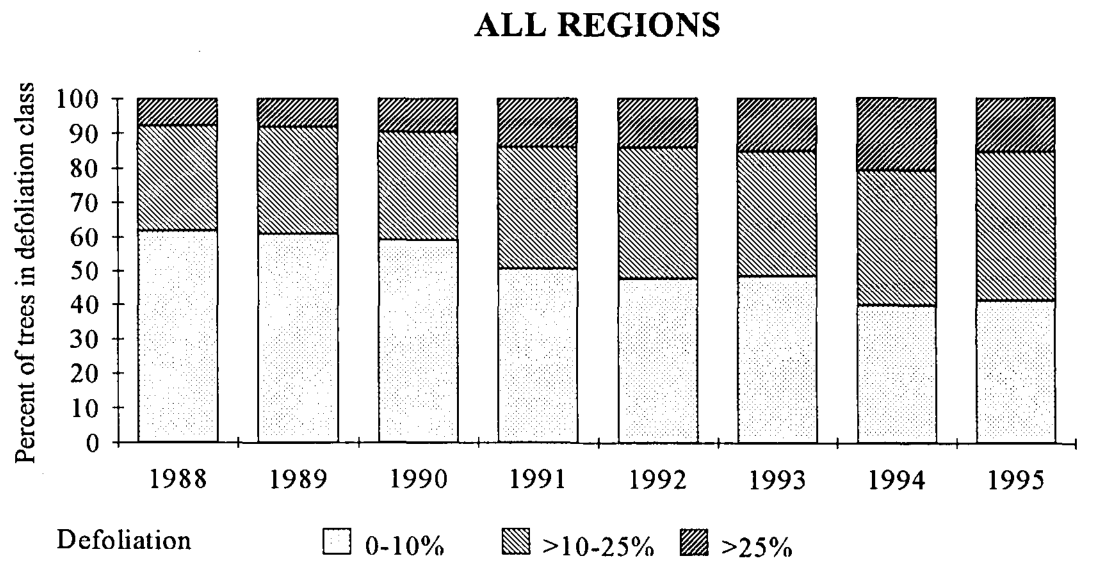


Figure 3.1.8.2-1a: Defoliation of *Pinus sylvestris* from 1988-1995

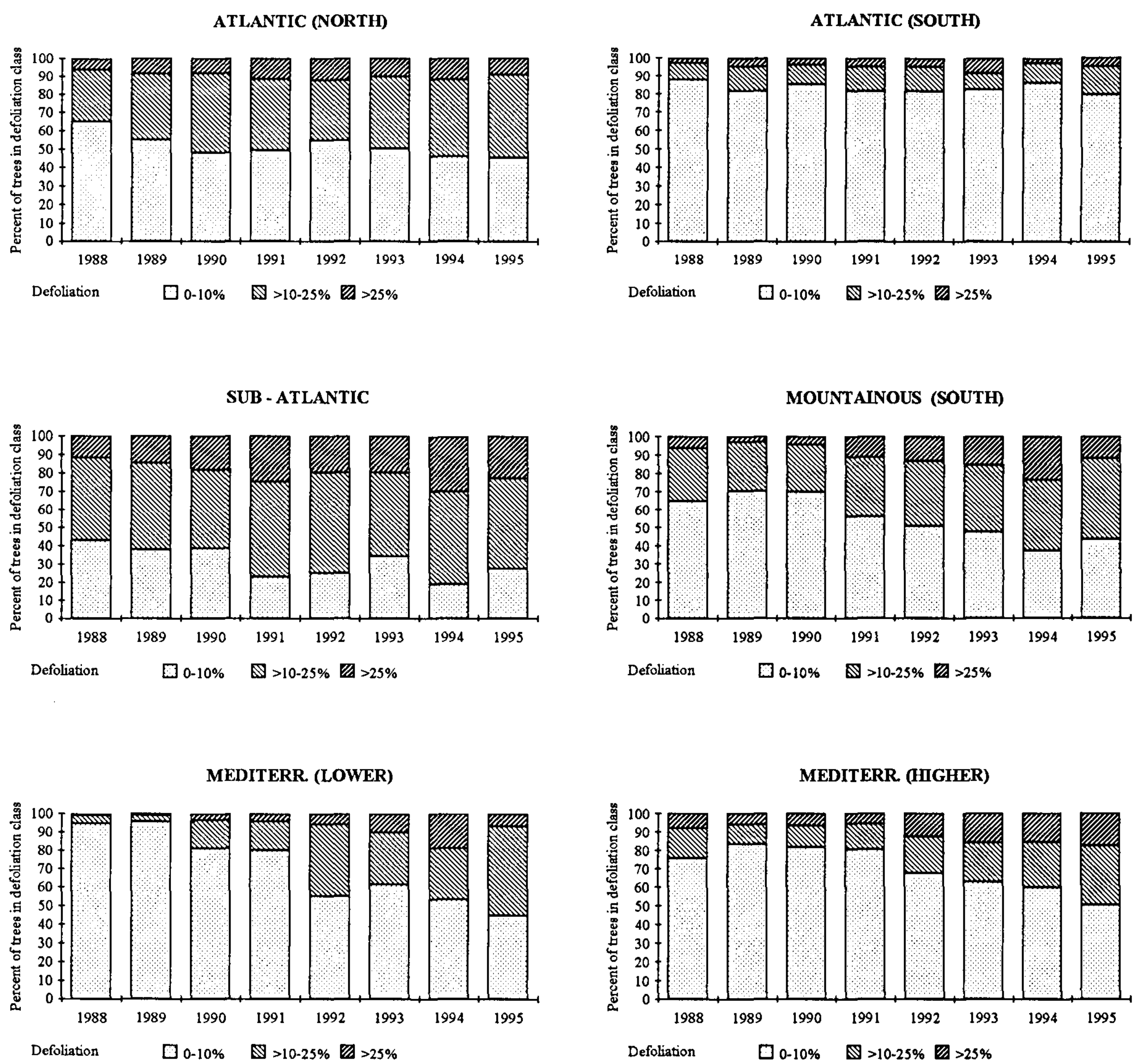


Figure 3.1.8.2-1b: Defoliation of *Pinus sylvestris* from 1988-1995

3.1.8.3 Fagus sylvatica

Representing the third largest sample within the common trees, *Fagus sylvatica* was evaluated in all climatic regions. The largest share of this species was found in the Sub-Atlantic region.

The proportion of damaged common *Fagus sylvatica* trees in the total sample of all regions increased from 10.3% in 1988 to 26.1% in 1995. A maximum was reached with 20.8% in 1992. In all regions, this increase in the damaged share was to be observed, though to a differing extent. Especially in 1995 a drastic deterioration occurred in comparison to previous years, with the exception of the Mediterranean (lower) region, which showed relatively small damage percentages, even improving in 1995.

The Sub-Atlantic region with the largest share of *Fagus sylvatica* trees mainly influenced the development of the whole sample. In this region, the share of damaged trees increased continuously from 12.4% in 1989 to 31.7% in 1992, and decreased to 23.3% in 1994. In 1995 an increase of 8% to 31.3% occurred. During the period of observation, the Sub-Atlantic and the Atlantic (north) region had far higher shares of damaged trees than the others. The defoliation in the Atlantic (north) region showed a sharp increase from 14.6% in 1988 to the maximum of 36.3% in 1990. After a decrease to 24.7% in 1991, the share of damaged trees remained at a high level of 29.2% and 28.2% in 1992 and 1993, respectively. In 1994, a decrease to 26.2% was found, followed by an increase to an absolute maximum of 40.8% in 1995. This represented the highest percentage of damaged *Fagus sylvatica* trees in 1995.

In 1988 and 1989, no damaged *Fagus sylvatica* trees were found in the Atlantic (south) region, and in the Mediterranean (lower) region only a small number of damaged trees were present. It increased in 1990/1991 to 9.0%. In 1994, the respective share decreased clearly from 7.2% to 5.4%. The highest percentage of damaged trees in the Atlantic (south) region was reached in 1995 with 16.2%. In the Mediterranean (lower) region the percentage of damaged trees increased from 1.0% in 1989 to 9.5% in 1994. In 1995 it decreased slightly to 7.2%. In the Mediterranean (higher) region the percentage of damaged trees increased steadily from 3.4% in 1988 to 14.5% in 1994. In 1995 it reached its highest value with 25.4%. The smallest increase between 1988 and 1994 and a relatively low percentage of damaged trees, ranging between 5.7% (1991) and 12.4%, was observed in the Mountainous (south) region. But in 1995 the share of damaged trees increased strongly to 22.4%.

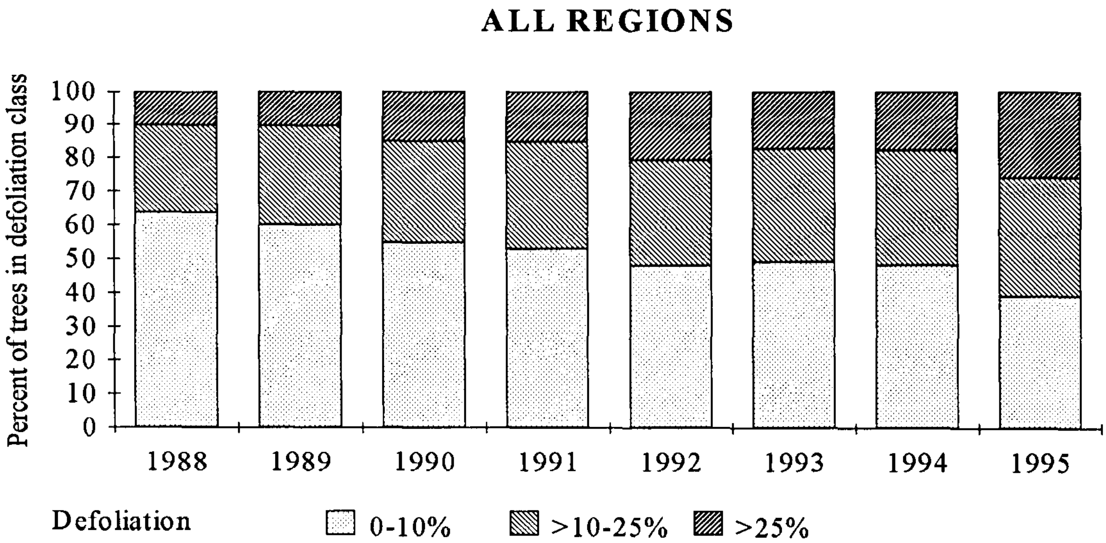


Figure 3.1.8.3-1a: Defoliation of *Fagus sylvatica* from 1988-1995

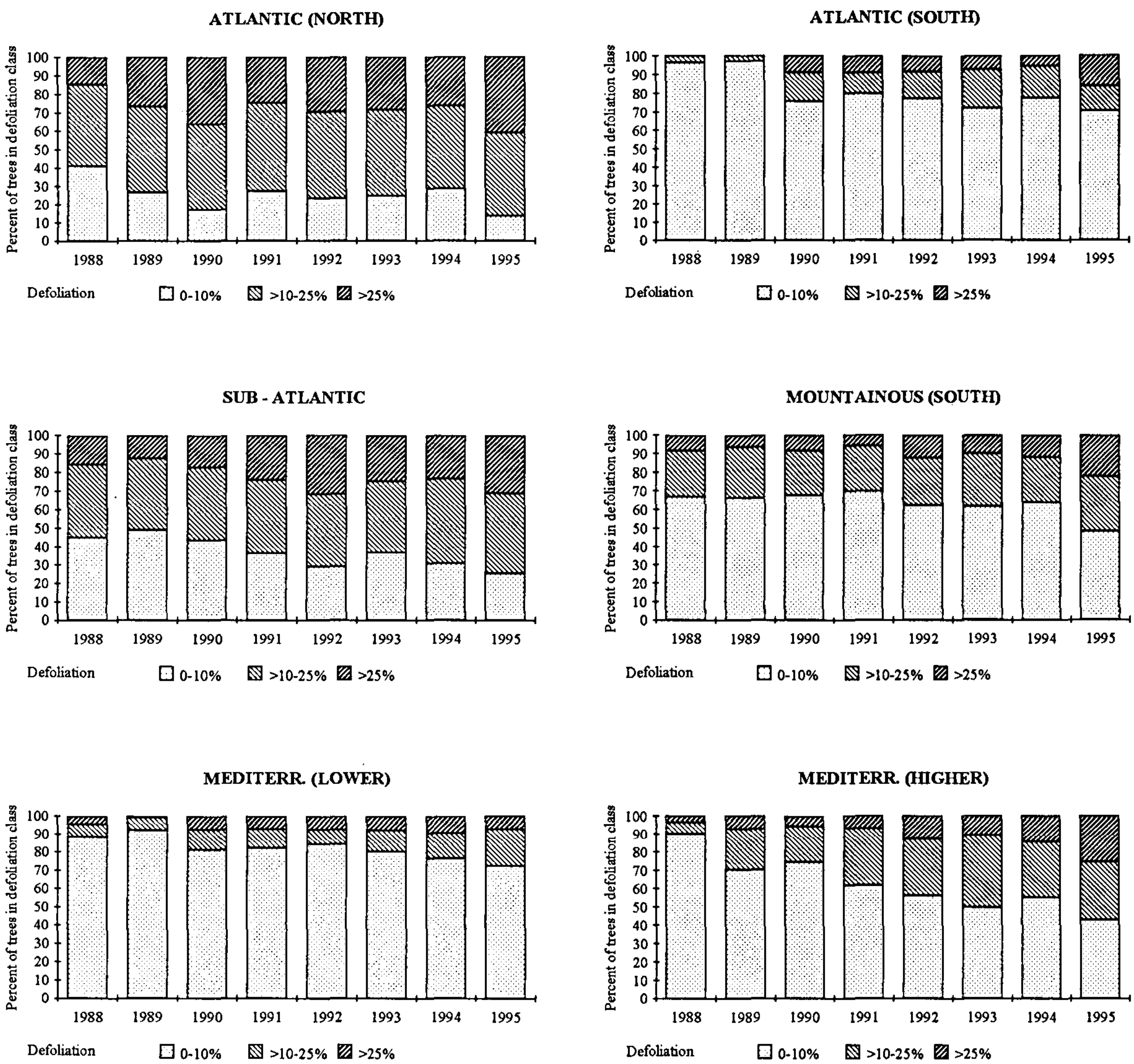


Figure 3.1.8.3-1b: Defoliation of *Fagus sylvatica* from 1988-1995

3.1.8.4 Quercus ilex

The largest amount of the common *Quercus ilex* trees was evaluated in the Mediterranean (lower) region. A further sample was investigated in the Mediterranean (higher) and a smaller amount in the Mountainous (south) region.

The changes in defoliation of the common *Quercus ilex* trees in the total sample of all regions until 1994 was characterized by shifts of trees between defoliation classes 0 and 1. From 1988 to 1990 the proportion of trees in defoliation class 0 increased from 62.2% to 76.3%. Accordingly, at the same time the share of class 1 decreased from 31.8% to 20.5%. This improvement in crown condition turned into a deterioration after 1990. The share of defoliation class 0 dropped to 57.6% in 1991 and continued its decrease to 15.2% in 1995. The share of trees in class 1 simultaneously increased to 57.3% in 1994 after a jump to 38.3% in 1991. As a result, the share of damaged trees remained at a low level until 1994, ranging between 3.1% in 1989 and 8.0% in 1992. After a slight improvement in 1993 the respective percentage increased sharply to 14.4% in 1994 and to 32.3% in 1995. The overwhelming proportions of sample trees in the Mediterranean (lower) and in the Mediterranean (higher) region strongly determined the development of the total common sample, which was therefore similar to the two Mediterranean samples.

The defoliation of *Quercus ilex* in the Mountainous (south) climatic region developed rather irregularly compared with the Mediterranean regions. The share of damaged *Quercus ilex* trees in the Mountainous (south) region showed a very sharp increase from 2.9% in 1988 and 1989 to 24.8% in 1990. After a remarkable decrease to 9.5% in 1991 the damaged sample jumped to 31.4% in 1992 and decreased again to 18.1% in 1993. After a sharp increase to 33.3% in 1994, the current survey presented no changes in the percentage of damaged trees, which is the highest proportion of damaged *Quercus ilex* trees of the three regions in 1994 and 1995.

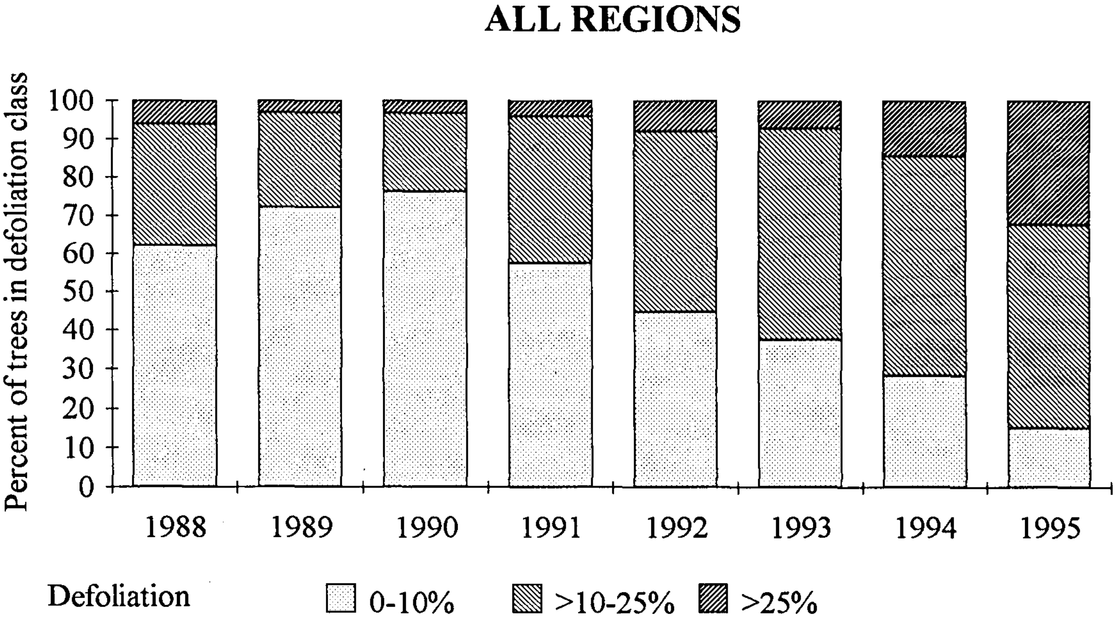


Figure 3.1.8.4-1a: Defoliation of *Quercus ilex* from 1988-1995

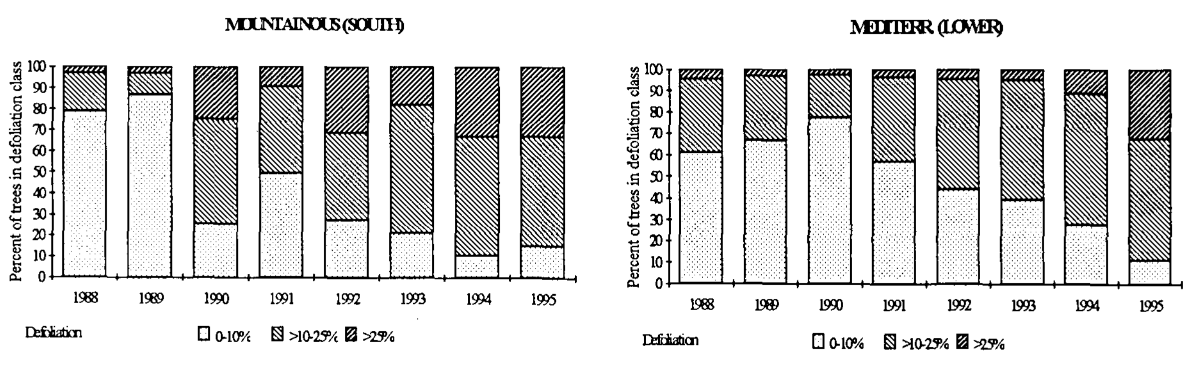


Figure 3.1.8.4-1b: Defoliation of *Quercus ilex* from 1988-1995

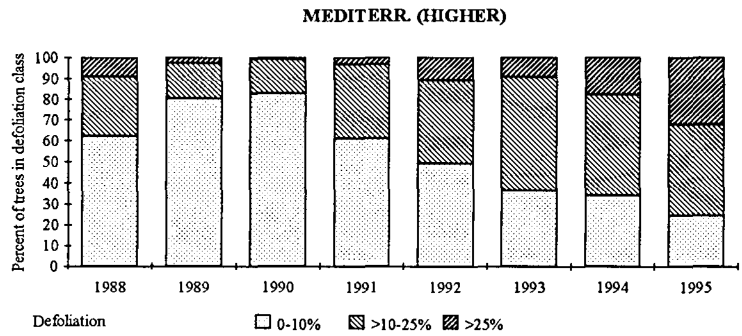


Figure 3.1.8.4-1c: Defoliation of *Quercus ilex* from 1988-1995

3.1.8.5 Pinus pinaster

As in the previous year, *Pinus pinaster* had its highest amount of common trees in the Mediterranean (lower) region. Evaluations were also made in the Mediterranean (higher) and Atlantic (south) regions.

In 1990, an obvious increase of the damaged share of common *Pinus pinaster* trees occurred in all regions from 5.9% in 1989 to 10.9%. After that, the respective percentage decreased to 7.7% in 1993. In 1994, an increase to 8.3% was observed, which was continued in 1995 (10.1%). This trend was greatly determined by that in the Mediterranean (lower) region, but it is also influenced by the very unsteady development of the small share in the Atlantic (south) region, especially in 1990 and 1991. The increase of damaged trees in 1994 and 1995 seems to be mainly influenced by the respective share in the Mediterranean (higher) region. In the Mediterranean (lower) region, a slight and continuous increase occurred from 5.8% in 1989 to 7.3% in 1992. After a decrease in 1993 to 7.1% the percentage of damaged trees rose to 9.6% in 1995. A slight and continuous increase was also found in the Mediterranean (higher) region from 2.9% in 1988 to 10.3% in 1995, interrupted by a little decrease from 4.8% in 1990 to 4.0% in 1991.

Quite a different development of the proportion of damaged trees was observed in the Atlantic (south) region. Here, a very sharp increase from 1.4% in 1988 to the maximum of 31.9% in 1990 occurred, followed by a remarkable decrease to 9.3% in 1992. Another slight decrease followed in 1993/1994 and 1995 with 7.5% and 7.2% of trees damaged, respectively.

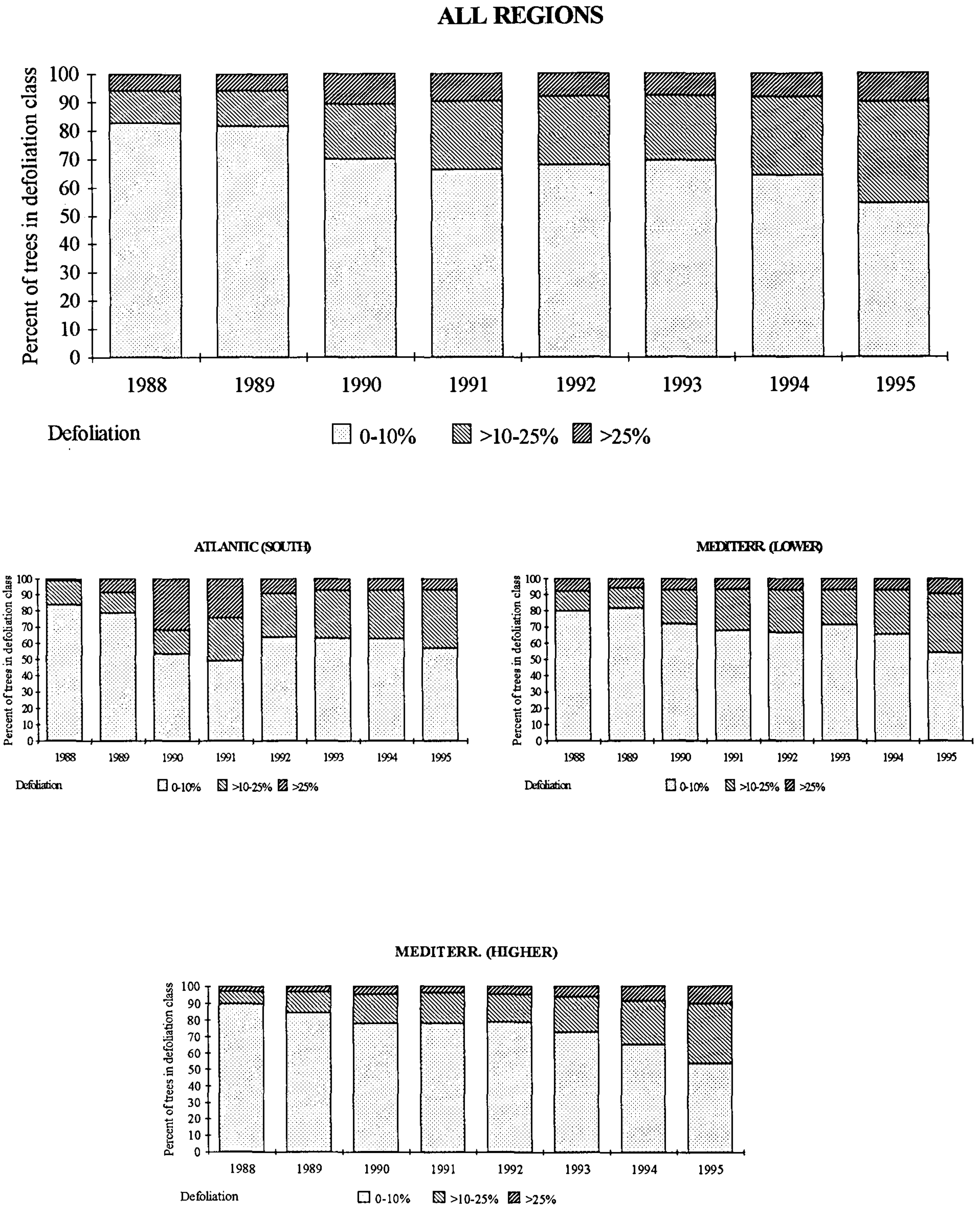


Figure 3.1.8.5-1: Defoliation of *Pinus pinaster* from 1988-1995

3.1.8.6 Pinus halepensis

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

The proportion of damaged common *Pinus halepensis* trees of the total sample including all regions remained at a low level until 1991 (2.7%), then jumped to 9.6% in 1992. After a very slight decrease in 1993, it increased again in 1994 (16.9%) and reached by far its highest peak with 24.8% in 1995. The development of the total common sample corresponds to that 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 5.7% in 1988 to 3.0% in 1989, remaining roughly at this level until 1991 and then increasing clearly to 11.0% in 1992 and dramatically from 10.7% in 1993 to 19.8% in 1994 and 26.3% in 1995. A similar development of the share of damaged trees was found in the Mediterranean (higher) region, although at a far lower level.

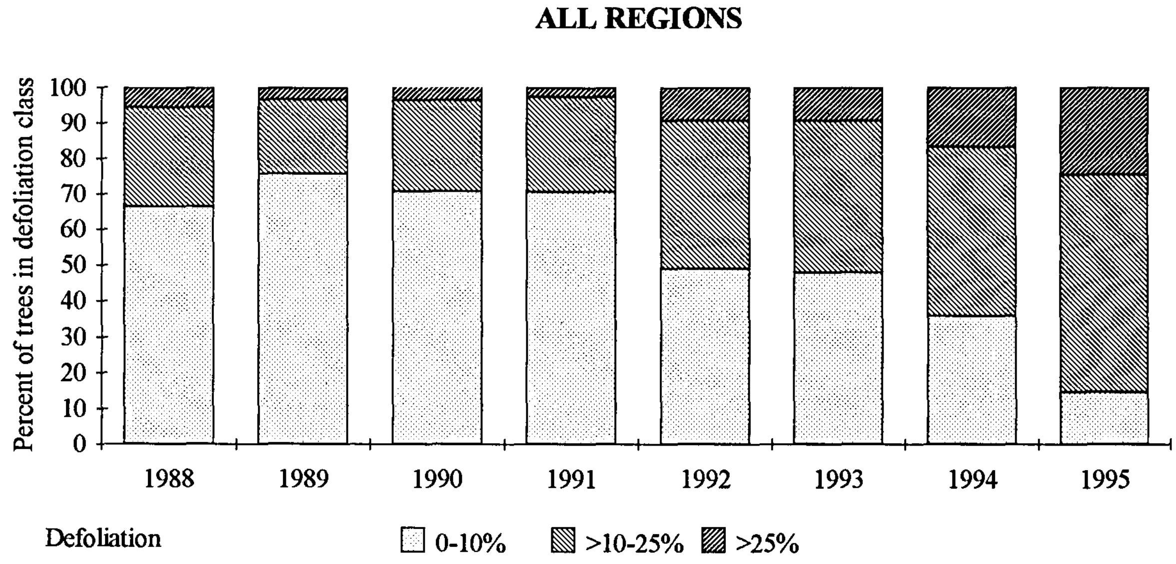


Figure 3.1.8.6-1a: Defoliation of *Pinus halepensis* from 1988-1995

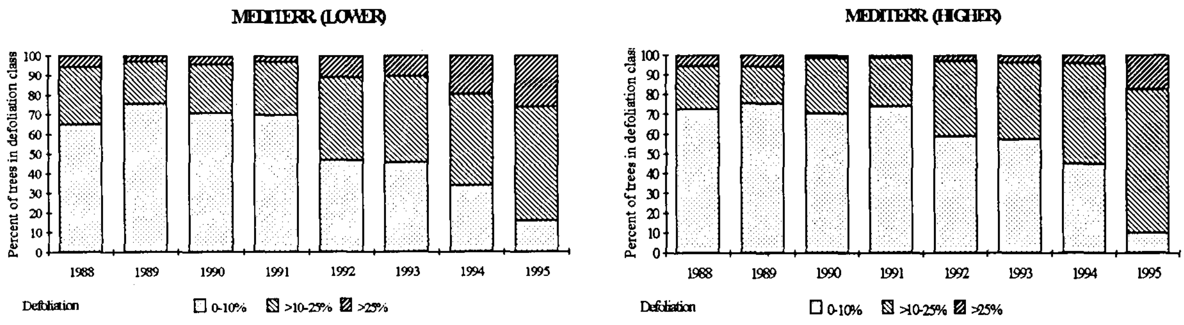


Figure 3.1.8.6-1b: Defoliation of *Pinus halepensis* from 1988-1995

3.1.8.7 Quercus suber

Nearly all common *Quercus suber* trees were situated in the Mediterranean (lower) region. It was also the species with the most trees located in one region.

After a dramatic increase in the share of damaged common *Quercus suber* trees of the total sample (including all regions) from 0.7% in 1988 to 9.4% in 1989 and particularly to 43.2% in 1990, the maximum of 43.9% was reached in 1991. However, a remarkable improvement occurred in 1993. The share of damaged trees diminished from 35.9% in 1992 and to 9.0% in 1993. In 1994, an increase to 11.7% was found, which continued to 23.6% in 1995.

Combined with the rapid increase in the share of damaged trees from 1988 to 1991 an increase was found in the share of trees in defoliation class 1. However, in contrast to defoliation classes 2-4, the increase in the share of trees in defoliation class 1 continued after 1991 and reached its highest level in 1995 with 54.5%. Accordingly, the proportion of non-defoliated trees dropped from 92.1% in 1988 to 25.3% in 1991. This remarkable decrease was followed by a sharp increase to 48.4% in 1993 and diminished to 40.4% and 21.9% in 1994 and 1995, respectively.

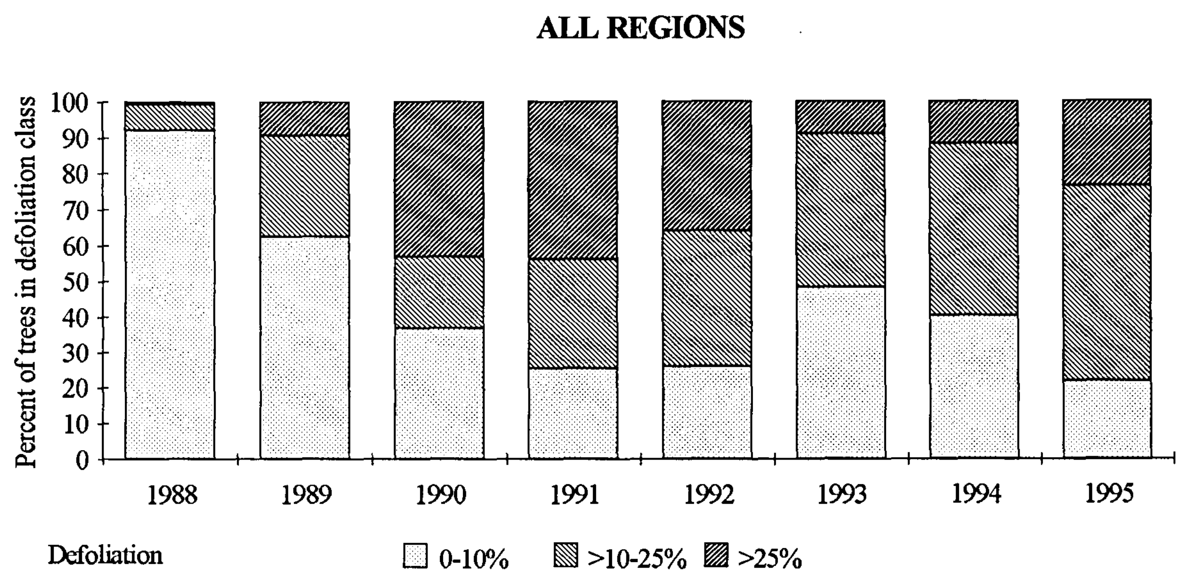


Figure 3.1.8.7-1: Defoliation of *Quercus suber* from 1988-1995

3.1.8.8 Pinus nigra

Most of the common *Pinus nigra* trees were found in the Mediterranean (higher) region. Further common trees were evaluated in the Mediterranean (lower) and the Mountainous (south) region.

The development of the share of damaged common *Pinus nigra* trees of the total sample, which covers all regions, was generally similar to those in the regions evaluated. Its main characteristics were an overall increase in defoliation, reaching its maximum in 1992, followed by an obvious recuperation in 1993, which continued slightly in 1994. In 1995 the share of damaged trees jumped again to nearly the same level as in 1992. After an increase in the proportion of damaged trees from 2.4% in 1989 to 19.9% in 1992, in the total common sample, a decrease to 13.1% and 11.5% occurred in 1993 and 1994, respectively. An increase followed in 1995 to 18.5% of trees damaged. In contrast, the share of trees in defoliation class 1 increased continuously from 24.1% in 1989 to 39.3% in 1993, but then decreased only slightly to 37.4% and 37.1% in 1994 and 1995, respectively. The share of non-defoliated trees correspondingly decreased rather gradually from 74.1% in 1989 to 45.4% in 1992 and increased again to 51.1% in 1994. In 1995 a decrease to 44.4% followed.

As in the previous years, the development of the total common *Pinus nigra* sample was correlated closely with that in the Mediterranean (higher) region, which shows the largest amount of damaged *Pinus nigra* trees. The share of damaged trees increased in this region from 3.3% in 1989 to its maximum of 22.1% in 1992 and decreased to 13.9% in 1994. In 1995 the percentage of damaged trees jumped again to 21.2%. The proportion of trees in the warning stage increased continuously, except for 1989 (23.5%), from 24.5% in 1988 to 41.4% in 1993 and decreased in 1994 to 40.7% and again to 37.2% in 1995. In the

Mediterranean (lower) region, the percentage of damaged trees increased from 4.3% in 1989 to 19.9% in 1990, decreased to 15.6% in 1991 and reached its first maximum of 22.3% in 1992. Then, a continuous decrease to 10.2% occurred until 1994, before it increased to a second maximum of 22.7% in 1995. In the Mountainous (south) region, where the share of common trees was similar to the Mediterranean (lower) region, the respective proportion decreased from 4.3% in 1988 to 1.8% in 1989, increasing again to 3.2% in 1990 and jumping to 12.6% in 1991. The maximum was reached in 1992 with 16.1%, followed by a sharp decrease to 7.4% in 1993. However, in contrast to the other regions surveyed, the respective share increased again to 8.1% in 1994 and only slightly to 9.5% in 1995.

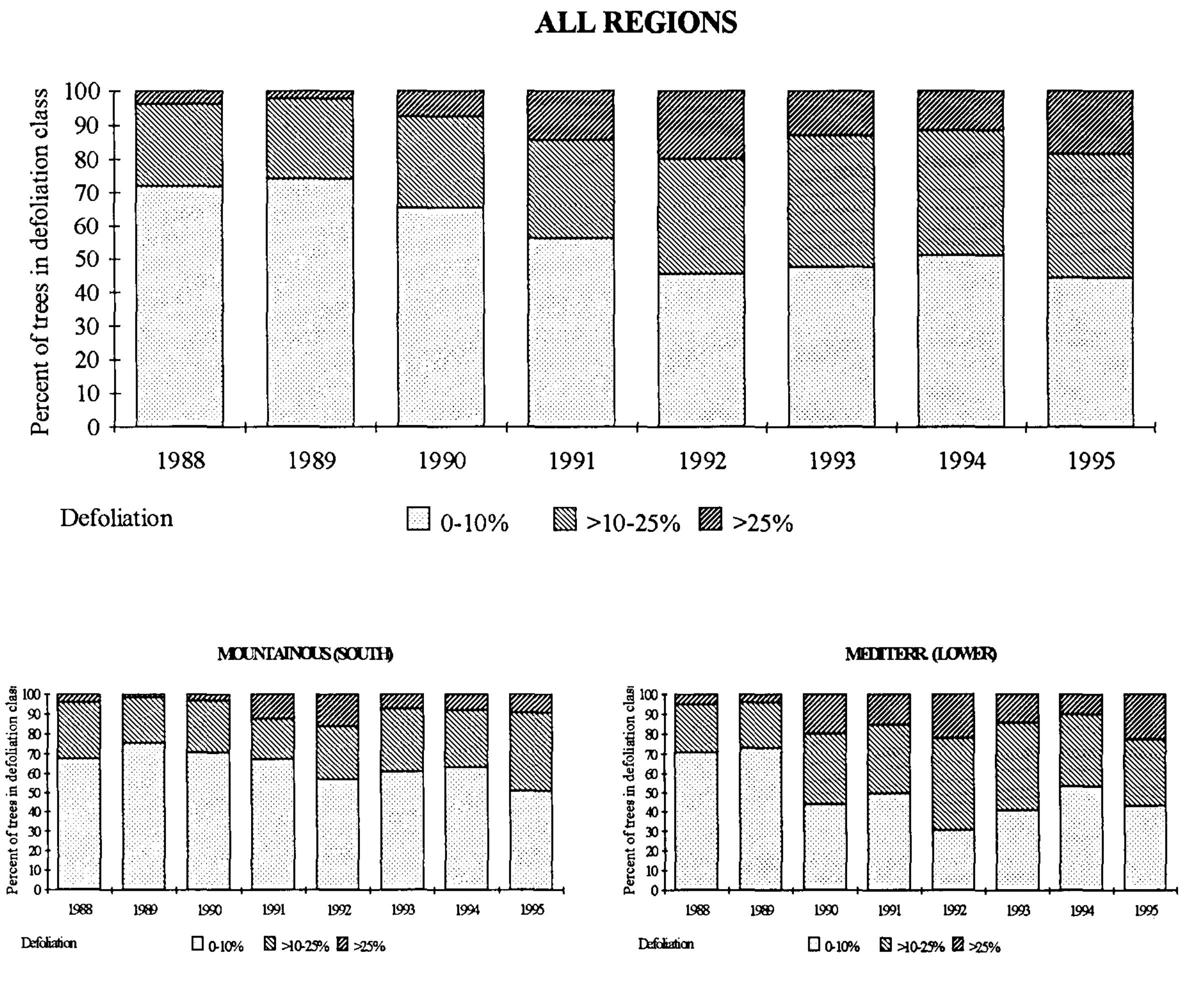


Figure 3.1.8.8-1a: Defoliation of *Pinus nigra* from 1988-1995

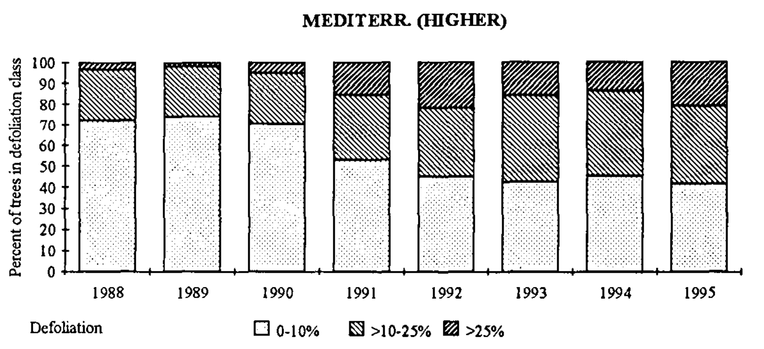


Figure 3.1.8.8-1b: Defoliation of *Pinus nigra* from 1988-1995

3.1.8.9 Quercus robur

Quercus robur had its largest proportions of common trees in the Sub-Atlantic and the Atlantic (north) region. A further comprehensive share of common *Quercus robur* trees was evaluated in the Atlantic (south) and Mountainous (south) regions.

The share of damaged common *Quercus robur* trees of the total sample of all regions increased continuously from 10.9% (1989) to 16.4% (1991) and 25.5% (1993), then decreasing slightly to 24.6% in 1994. In 1995 the percentage of trees damaged increased again to 26.2%. After a remarkable decrease in the percentage of damaged trees in the Atlantic (north) region, from 22.2% in 1988 to 10.0% in 1989, a continuous increase to 16.5% in 1991 was found in this region, too. After a slight decrease, the respective share also jumped clearly from 15.8% in 1992 to 33.0% in 1993 and continued its increase to 35.0% in 1994. In 1995 it decreased strongly to 25.1%. The share of damaged trees in the Sub-Atlantic region increased from 6.1% in 1989 to 28.6% in 1993, followed by a slight decrease to 24.5% in 1994 and increased again to 31.0% in 1995. This represented the highest amount of damaged *Quercus robur* trees in this year together with the Atlantic (south) region, where another smaller amount of damaged *Quercus robur* trees was found. In contrast to the other regions surveyed, this share increased from 8.0% in 1988 to 10.6% in 1989 and decreased again to 8.0% in 1990. After another deterioration, a slight decrease of the respective share from 10.1% in 1991 and 9.6% in 1992 to 8.5% occurred in 1993, which continued more obviously in 1994 to 7.4%. In 1995, this relatively low share as compared to the other two regions, increased again to 11.7%. In the Mountainous (south) region the smallest share of damaged *Quercus robur* trees occurred. The development in this region was quite unsteady, starting with an increase from 10.7% in 1988 to 19.0% in 1990. Then, the respective proportion decreased to 10.7% in 1992, followed by further increases, to 18.2% in 1994 and to 29.8% in 1995, its highest level.

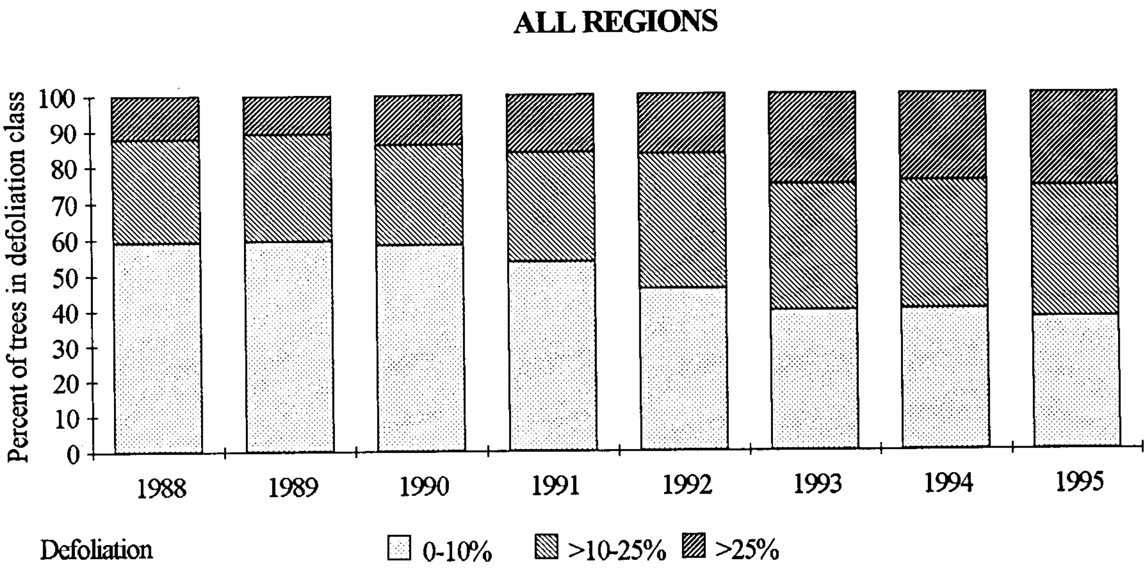


Figure 3.1.8.9-1a: Defoliation of *Quercus robur* from 1988-1995

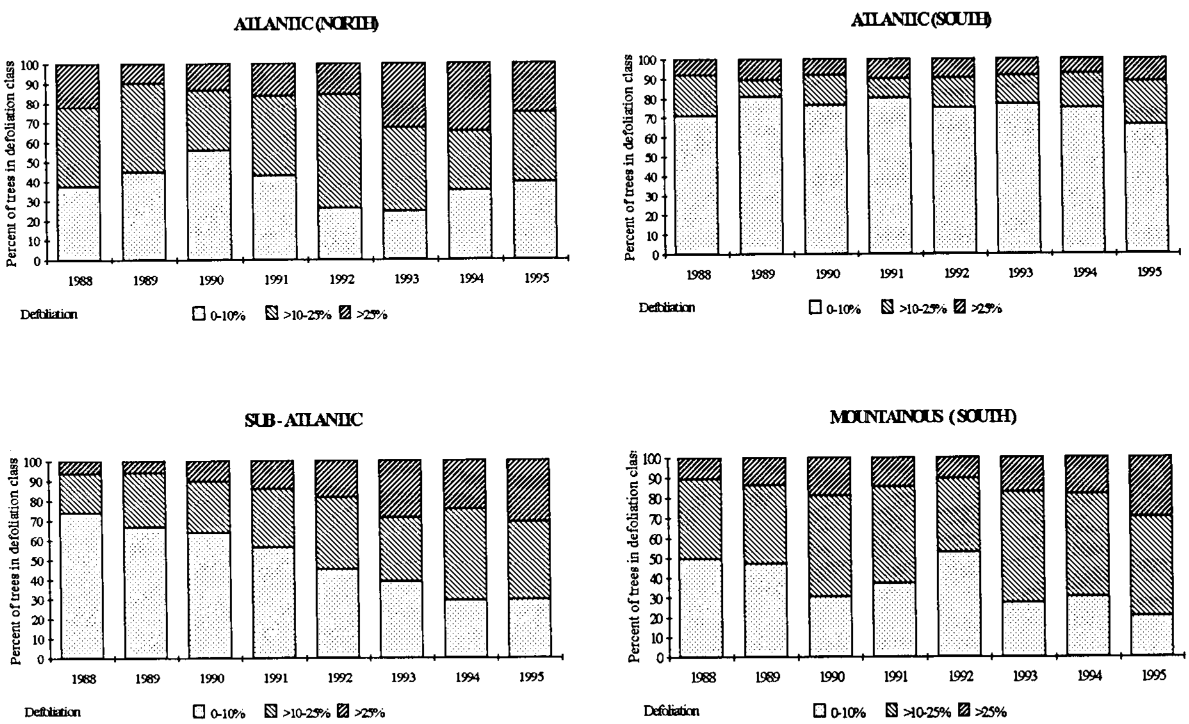


Figure 3.1.8.9-1b: Defoliation of *Quercus robur* from 1988-1995

3.1.8.10 Quercus petraea

Most of the common *Quercus petraea* trees were found in the Sub-Atlantic region. A smaller amount of trees was also investigated in the Mountainous (south) and Mediterranean (higher) regions.

The sample of damaged common *Quercus petraea* trees of the total sample including all regions showed a decrease from 13.2% in 1988 to 10.0% in 1990. After a subsequent rise to a steady level (17.0% in 1991 and 17.3% in 1992), an obvious increase in the share of damaged trees to 23.3% was found in 1993, which continued slightly to 23.4% in 1994 and to 27.9% in 1995. 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 12.4% in 1988 to 9.8% in 1990. After a jump to 17.3% in 1991, and a following decrease to 15.7% in 1992, the respective proportion of trees increased again to 25.0% in 1994 and 30.9% in 1995.

In the Mountainous (south) region, the development in the defoliation of *Quercus petraea* was rather irregular. The share of damaged trees decreased from 25.2% in 1988 to 12.2% in 1989, then increased until 1992 to 21.8% and jumped to 35.4% in 1993. A remarkable decrease to 22.4% was found in 1994, increasing again to 33.3% in 1995.

The proportion of damaged *Quercus petraea* trees in the Mediterranean (higher) region, in which the smallest amount occurred, decreased from 15.9% in 1988 to 10.6% in 1989. In the following years, the respective share increased continuously up to 29.2% in 1994 and jumped to 35.4% in 1995.

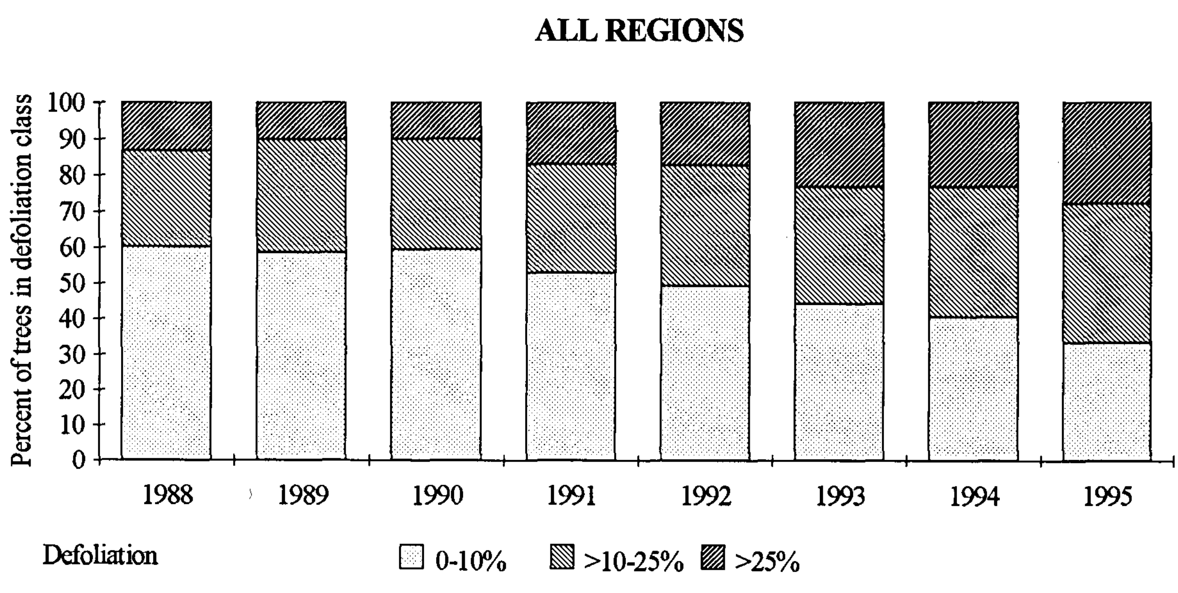


Figure 3.1.8.10-1a: Defoliation of *Quercus petraea* from 1988-1995

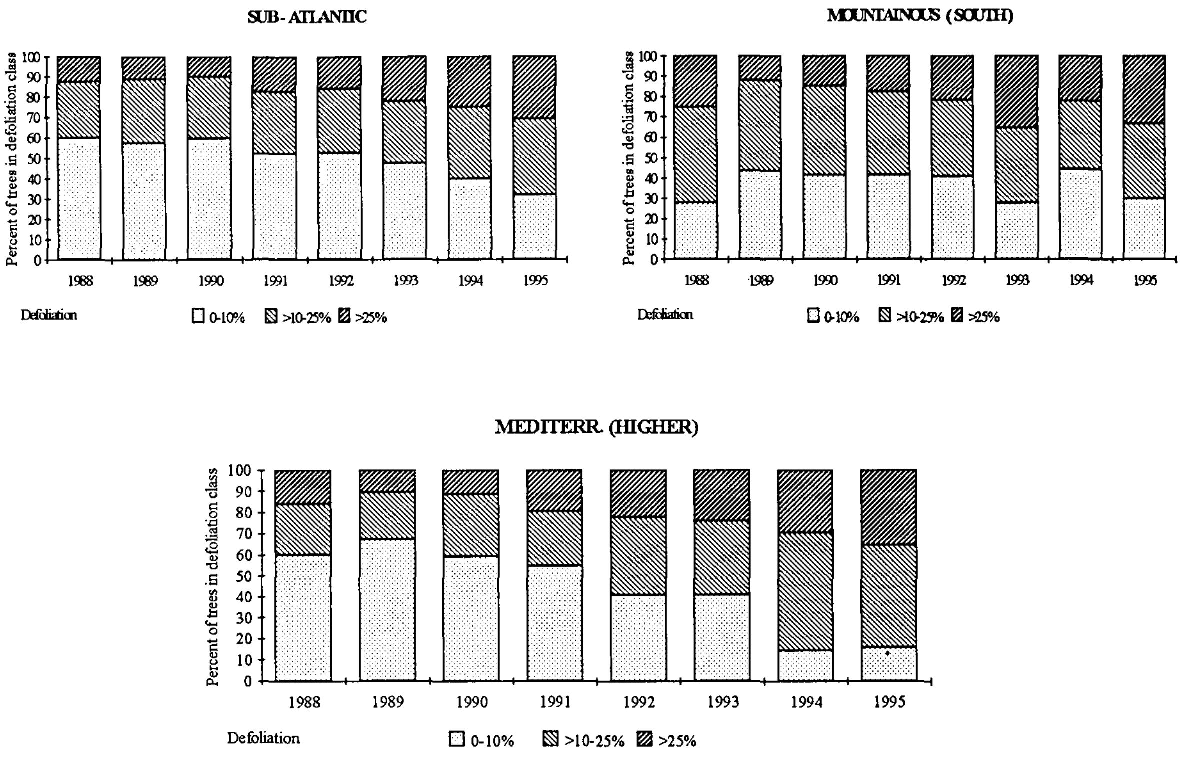


Figure 3.1.8.10-1b: Defoliation of *Quercus petraea* from 1988-1995

3.1.8.11 Abies alba

The common *Abies alba* sample trees appeared mostly the Sub-Atlantic and Mountainous (south) regions, having a little larger proportion in the Sub-Atlantic region.

After a steady increase since 1989 (with the exception of 1992) and a small improvement in 1994, the result of the 1995 assessment showed again an increase in the proportion of damaged common *Abies alba* trees, in all regions, from 24.2% (1994) to 25.4%. In the Mountainous (south) region a decrease to 27.4% in 1994 and to 24.9% in 1995 was found after an increase from 25.6% in 1992 to 34.5% in 1993. In the Sub-Atlantic region, the share of damaged trees decreased from 27.8% in 1988 to 22.2% in 1990, reaching its maximum of 29.6% in 1991 and decreasing again to 25.2% in 1992. Then, a much smaller increase to 27.0% occurred, followed by another decrease to 24.3% in 1994. In 1995 the percentage of trees damaged increased to 27.8%.

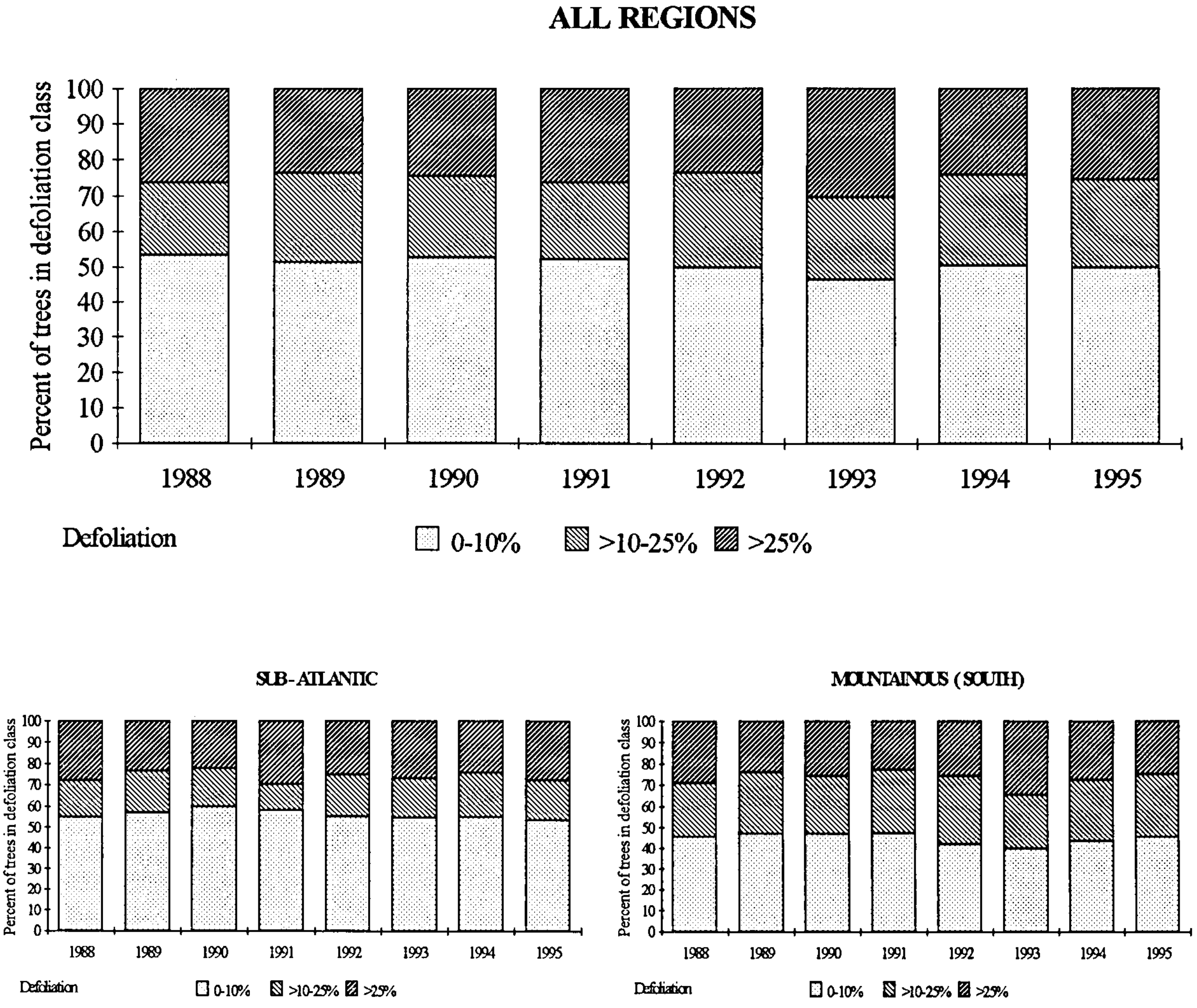


Figure 3.1.8.11-1: Defoliation of *Abies alba* from 1988-1995

3.1.8.12 Picea sitchensis

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

A sharp increase was found in the proportion of damaged common *Picea sitchensis* trees of the total sample covering all regions from 2.4% in 1988 to 20.5% in 1989, followed by a remarkable decrease to 3.4% in 1990. Another increase to 17.9% appeared in 1991. After a slight decrease from 1991 to 1992, a further sharp increase to 28.6% occurred in 1993. This value decreased again to 20.5% in 1994 and increased in 1995 to 22.2 %. The observed increase in defoliation since 1988 is thought to be mainly due to *Elatobium.*

The share of trees in the warning stage increased from 20.0% in 1988 to 32.9% in 1989, followed by a decrease to 24.4% in 1990. Since 1991, this share has increased steadily to 32.1% in 1993, jumping to 40.3% in 1994 and decreasing again to 34.2% in 1995.

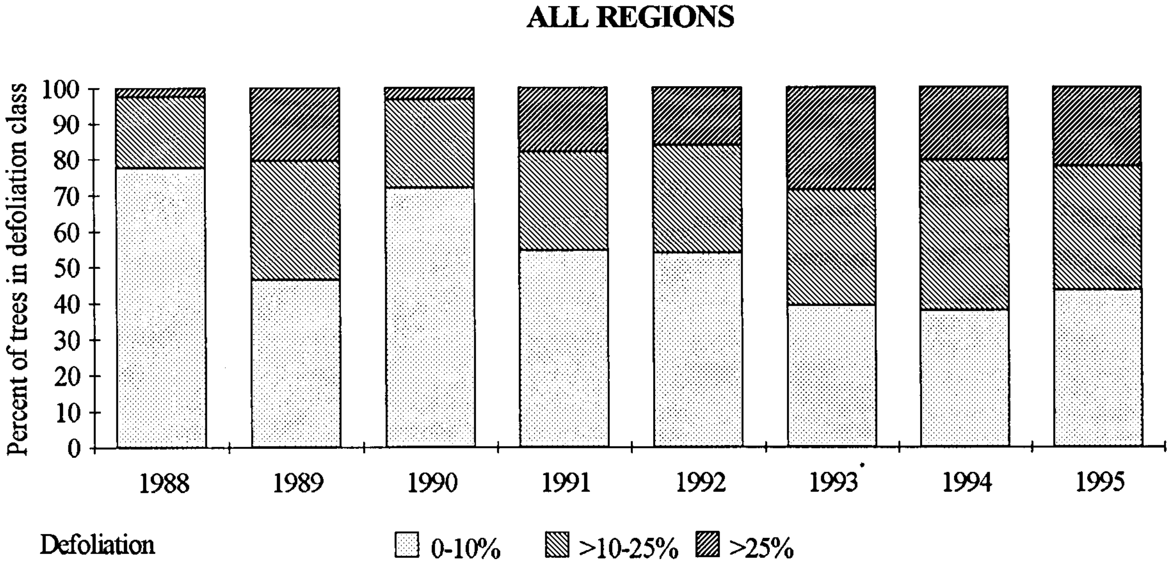


Figure 3.1.8.12-1: Defoliation of *Picea sitchensis* from 1988-1995

3.1.9 Identifiable damage causes

Eight damage types can be identified on the sample trees, namely:

- **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 damage is reported. The Tables 3.1.9.1-1 and 3.1.9.1-2 show the numbers of observations (trees and plots) of these damage types for all countries with the exception of Czech Republic and Italy, which submitted no data for damage types. Italian data are currently under validation

The numbers and percentages of trees and plots of the respective damage types are related to all affected trees (all damage types). It is possible that more than one type of identifiable damage occurs on a single tree. Such trees will therefore be represented in the following tables more than once.

3.1.9.1 Identifiable damage causes in relation to trees assessed

Table 3.1.9.1-1 shows for each country the numbers of trees on which the individual damage types were observed (multiple damage allowed). It contains also the quantity of trees showing easily identifiable damage by one or more causes on the one hand and no easily identifiable damage on the other hand (without multiple damage). Percentages of the total trees assessed are displayed in brackets.

Thus, on 106 609 trees (90.9% of the total tree sample) identifiable damage was investigated. In the following text this part of the total tree sample is termed as the "assessed tree sample". 28 218 trees (26.5%) of them showed identifiable damage of one or more causes. On the other trees identifiable damage was not present (73.5%). Table 3.1.9.1-1 shows also the distribution of trees observed by damage type for total Europe, Table 3.1.9.2-1 contains the same in relation to plots.

In total Europe, as in the previous years, the most commonly observed type of damage was caused by **insects** (8.9% of the trees and 23.2% of the plots). The second and third most commonly observed types were **abiotic agents and fungi** representing 7.1% and 5.0%, respectively, of the assessed tree sample.

The presence of the damage types **other damage** and **action of man** was observed less frequently, representing 4.7% and 3.5%, respectively, of the total tree sample.

Game/grazing, fire and damage by **known pollution** (i.e. classical smoke damage caused by air pollution of nearby emittents) were recorded to a far smaller amount, namely on 1.0%, 0.6% and 0.2% of the trees, respectively. Of the assessed sample, 26.5% of the trees was damaged by more than one damage type.

3.1.9.2 Identifiable damage causes in relation to plots

Table 3.1.9.2-2 lists the sums of all plots containing at least one tree of a particular easily identifiable damage type in respective columns.

As a result of the distribution of the trees showing damage types to the particular plots, the order of the most frequent damage types is different from the tree-related order. Now, **other damage** is the most registered type (1306 plots, 26.2%), followed by insect damage (1156 plots, 23.2%), abiotic agents (1074 plots, 21.6%), fungi (883 plots, 17.7%) and action of man (821 plots, 16.5%).

Table 3.1.9.1-1: Observations of identifiable damage in the participating countries (tree-related)

Country	Numbers of observations: Game/ Grazing	Insects	Fungi	Abiotic agents	Action of man	Fire	Known pollution	Other	Σ	One or more damage identified (% of total)	No damage identified (% of total)	Total number of trees (100%)
Austria	208	0	0	593	476	0	0	22	1472	979 (46.6)	1122 (53.4)	2101
Belgium	7	48	6	10	0	0	0	1	72	72 (10.6)	606 (89.4)	678
Bulgaria	2	1016	1578	134	56	1	1	49	2837	2443 (50.8)	2369 (49.2)	4812
Croatia	79	385	199	174	134	32	92	0	1095	798 (40.5)	1172 (59.5)	1970
Czech Republic	-	-	-	-	-	-	-	-	-	-	-	-
Denmark	0	0	0	16	56	0	0	0	72	72 (12.5)	504 (87.5)	576
Estonia	40	56	562	7	38	1	0	0	704	660 (30.6)	1500 (69.4)	2160
Finland	66	525	524	464	161	0	0	1767	3507	3290 (37.6)	5464 (62.4)	8754
France	16	879	375	514	108	8	0	358	2258	1892 (17.4)	8959 (82.6)	10851
Germany	151	975	46	119	57	54	0	0	1402	1286 (11.8)	9621 (88.2)	10907
Greece	133	685	23	33	31	2	0	176	1083	976 (43.4)	1272 (56.6)	2248
Hungary	9	259	480	276	73	0	0	54	1151	839 (62.5)	503 (37.5)	1342
Ireland	0	66	127	218	0	0	0	135	546	316 (71.7)	125 (28.3)	441
Italy	-	-	-	-	-	-	-	-	-	-	-	-
Latvia	0	37	10	24	71	0	0	0	142	142 (6.3)	2120 (93.7)	2262
Lithuania	14	239	36	21	117	1	0	124	552	432 (24.3)	1345 (75.7)	1777
Luxemburg	0	15	0	0	0	0	0	0	15	15 (15.6)	81 (84.4)	96
Moldova	0	58	0	2	1	1	0	0	62	61 (23.2)	202 (76.8)	263
Netherlands	0	32	24	0	0	0	0	0	56	52 (20.2)	205 (79.8)	257
Norway	0	207	14	611	356	0	0	373	1561	1186 (30.4)	2719 (69.6)	3905
Poland	0	760	288	0	0	0	0	0	1048	989 (11.5)	7651 (88.5)	8640
Portugal	29	359	140	129	1035	45	30	49	1816	1553 (36.7)	2677 (63.3)	4230
Romania	46	682	226	459	143	10	85	39	1690	1262 (22.0)	4474 (78.0)	5736
Russia	0	58	0	2	1	1	0	0	188	171 (5.4)	3009 (94.6)	3180
Slovac Republic	35	489	116	157	213	117	33	0	1160	938 (18.4)	4153 (81.6)	5091
Slovenia	1	186	26	76	169	4	2	0	464	377 (48.0)	409 (52.0)	786
Spain	46	673	365	3101	153	315	0	778	5431	4980 (45.7)	5916 (54.3)	10896
Sweden	126	51	71	118	333	9	0	874	1582	1504 (14.6)	8810 (85.4)	10314
Switzerland	0	85	16	158	5	0	0	22	286	247 (30.0)	577 (70.0)	824
United Kingdom	8	600	32	125	4	0	0	4	773	686 (45.4)	826 (54.6)	1512
Σ	1016	9520	5306	7580	3757	600	243	5003	33025	28218 (26.5)	78391 (73.5)	106609

Table 3.1.9.2-1: Observations of identifiable damage in the participating countries (plot-related)

Country	Numbers of observations											
	Game/ Grazing	Insects	Fungi	Abiotic agents	Action of man	Fire	Known pollution	Other	Σ	One or more damage identified (% of total)	No damage identified (% of total)	Total number of plots (100%)
Austria	23	0	0	75	56	0	0	18	172	76 (100.0)	0 (0.0)	76
Belgium	2	3	1	3	0	0	0	1	10	6 (20.7)	23 (79.3)	29
Bulgaria	1	47	65	36	16	1	1	9	176	95 (79.2)	25 (20.8)	120
Croatia	11	37	27	32	31	12	6	0	156	63 (76.8)	19 (23.2)	82
Czech Republic	-	-	-	-	-	-	-	-	-	-	-	-
Denmark	0	0	3	5	0	0	0	0	8	7 (29.2)	17 (70.8)	24
Estonia	16	20	62	4	22	1	0	0	125	74 (82.2)	16 (17.8)	90
Finland	29	136	160	135	87	0	0	366	913	434 (95.4)	21 (4.6)	455
France	6	152	67	89	29	1	0	53	397	265 (48.8)	278 (51.2)	543
Germany	24	109	16	25	11	3	0	0	188	144 (34.5)	273 (65.5)	417
Greece	7	47	4	15	6	1	0	27	107	78 (82.1)	17 (17.9)	95
Hungary	4	49	62	55	26	0	0	17	213	63 (100.0)	0 (0.0)	63
Ireland	0	12	9	16	0	0	0	10	47	21 (100.0)	0 (0.0)	21
Italy	-	-	-	-	-	-	-	-	-	-	-	-
Latvia	0	5	7	1	15	0	0	0	28	24 (25.5)	70 (74.5)	94
Lithuania	6	29	19	11	19	1	0	48	133	58 (79.5)	15 (20.5)	73
Luxemburg	0	3	0	0	0	0	0	0	3	3 (75.0)	1 (25.0)	4
Moldova	0	3	0	1	1	1	0	0	6	5 (45.5)	6 (54.5)	11
Netherlands	0	5	5	0	0	0	0	0	10	8 (61.5)	5 (38.5)	13
Norway	0	43	12	151	162	0	0	128	496	270 (69.9)	116 (30.1)	386
Poland	0	108	94	0	0	0	0	0	202	162 (37.5)	270 (62.5)	432
Portugal	1	58	32	11	48	4	1	6	161	99 (70.2)	42 (29.8)	141
Romania	9	48	34	41	32	1	4	10	179	100 (41.2)	143 (58.8)	243
Russia	0	20	2	1	4	0	0	3	30	23 (17.2)	111 (82.8)	134
Slovac Republic	14	21	34	41	62	30	9	0	211	81 (73.0)	30 (27.0)	111
Slovenia	1	24	7	19	27	2	2	0	82	33 (100.0)	0 (0.0)	33
Spain	9	101	99	169	25	17	0	163	583	358 (78.9)	96 (21.1)	454
Sweden	38	19	55	78	138	3	0	434	765	520 (71.6)	206 (28.4)	726
Switzerland	0	20	3	34	1	0	0	12	70	40 (85.1)	7 (14.9)	47
United Kingdom	3	37	4	26	3	0	0	1	74	47 (74.6)	16 (25.4)	63
Σ	204	1156	883	1074	821	78	23	1306	5545	3157 (63.4)	1823 (36.6)	4980

3.1.9.3 Identifiable damage causes in relation to defoliation and discolouration

Table 3.1.9.3-1 contains the percentage of the affected (defoliation/discolouration) tree sample by easily identifiable damage types for EU and total Europe. For example the easily identifiable damage type **fungi** is listed with 7.9%. This means that on 7.9% of all plots on which easily identifiable damage types were reported, they show the identifiable damage type fungi and were defoliated >25% (defoliation class 2, 3 and 4). Summing up the percentages of all different damage types of one column results in a higher percentage than the counterpart percentage to "No damage type identified" (last row of the table) because for a tree more than one easily identifiable damage type can be reported.

Among the trees showing any identifiable damage, the proportions of trees in defoliation classes 2-4 ranged between 0.4% (99 trees) (**known pollution**) and 13.5% (3 473 trees) (**insects**) in total Europe. For 37.6% of the trees in defoliation classes 2-4 (9 677 trees) **one or more identifiable damage types** were reported. No identifiable damage was reported for 62.4% of the defoliated trees.

Table 3.1.9.3-1: Percentages of trees with defoliation >25% and discolouration >10% by identified damage types (without Czech Republic and Italy).

	Defoliation % in classes 2, 3, 4 (>25%)		Discolouration % in classes 1,2,3,4 (>10%)		Observations			
					% of the assessed tree sample		% of the assessed plot sample	
Damage type	Total Europe	EU	Total Europe	EU	Total Europe	EU	Total Europe	EU
Game/Grazing	0.9	1.4	0.7	1.0	1.0	1.2	4.1	4.6
Insects	13.5	12.7	14.5	11.2	8.9	7.7	23.2	22.3
Fungi	7.9	5.0	10.5	8.8	5.0	2.7	17.7	14.9
Abiotic agents	11.4	18.4	16.5	23.1	7.1	8.6	21.6	21.1
Action of man	3.9	3.9	6.9	10.5	3.5	3.7	16.5	13.2
Fire	1.4	2.7	4.8	9.0	0.6	0.7	1.6	1.0
Known pollution	0.4	0.0	0.4	0.0	0.2	0.1	0.5	0.0
Other	6.0	11.5	6.7	8.1	4.7	6.8	26.2	35.3
One or more damage type(s) identified	37.6	48.0	48.9	59.6	26.5	27.7	63.4	67.5
No damage type identified	62.4	52.0	51.1	40.4	73.5	72.3	36.6	32.5

The most pronounced negative effect in terms of discolouration was observed from trees affected by **abiotic agents** with 16.5% of the trees in discolouration classes 1-4, followed by insects (14.5%), fungi (10.5%), action of man (6.9%), other damage (6.7%) and fire (4.8%). 51.1% of the discoloured trees showed **no identifiable damage** of the above mentioned types. Figure 3.1.9.3-1 presents the numbers of trees by damage types and defoliation/discolouration.

The pie diagram in the map (Figure 3.1.9.3-2) shows that the percentage of trees damaged increases if a subsample of plots with identifiable damage types is taken as a basis. Figure 3.1.9.3-2 presents all plots with more than half of the trees showing one or more identifiable damage types (834 plots). Compared to the share of damaged trees using the total plot sample as a basis (see Figure 3.1.2-1) an increase of 16.9% to 51.3% occurred. Comparing the plot distribution of both maps, Figure 3.1.9.3-2 shows also that most of the tree damage in central Europe is not due to easily identifiable damage.

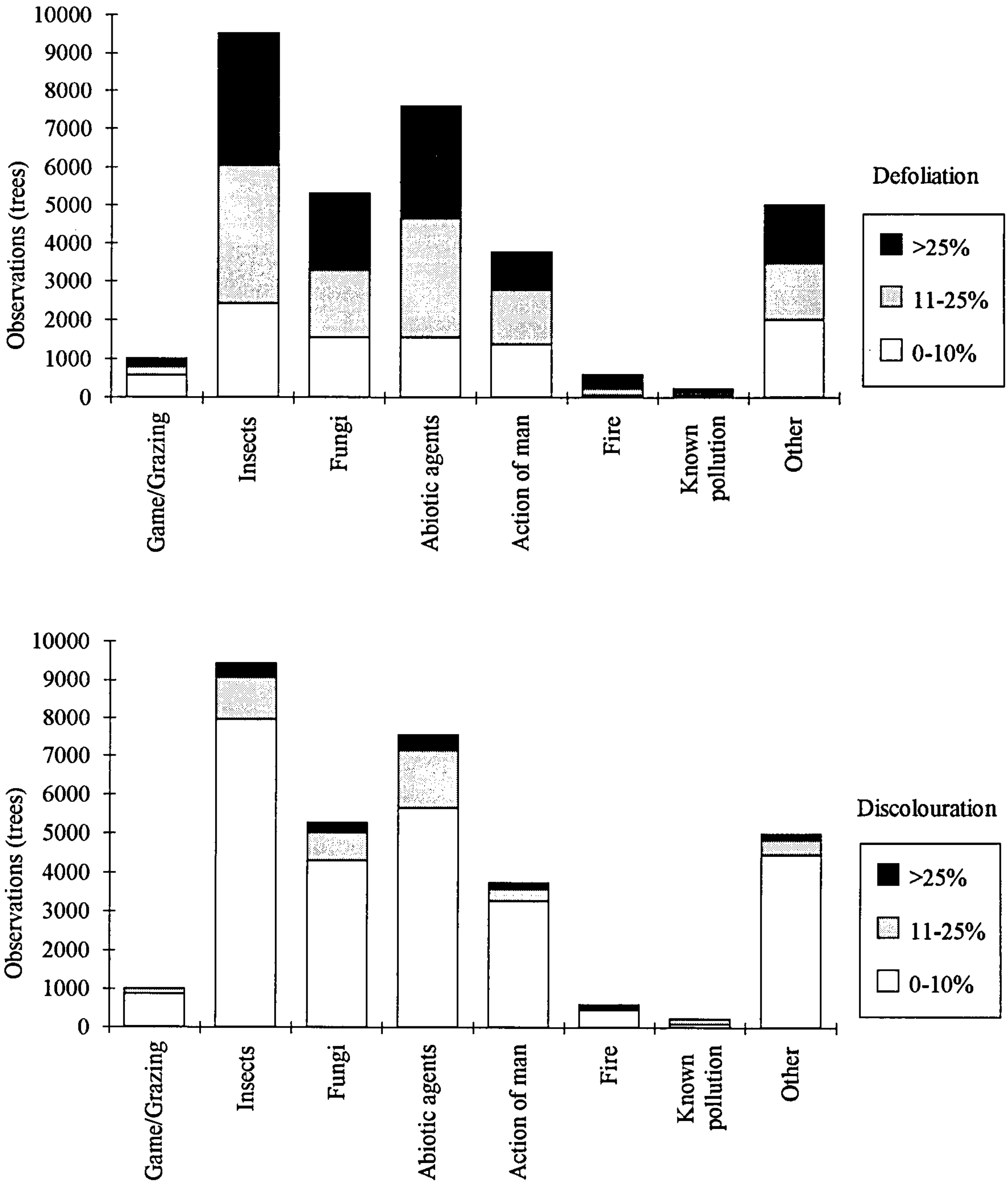


Figure 3.1.9.3-1: Observations of identifiable damage types by defoliation/discolouration damage classes for total Europe

Interpretation of the data related to identifiable damage is difficult. The main problem is that some of the damaging agents are identified with greater certainty than others. Damage types were observed on a low proportion of sample trees (0.2 to 8.9%) only. Therefore, the data presented here only give a general indication of the effect of several damage types.

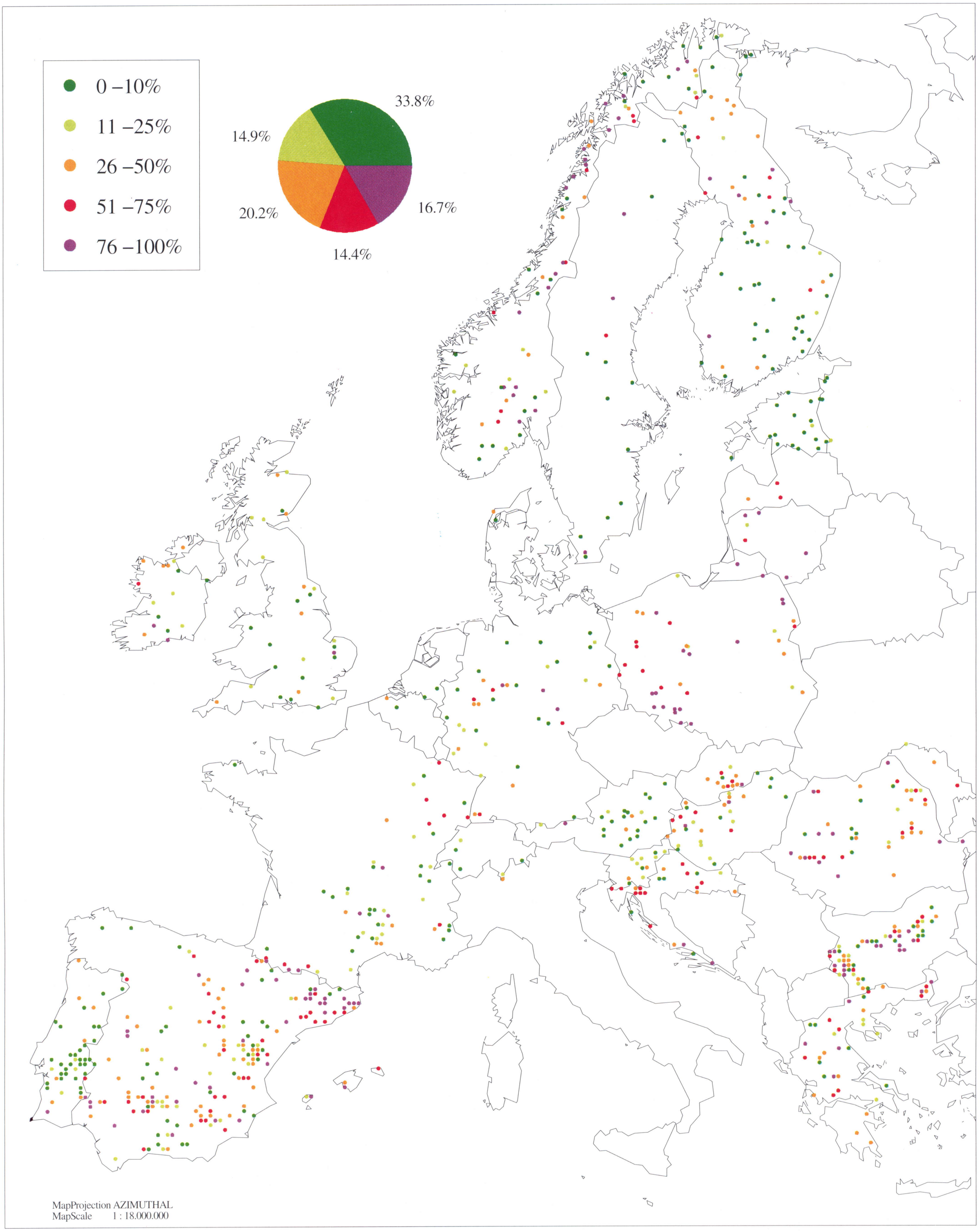


Figure 3.1.9.3-2: Percentage of trees damaged for plots containing more than the half of trees with one or more identifiable damage type(s) reported

3.2 National surveys

3.2.1 General view

In 1995, 28 European countries submitted national reports in order to present the results of their national surveys (Chapters 3.2.2 to 3.2.8). Numerical data were available from 30 countries, which are tabulated in 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 for all species in Annex II-2, for the conifers in Annex II-3 and for the broadleaves in Annex II-4. 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 results of the submitted national surveys concerning all species assessed can be summarized as follows:

Although no direct comparisons between different countries are possible because of differences in the application of the common methodology and general variations in climatic and site factors as well, the data approve a division of the countries into three groups.

As in the previous year, in Ireland only conifers and in Austria only trees 60 years and older were assessed. In two countries, namely Austria and Portugal, the percentage of sample trees classified as damaged (defoliation classes 2-4) was lower than 10%.

In nine of the countries the percentage of sample trees classified as damaged ranged between greater 10% and 20%. These countries are Estonia, Finland, France, Hungary, Italy, Latvia, the Russian Federation, Sweden, and the United Kingdom.

In another 19 countries, namely Belarus, Belgium (including Flanders and Wallonia), Bulgaria, the Czech Republic, Denmark, Germany, Greece, Ireland, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Romania, the Slovak Republic, Slovenia, Spain, Switzerland and Ukraine, the percentage of sample trees classified as damaged was greater than 20%, with a maximum of 59.6%. These are nearly two thirds of the member states from which survey results were reported.

A deterioration has occurred in 18 countries from which survey results were reported. The following Table 3.2.1-1 describes the changes of defoliation observed between 1994 and 1995 in classes 2-4 by referring to all the 30 countries by which survey results were submitted (Annexes II-5 to II-7). 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.

Table 3.2.1-1: Changes in defoliation observed between 1994 and 1995 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	22	4	1	-	1	-	-
Conifers	24	1	3	-	1	1	-
Broadleaves	20	5	2	-	-	1	-

As regards all species, a slight increase in defoliation occurred in four countries, whereas a slight decrease was observed only in one country. Changes in defoliation are obvious in the conifers and the broadleaves as well. Concerning the conifers, an increase occurred in four countries, whereas a decrease was observed only in two. In three countries the increase in the conifers was moderate, but no substantial increase was found. In comparison to 1994, the defoliation among the broadleaves clearly increased. In five countries a slight and in two countries a moderate increase occurred. However, in none of the countries there was a substantial increase in the broadleaves. In one country a moderate decrease was found.

3.2.2 Northern Europe

3.2.2.1 Estonia

In Estonia, 91 sample plots by using a 16 x16 km grid were surveyed in 1995. The survey was carried out in September, October and November 1995, 2 184 trees were assessed - 1 464 pines, 625 spruces, 53 birches, 12 aspens. Compared to the results from 1989 to 1994, a remarkable improvement of crown condition was reported, especially in stands of *Pinus sylvestris*, but to a lesser extent in spruce stands, too. For comparison, the percentage of healthy pine trees was 22% in 1991, 32% in 1993 and 37% in 1995. Only 6% of *Picea abies* and 17% *Pinus sylvestris* trees were in defoliation classes 2-4.

There were considerable regional differences. The most severe defoliation in stands of *Picea abies* occurred in the western, north-western and north-eastern parts of Estonia. The most severe defoliation in stands of *Pinus sylvestris* occurred in the north-western and western parts of Estonia and in the vicinity of Tallinn.

In addition to atmospheric pollution, some biotic and abiotic factors have had unfavourable influence on the health condition of forests, especially in the south-eastern part Estonia. The site and climatic conditions vary in the different parts of Estonia. The high level of defoliation in Estonian north-western alder forests can be related to poor soil conditions.

The occurrence of pathogens was investigated on all sample plots. As specific biotic stresses, disease was found on 623 sample trees, root rot was found on 8, *Ascocalyx abietina* on 198 and *Lophodermium seditiosum* on 409 sample trees. Insect damages were found on 58 sample trees. Attacks by *Ips typographus* and other bark beetles occurred on 10 spruces, by *Tomicus piniperda* on 47 and *Pissodes piniphilus* on 2 pines. Mechanical injury was registered on 41 sample trees. The bad crown conditions could be attributed to moose damages or diseases connected with moose damages on 40 sample trees, especially in middle-age spruce stands.

Monitoring of epiphytic lichens were used for bioindication of atmospheric pollution on 12 sample trees of 14 sample plots.

From 1989 to 1994 also chemical soil indices were investigated on all sample plots. The second assessment of soil chemical on sample plots began in 1994.

3.2.2.2 Finland

The systematic network was established in 1985-1986 in connection with the 8th National Forest Inventory. The country is divided into a northern and a southern part (demarcation line along latitude 66°). A lower sampling density is used in the northern region. The sampling units in the north and south are 3-plot clusters arranged in a 32x32 km grid and 3-plot clusters in a 16 x 16 km grid.

Until 1994, the size of the circular plots used in the annual crown condition assessment was 300 m^2 (radius 9.77 m). All trees with a diameter at breast height of at least 4.5 cm in dominating crown layer were inspected. The number of trees per sample plot varied between 2 and 40. The average number of trees in the sample plot was about 11.

Because of the fixed size of plots used in Finland 1986-1994, the number of sample trees in many plots was insufficient to fulfil the minimum criteria for the tree number (20 in southern and 10 in northern Finland according to the Commission regulation EC No. 1398/95). During the summer 1995, over 4 000 new trees and 82 new sample plots were added to the sample. The new trees were added systematically to the sample by increasing the radius of the plot. As a consequence of varying the radius, the size of plots is not fixed any more. In 1995, the total number of trees was 8 754 in 455 plots (average number of trees per plot: 19). The number of common sample trees 1994/1995 was 4 039.

In addition to the changes in the number of sample trees and plots also the scaling of defoliation was changed. In 1995, defoliation was assessed in 5% classes instead of 10% classes as used in previous years.

In 1995, 61.3% of all trees were classified as defoliation class 0 and 25.4% were slightly defoliated. 13.3% had a defoliation of more than 25%, but only three trees were dead.

The average tree-specific defoliation was 19% in stands of *Picea abies*, 9% in stands of *Pinus sylvestris*, and 11% in the broadleaves. Extensive needle/leaf discolouration was rare in *Pinus sylvestris* stands (1%) and in the broadleaves (0.5%). On the contrary, 11% of the *Picea abies* stands showed foliage discolouration symptoms. A positive correlation between defoliation and discolouration was detected for *Picea abies* ($r=0.366$, $p<0.0001$, $N=2\ 822$).

Compared to 1994, no remarkable changes in defoliation level were observed on any tree species (common sample trees). During the whole monitoring period (1986-1995) the average defoliation level has increased by 3 percent points in conifers. In broadleaves, it is not possible to analyse defoliation change because of changes in the sample.

42% of *Pinus sylvestris*, 34% of *Picea abies* and 31% of the broadleaves showed some kind of biotic or abiotic damage symptoms. The most common biotic agents were *Tomicus* spp. (7%) and *Gremmeniella abietina* (5%) in *Pinus sylvestris*, fungal pathogens on *Picea abies* (4%) and attacks of insects in broadleaves (2%). Abiotic damage was detected on 5% of the *Pinus sylvestris*, 10% of the *Picea abies* and 7% of the broadleaves. The proportion of trees showing damage symptoms increased with defoliation level.

Except for damages in *Betula* spp. stands caused by *Oporinia autumnata* in Lapland in the 1960s and damages in *Pinus sylvestris* stands caused by "pine saw fly" in Central Finland in the 1980s, no large scale insect damage has occurred in the last decades. Concerning fungal pathogens, an epidemic of *Gremmeniella abietina* broke out in western Finland in the 1980s. Local damage areas of *Gremmeniella abietina* have also been found in the 1990s.

In Finland, forest defoliation increases towards the north. Stand age and different weather and climatic greatly affect defoliation. Especially in the northern parts of the country, harsh climate strongly affects forest development. In addition to natural factors, atmospheric deposition is assumed to be a predisposing factor for forest damage. In southern Finland there were significant correlations between modelled air pollution depositions (data from 1990) and discolouration of *Picea abies*. Bioindicators, such as epiphytic lichens and algal growth on needles, also indicate pollutant effects in this region.

3.2.2.3 Latvia

Latvia joined the ICP-Forests Programme in 1990. In 1995, 399 Level I plots were assessed. The highest mean defoliation level is still for pine - 24.1%. Defoliation levels of other tree species are lower: for spruce 16% and for broadleaves in average 13.6%. In terms of defoliation the condition of all tree species, particularly of pine, reveals a trend of improvement. Compared to 1994, the proportion of moderately and severely damaged pine stands has decreased.

The highest crown defoliation for all species was observed in 1992/93 (pine even 33.2%). Since 1993 a trend of improvement in crown condition has been observed; the proportion of moderately and severely damaged stands diminished.

In 1995 particularly high defoliation level of pine was observed in several plots in the vicinity of Riga obviously due to insects. This year, the maximum of population size reached two insect species, *Lymantria monacha L.* and *Gilpinia pallida Kl.* The damaged area covers about 10 000 ha at present. The massive insect outbreak can be promoted by the large pine monoculture areas on poor sandy soils and the weakening of stands as a result of pollution in the vicinity of a city. Furthermore, the percentage of damaged spruce is remarkable. The reason for this is stem damage caused by moose in previous years with the following stem decay and attacks by *Ips typographus L.*

In order to improve the system of forest health assessment in Latvia, in 1994 EMAP Forest Health Monitoring (FHM) Programme started. Also investigations within several other local and international programmes, started in previous years, continued in 1995. The most important of them are studies within the ICP Integrated Monitoring Programme.

3.2.2.4 Lithuania

There are about 960 permanent observation plots (POP) in the national grid of forest monitoring (4x4 km), which was set up in 1988. Due to the lack of financial resources, the number of POP was reduced in 1992, but the investigations on 73 POP (16x16 km) have been carried out permanently. In 1995 more than 7 700 trees on 317 plots were assessed (244 plots in the grid 8x8 km and 73 plots in the grid 16x16 km) and growth conditions of trees including soil, environment pollution and chemistry of needles has been investigated. The results confirmed the continuous slight deterioration of forest health, despite air pollution from local sources has decreased by about the half. Mean defoliation increased from 23.0% in 1994 to 24.2% in 1995 (during the period 1989-1995 defoliation increased by more than 5 percent points). The number of healthy trees remained stable - 15-20%, but the share of dead trees increased drastically from the annual average rate 0.5 - 0.6% in 1991-1994 to 3.4% in 1995. Conifers were damaged especially heavily - 4.6% of the trees died by insects attacks. The *Picea abies* stands older than 60 years were damaged severely, dead trees comprised about 18% of all trees assessed and 15% of them showed easily identifiable damage caused by *Ips typographus*. According to the national forest pathology service, the scale of damage is the highest in this century. It is supposed that high long-range transboundary air pollution, which consists of 80-90% of whole background pollution, mild winters and the drought in 1994 were the inciting factors for such kind of forest decline.

Investigations of differences in forest decline were performed in different polluted regions. Effects of SO_2, NO_x, BaP etc. have proved that trees are stressed permanently and the amount of proline in its needles is much higher due to their air pollution.

3.2.2.5 Norway

In a nation-wide 9x9 km grid of sample plots, the Norwegian Institute of Land Inventory annually inspects about 8 000 conifers (*Picea abies* and *Pinus sylvestris*), and in a similar 18x18 km grid network about 2 000 broadleaved trees (*Betula* spp.). The conifers have been assessed since 1988, *Betula* spp. since 1990. In 1995, a total of 8 429 trees on 928 sample plots were assessed.

35.0% of all sample trees showed no symptoms of defoliation. 36.2% were slightly, 23.4% moderately and 5.3% severely defoliated. 0.1% of all trees were dead. 24.0% of the conifers, but 47.4% of all *Betula* spp. trees were damaged.

The results of the 1995 assessment confirmed the continuous slight deterioration of forest condition. Compared to 1994, the rate of trees in defoliation class 0 decreased by 2.9 percent points and the share of damaged trees rose by 1.9 percent points.

43.5% of all *Picea abies* trees showed no symptoms of defoliation, which is 4.1 percent points less than 1994. The rate of damaged trees increased by 2.2 percent points to 27.8%. In 1995, the proportion of *Pinus sylvestris* trees in defoliation class 0 decreased by 1.3 percent points to 36.6% and the share of trees in defoliation classes 2-4 rose by 1.1 percent points to 19.2%.

The condition of *Betula* spp. has been considerably deteriorating since the beginning of the time series in 1990. In this period, the rate of trees without symptoms of defoliation has been continuously decreasing from 46.0% to 13.7% in 1995. The proportion of damaged trees increased from 18.2% in 1990 to 47.6% in 1994 stabilised in 1995 (47.4%).

Additionally, about 40 900 conifers on 747 plots (Local Country Monitoring Plots) were inspected. On these, comparison of the 1994 and 1995 data revealed a slight deterioration for *Picea abies*, but no significant change for *Pinus sylvestris*. The negative trend has been obvious since the establishment of the plots in 1988. There are indications that the drought in summer 1994 has incited discolouration and later defoliation. In 1995, which was a moister year, the trees were more defoliated but appeared less discoloured. The summer 1994 also initiated extensive flowering of *Picea abies*, resulting in heavy cone production in 1995. In certain regions, fungi and insects have partially contributed to a negative development of tree condition.

On Level II, studies are performed by the Norwegian Forest Research Institute (NISK) on 17 permanent plots concerning cause-effect relationships between forest damage and air pollution. Air and precipitation quality have been measured by the Norwegian Institute for Air Research (NILU). Results will be reported in separate publications by NISK and NILU.

The causes for the continuous worsening might be an interaction of adverse climate, general stress and air pollution. Monitoring shows that the loads of long-range transported pollutants are relatively higher in the coastal parts than in the central and northern parts of Norway. Air pollution is supposed to be a predisposing factor which enhances the sensitivity to other biotic or abiotic stress factors. Inciting factors are the marginal conditions for tree growth, e.g. harsh climatic factors as they occur in large areas of Norway. Flowering and cone production are also contributing to the deterioration of tree vitality, in addition to pathogens and pests.

3.2.2.6 Sweden

In 1995, the selection procedure of plots and sample trees was changed. A selection of 773 permanent plots will now be assessed every year (formerly every 5th year) and the number of sample trees per plot has increased. The number of sample trees from temporary plots have decreased so that the total number of assessed trees remains about the same.

In 1995, 61.6% of all trees showed no symptoms of defoliation. 24.2% were slightly defoliated and the rate of damaged trees was 14.2%. 14.5% of the conifers and 7.9% of the broadleaves were in defoliation classes 2-4.

Compared to 1994, the condition of the conifers was nearly unchanged. The defoliation of *Pinus sylvestris* showed a general decrease in the whole country. However, a very abundant male flowering gives uncertainty to the figures from south Sweden. *Picea abies* improved in the northern part of the country.

On a longer term basis, no obvious trend can be found. The forest damage level as well as the year-to-year variation is interpreted as an effect of natural stress factors combined with direct and indirect effects of anthropogenic air pollutants.

3.2.3 Central Europe

3.2.3 Austria

In the 1995 survey, 6 349 trees have been assessed on 216 sample plots. As in the previous years, only trees older than 60 years were assessed.

67.1% of all assessed trees were not defoliated and 26.3% were classified as defoliation class 1. The proportion of damaged trees was 6.6%. In contrast to the last years, in all defoliation classes the differences between conifers and broadleaves were relative small.

The regions most affected by defoliation remain the same as in the previous years, i.e. the northern limestone Alps and the eastern lowlands.

In 1995, the improvement of forest condition continued. The rate of damaged trees decreased by 1.2 percent points. A closer look at the results shows, that the greatest changes occurred between the defoliation classes 0 and 1: For all species, the share of trees in class 0 increased by 7.3 percent points, whereas the rate in class 1 decreased by 6.0 percent points. With the exception of 1993, the proportion of not defoliated trees has been increasing since the beginning of the time series in 1989, when it was 49.4%. The opposite is true for damaged trees: The share decreased from 10.8% in 1989 to 6.6% in 1995.

For individual tree species, the development of defoliation was as follows:

- *Picea abies*, the main tree species with 65.6% of all samples trees, showed no changes in crown condition between 1994 and 1995. In 1995, 67.1% of the trees showed no symptoms of defoliation and 6.5% were in defoliation classes 2-4.
- The crown condition of *Pinus sylvestris* remarkably improved. Compared to 1994, the rate of trees in defoliation class 0 sharply increased from 30.8% to 60.2%. The share of damaged trees decreased by 9.9 percent points to 8.2%.
- In 1995, 84.4% of all *Larix* spp. trees had less than 10% defoliation, which are 6.7 percent points more than in the last year. 2.3% were classified as defoliation classes 2-4 (+1.2 percent points).
- The rate of not defoliated *Abies alba* increased by 14.1 percent points to 65.5% in 1995. The percentage of damaged trees decreased by 6.5 percent points to 9.5%.
- The condition of *Fagus sylvatica* improved. The proportion of trees without symptoms of defoliation remarkably increased by 22.1 percent points to 74.2%. The rate of damaged trees remained very low (4.7%).
- *Quercus* spp. also considerably improved. The share of trees in defoliation class 0 increased by 16.2 percent points to 51.6%. However, *Quercus* spp. still showed the highest defoliation of all assessed species. In 1995, the rate of damaged trees decreased by 7.4 percent points to 13.5%.

The crown condition of *Pinus sylvestris* and the broadleaves have benefited from the rainy spring weather. These species especially are growing in the eastern parts of Austria with continental dry climate.

The needle/leaf sampling from about 800 sample trees has been continued. The analysis of the sampling of 1993 concerning contents of iron, manganese and zinc has been completed. On about 90% of the sample plots the supply of iron was within the optimum. A deficiency of iron was not found. For manganese no exceeding of the thresholds was found. On 98% of the sample plots the values for manganese ranked within the thresholds for best supply. A malnutrition of zinc was found on 1.6% of the sample plots, where the pH-value of the soil is very low. On 1.2% of the sample plots the values for zinc exceeded the thresholds.

3.2.3.2 Croatia

The condition of forests in Croatia has been systematically monitored since 1987. For this purpose plots of 4x4 km, and in some areas of 4x2 km, have been established. There were an estimated 24 trees in each plot. Apart from defoliation and discolouration many other parameters, corresponding to Level II, have been monitored, such as damage caused by diseases, insects, wildlife, mechanization, microfilia, tree tops quality, epiphytes, etc. Due to the war monitoring was changed to plots of 16x16 km, and methodology for transnational estimation was applied.

Results obtained during the last 9 years show that the forest condition has been worsening constantly. The defoliation share of classes 2-4 amounted to 7.9% in 1987, 9.5% in 1988, 10.3% in 1990, 15,6% in 1992, 19.2% in 1993 reaching an alarming 28.8% in 1994. The fact that the most valuable tree species in Croatia are most damaged presents a particular problem (*Abies alba* approx. 60%, *Quercus robur* approx. 50%).

During the last 25 years the annual mean temperature has been constantly increasing in some areas, while at the same time the amount of precipitation has been decreasing. The number of days with snow has became considerably lower. There has been a sequence of years with climatic excesses, such as summer droughts and scorching heat, torrential rain, uneven distribution of precipitation, late and early frosts, etc.

There has been no reduction of pollution, and gradation of harmful insects and plant diseases represents a growing problem. Forestry mechanization continues to cause heavy damage.

Lowland forest decline can be attributed to the change of water regime (lowering of the ground water level, intensified stagnancy of water) and to polluted inundation waters. That is primarily a consequence of various hydro-engineering interventions (hydro-land reclamation in agriculture, amelioration of river courses, construction of hydro-electric power plants etc.). Furthermore, reduction of the natural diversity of forest stands should be added to the aforementioned. Forest fires represent the biggest problem in the Mediterranean region.

3.2.3.3 Czech Republic

Forest health state was evaluated on 199 monitoring plots (Level I) in 1995 with a total number of 12 889 trees representing 24 tree species in the elevation of 200 to 1 300 m a.s.l. The major part of evaluated plots is situated in stands of 4th and 5th age class (60-100 years). Observation of forest health state was directed to older stands where the intromission effect is more evident. From the whole number of evaluated trees there were presented following species: *Picea abies* 74.5%, *Pinus sylvestris* 13.7%, *Larix decidua* 3.3%, *Fagus sylvatica* 2.8%, *Quercus petraea* 2.6%.

Values of defoliation and social position were observed on all plots. On 108 plots of the 16 x 16 km net dendrometric data were measured, phytocenological survey was done, there were taken and analyzed soil samples, soil profile was described and soil type according to classification both national and FAO was defined. Samples for leaf analysis were collected on 40 plots.

The survey gives the following results:

1. Defoliation development in coniferous and deciduous trees was quite opposite in comparison with the year 1994. While the percentage of coniferous trees estimated by damage classes 1-4 increased from 93.4% in 1994 to 94.2% in 1995, the respective percentage of broadleaved trees fell from 86.8% in 1994 to 85.4% in 1995.

2. The development of coniferous trees is influenced by the most represented species *Picea abies* where the percentage increased from 92.5% to 94.2%, and *Abies alba* from 98.9% to 100%. There was a slight improvement in *Pinus sylvestris* and *Larix decidua.*

3. Beech did not change significantly in any defoliation degree. The percentage of the oak species *Quercus petraea* fell from 99.2% to 97.0%, at the same time the percentage of trees with mean defoliation (26-60%) significantly decreased from 77.0% to 46.7%.

4. From description of soil profiles and classification the following representation of soil types on plots assessed is evident:

Dystric Cambisols	*28.7%*	*Cambic Podzols*	*13.9%*
Dystric Planosols	*12.0%*	*Gleyic Cambisols*	*11.1%*
Cambic Arenosols	*7.4%*	*Gleyic Podzoluvisols*	*5.6%*
other types	*21.3%*		

5. Chemical analysis of soil samples, which was done in autumn 1995, showed among others the increased content of Pb; it was found on the monitoring plots in Western Bohemia, in the area influenced by mining of uranium ore. High content was also found on the plot in Southern Bohemia, close to the frontier, where pollution does not originate from inland sources, further on another 3 plots on north-eastern Moravia, influenced by high concentration of heavy industry in this region.

The year 1995 belonged to the climatic period with dry and warm summer season and quite irregularly spread precipitation. This manifested in the whole weakening of health state of stands and in their reduced resistance to further biotic and abiotic factors. In Moravia bark beetle gradation occurred, while in northern Moravia this pest caused full-area decline of spruce stands on several localities and in southern Moravia the similar damages were found in pine stands.

From about mid-80s emission of sulphur and partly also nitrogen have lowered, but volume of damage of forest stands shows an increasing tendency. This proves that there is a certain time delay between changes in air quality and stand reaction to these changes. Therefore it is not possible to establish direct and close dependence between forest damage and extent of air pollution.

3.2.3.4 Germany

In 1995, 38.9% of the assessed trees showed no symptoms of defoliation. 39.0% were slightly, 20.2% moderately and 1.9% severely defoliated and dead, respectively. The rate of damaged trees was 18.3% for the conifers and 29.9% for the broadleaves.

Compared to 1994, the share of damaged trees decreased by 2.3 percent points. This improvement is mainly due to a decreasing rate for the conifers (-3.3 percent points), whereas the respective share for broadleaves remained on its high level (-0.2 percent points).

The rate of damaged *Picea* spp. decreased nation-wide by 3 percent points to 21%. In the eastern German Laender (-6 percent points to 27%), the rate of damaged trees decreased continuously since 1991, when it was 38%. In the north-western and southern German Laender, where the respective share dropped by 3 percent points to 13% and 21%, respectively, the time series, which date back to 1984, show no trend.

The percentage of *Pinus* spp. in defoliation classes 2-4 improved nation-wide by 5 percent points to 15% and reached the lowest level since the beginning of the new time series in 1991, when it was 29%. This is due to a continuous improvement in the eastern German Laender: Here the respective rate decreased by 5 percent points to 13% in 1995, which is only one third of the share of 1991 (39%). The rate of damaged *Pinus* spp. fell by 2 percent points to 9% in the north-western German Laender and by 5 percent points to 22% in the southern German Laender. For both Laender-groups no trend is visible in the time series.

Fagus sylvatica is the only tree species with a deterioration in 1995. The rate of damaged trees increased nation-wide by 5 percent points to 37% and reached nearly the peak of 1992 (37%). The deterioration is most obvious in the eastern German Laender, where the respective rate rose from its lowest level in 1994 by 12 percent points to 40%. In the north-western German Laender the share of trees in defoliation classes 2-4 increased by 9 percent points to 33% and reached the second highest value since the beginning of the time series in 1984 .The same is true for the southern German Laender, where the respective percentage increased by 2 percent points to 38%.

For *Quercus* spp. an improvement in health condition could be noted after two bad years. Nation-wide the proportion of damaged trees decreased by 10 percent points to 35 %. The improvement was most obvious in the eastern German Laender, where the share decreased by 10 percent points to 36%, the lowest level since the beginning of the time series there in 1990, when it was still 69%. In the north-western and southern German Laender the rate of trees in defoliation classes 2-4 decreased by 7 percent points to 23% and by 9 percent points to 42%, respectively. Nevertheless, in both Laender-groups the level is still higher than in most of the years before.

Abies spp. has been the most damaged species since the beginning of the time series in 1984. In 1995, the proportion of trees in defoliation classes 2-4 slightly decreased by 1 percent point to 49%. Only 19% of the trees showed no symptoms of defoliation. *Abies* spp. is found only in the southern part of Germany and covers less than 2 % of the German forest area.

In general, the weather was favourable for the forest condition in 1994 and 1995. The summer periods were hot and dry, but precipitation partly above the average were recorded at the beginning of the growing season.

In 1995, the defoliation was unessentially influenced by pest attack. *Quercus* spp. remains the tree species most seriously attacked by insects. After the collapse of a mass reproduction of *Lymantria dispar*, which caused considerable damages in the last two years, *Quercus* spp. was attacked by *Tortrix viridana* and *Operophtera* spp.

It can be noted, that the improvement of the forest condition in the eastern German Laender since 1991 is parallel to the strongly decreasing level of air pollutants, above all sulphur dioxide (SO_2).

3.2.3.5 Liechtenstein

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

3.2.3.6 Poland

Assessment of forest condition in 1995 was performed on 1 174 permanent observation plots for pine, spruce, fir, oak, beech and birch stands over 40 years old. Defoliation and discolouration were assessed in 5% steps. 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.

Overall, 5.7% of the sample trees were without any defoliation. Slight to severe defoliation (classes 1 to 4) affected 94.3% trees. Moderate to severe defoliation (classes 2 to 4) was found in 52.6% trees. In conifers, 94.8% of the sample trees showed defoliation >25% (classes 2 to 4). 0.2% trees were found dead.

In broadleaves, 92.7% of the trees had more than 10% defoliation (classes 1 to 4) and 56.6% had more than 25% defoliation (classes 2 to 4). 0.3% trees were found dead. The highest defoliation amongst conifers was observed in spruce stands, with 69.6% trees being moderately to severely defoliated. The highest defoliation amongst broadleaves occurred in oak trees, with 60.1% trees in damage classes 2 to 4.

Discolouration (classes 1 to 4) was observed on 4.4% of the conifers and 8.9% of the broadleaves.

Comparing the survey results for 1994 and 1995, the share of trees with more than 25% defoliation decreased by 2.3 percent points, in conifers by 1.1 percent points and in broadleaves by 4.8 percent points. These differences are not statistically significant. However, a statistically significant improvement was observed in fir, the percentage of trees defoliated more than 25% decreased by 16.4 percent points.

1995 was the first year in which forest health condition was slightly better than in the year before. It reflects the effects of the decreasing air pollution level (especially SO_2 and NO_x) on forest health condition observed during the last years. Also higher precipitation during the vegetation period in 1995 influenced the health status of forests. As in the last years, the high level of forest damage was noticed in the Silesian region most affected by anthropogenic stress factors.

3.2.3.7 Slovak Republic

Climatic conditions of the year 1995 were similar to those of the last year (dry summer). Similarly, low precipitation significantly influenced losses of needles and leaves; no significant changes were observed as compared to the previous year (except for *Robinia* spp.) 14% of the sample trees were healthy (15% in 1994), 44% were in damage class 1 (43% in 1994), 38% in damage class 2 (36% in 1994), 3% in damage class 3 and 1% in damage class 4. Broadleaves showed a better health condition than conifers. The low share of only 8% of undamaged coniferous trees (class 0) gives evidence of the permanent unfavourable influence of load factors on forest ecosystems. Furthermore, *Fagus* spp. and *Carpinus* spp. seemed to be affected by unfavourable factors. Regarding leaf losses, there was found a significant improvement in *Robinia pseudoacacia L.*, however still being one of the most damaged species together with *Populus* spp..

3.2.3.8 Slovenia

In 1995 the fourth national inventory on a 4x4 km grid was done (712 plots, 16 172 trees). From methodological point of view double stage sampling with fixed number of trees is used and trees of all social classes above 10 cm diameter breast height are assessed. Tree damages are recorded by position on the tree and by types of causes. The sample comprises a large number of species, but is dominated by beech and spruce. The proportion of trees more than 25% defoliated is 25% (19% of the broadleaves and 34% of the conifers). The most defoliated species are fir (59.7% of trees more than 25% defoliated), oak (40%) and chestnut (39.8%). Known damages of the crown were recorded on the 23% of sample trees. The most important causes of known damages are primarily insects and forest management operations. Chestnut is seriously affected by cancer while causes for other species are not specified. In comparison with the previous inventory of the same intensity in 1991, a serious shift of proportion of trees more than 25% defoliated is obvious for oak and beech (beech from 4% to 14%). The proportion of broadleaves in the class of moderately to severely defoliated trees has been rising since 1987, while the same proportion for conifers has been varying. The plot map shows that the most serious deterioration is present in those parts of the country which are not under the direct pressure of polluted air. Stands of broadleaves show obvious deterioration while defoliation in the Alpine area shows more variation. In 1995, soil assessment was made and several new site and stand parameters were observed among other additional investigations. Soil and foliar samples were taken on the 16 x 16 km grid. Chemical analyses will be completed in 1996. The decision about the Level II plots was changed since financial support is not provided. Combining the work of both levels with the Integrated Monitoring and other programmes will hopefully provide cost efficiency of the inventory and improve the interpretation of results.

3.2.3.9 Switzerland

In 1995, the national inventory of forest condition in Switzerland was changed from an 8 x 8 km grid to a 16 x 16 km grid. Plots on the 8 x 8 km grid will be assessed every third year (i.e. next in 1997), or more often in the case of a marked change in forest condition. Fixed-area plots (500 m^2 in a flat plane) are used, resulting in a variable number of trees per plot. All trees, regardless of social class, with a diameter at breast height (dbh) greater than 12 cm are assessed within an inner circle of 7.98 m radius (representing 200 m^2 area), and all trees with a dbh greater than 36 cm are assessed in an outer circle. A second plot, with a centre located 25 m from the centre of the main plot, is also assessed. Trees in the plots are unmarked so that they are not accorded to any preferential silvicultural treatment.

The individual tree data submitted to the UN/ECE in 1995 consisted of all trees in KRAFT social classes 1-3 in both the original and the satellite plots. This contrasts with results presented in previous years, when all results for defoliation were weighted by the basal area of the tree concerned.

The Swiss data presented in the national tables represent all available data (i.e. including KRAFT classes 1-5). However, the results have been adjusted such that they are no longer weighted by basal areas.

The defoliation results are the figures that are obtained after the defoliation attributable to known causes is taken into consideration and deducted from the overall defoliation estimates. Overall defoliation, regardless of cause, has been recorded since 1990, but these data have not been submitted to the International Co-operative Programme.

A variety of indices are assessed, including crown transparency and discolouration, and these provide a picture of the overall condition of each tree. Discolouration is assessed according to Munsell colour charts, so that trees that are "off-colour" can be readily separated from those that are chlorotic. For the UN/ECE report, results are adjusted to fit the discolouration scale described in the Manual. Other indices include the extent and nature of stem damage and the number and location of dead branches and twigs within the crown.

The results from the 16 x 16 km grid provide only a rough indication of possible trends in forest condition between 1994 and 1995. An analysis of the results from different 16 x 16 km grids has indicated that the trends in these grids in individual years may differ. Consequently, the sample of trees is not considered to be sufficiently large to permit detailed statements on the condition of forests within Switzerland and therefore no such statements have been made. Instead, the results should be used within the context of an assessment of forest condition in Europe, bearing in mind, however, the substantial differences in assessment standards between countries.

3.2.4 Southern Europe
3.2.4.1 Greece

In the 1995 survey, a total of 1 864 trees (79 sample plots in high forests) and 384 shrubs (16 sample plots in maquis) were assessed. The number of trees observed in 1995 was smaller than in 1994 because one plot with *Pinus halepensis* was destroyed by fire.

In 1995, 38.1% of all trees assessed in high forests showed no symptoms of defoliation and 36.8% were slightly defoliated. The proportion of trees in defoliation classes 2-4 was 25.1%. 13.6% of the conifers, but 38.2% of the broadleaves were damaged.

Compared to 1994, the condition of the conifers stabilised, whereas the condition of the broadleaves further deteriorated. The share of conifers in defoliation class 0 increased by 2.3 percent points, whereas the respective rate of broadleaves decreased by 2.1 percent points to the lowest level since 1988. The proportion of damaged conifers was nearly unchanged (+0.4 percent points), whereas the corresponding share of broadleaves rose by 3.2 percent points to a new maximum value.

In the maquis, 14.0% of the sample shrubs were in defoliation class 0. 51.6% were slightly defoliated and 34.4% were damaged.

As in 1994, the weather was favourable for the forest condition: The summer of 1995 was wetter than in the previous years.

About 30.4% of all trees assessed in 1995 showed signs of insect attacks. 1.3% had some fungal diseases, whereas 1.8%, 1.5% and 9.4% suffered from adverse effects of abiotic, human, or from other agents, respectively. 1.25% of the trees were destroyed by fire. In 1995, 1 480 fires destroyed about 25 000 ha high forests and maquis.

28.4% of all shrubs observed showed signs of intensive grazing and 37.3% suffered from insect attacks. 3.6% and 1.6% were affected by adverse effects of abiotic and human agents, respectively. As in the previous years, there are some more unfavourable factors to forest condition:

- Forest grazing, mostly overgrazing during the regeneration period and in the early stages of stand development of *Abies* spp. and *Quercus* spp.
- Lack of proper management, combined with „negative cuttings“ of nearby villagers
- Attacks by the insect *Lymantria dispar* and the fungus *Microsphaera alphitoides* on *Quercus conferta*, *Thaumetopoea pityocampa* on *Pinus* spp., *Rhynchaenus fagi* on *Fagus* spp. as well as infestations by *Cacoecia murinana* and *Viscum album* in stands of *Abies* spp.

3.2.4.2 Italy

In 1995, 4 549 trees in 210 plots were assessed. 56.2% of all trees were classified as defoliation class 0 and 24.9% as defoliation class 1. 15.9% were moderately and 3.0% severely defoliated. No tree was dead. The rate of damaged trees was 19.4% for conifers and 18.5% for broadleaves.

The 1995 survey reveals the following for the main species:

- 45.5% of all *Pinus* spp. trees showed no symptoms of defoliation. 31.1% were classified as damaged.
- 75.3% of all *Picea abies* trees were classified as not defoliated. The rate of damaged trees was 9.0%.
- For *Larix decidua*, the rates of not defoliated and damaged trees were 63.3% and 19.4%, respectively.
- The proportion of *Quercus* spp. trees without symptoms of defoliation was 52.0%, whereas 19.8% were damaged.
- 64.6% of all *Fagus sylvatica* trees were not damaged and 12.5% were damaged.
- Only 43.2% of all *Castanea sativa* trees were classified as defoliation class 0, but 24.9% were damaged.. The rate of damaged trees was 30.3% in the class with trees younger than 60 years, but only 0.9% in the class with trees 60 years and older.

Compared to the previous years, no changes of the defoliation values have been observed. Only two significant phenomena are remarkable:

- A further increase in defoliation of *Castanea sativa* for trees under 60 years old, probably connected with attacks by the persistent myco-parasite *Endothia parasitica*
- A further increase in defoliation of all conifers for trees under 60 years old, with particularly high values in *Larix decidua*, probably connected with air pollution.

Due to some gaps in knowledge, the causal connections and synergism between forest damage, air pollution, climatic fluctuations, global changes and parasite influence cannot be analyzed and proved by a scientific approach. Therefore, also activities for forest recovery have not been committed yet. The investigation of socio-economical implications on forest decline cannot be reliable at a national level. At present, the area of potential deforestation cannot exactly be given.

Recent data for the total area per species are not available for this report. Data of the Sardinia Region are missing. Analytical data per region are not reported, due to some problems of reliability and significance.

3.2.4.3 Portugal

In 1995, 141 plots with 4 230 sample trees were assessed. 72.0% of all trees were under 60 years old. The respective share was 98.9% for the conifers and 57.4% for the broadleaves.

52.4% of all trees showed no symptoms of defoliation and 38.5% were slightly defoliated. The rates of trees moderately and severely defoliated were 8.8% and 0.3%, respectively. No tree was dead. 6.6% of the conifers and 10.4% of the broadleaves were damaged.
In 1995, for the main tree species the damage level was as follows:

- 68.2% of all *Pinus pinaster* trees were in defoliation class 0 and 6.5% in defoliation classes 2-4.
- 28.0% of all *Quercus* spp. trees showed no symptoms of defoliation, whereas 14.0% of the trees were classified as damaged.

85.1% of all *Eucalyptus* spp. trees were not damaged. Only 1.4% were damaged.

In contrast to the previous years, the forest condition declined in 1995. The proportion of trees classified as defoliation class 0 decreased by 11.4 percent points. The percentage of damaged trees rose by 3.4 percent points, but was still far beneath the high damage level of 1990-1992.

The deterioration in 1995 was more obvious in broadleaves than in conifers. The rate of conifers in defoliation class 0 slightly decreased by 3.6 percent points, whereas the corresponding share for broadleaves strongly declined by 15.1 percent points. The proportions of damaged conifers and broadleaves increased by 1.2 percent points and 4.6 percent points, respectively.

3.2.4.4 Spain

In the 1995 survey, 10 896 trees on 454 plots were assessed. 72.7% of all trees were younger than 60 years. The respective rate was 82.6% for conifers and 63.1% for broadleaves.

The rates of trees in defoliation classes 0 and 1 were 28.7% and 47.8%, respectively. 18.9% of all trees were moderately and 2.6% severely defoliated. The share of dead trees was 2.0%. The proportion of damaged trees was 18.1% for conifers and 28.7% for broadleaves.

For the main tree species, the damage level in 1995 was as follows:

- Only 10.1% of all *Pinus halepensis* trees showed no symptoms of defoliation, but 26.2% were damaged.
- The proportion of *Pinus sylvestris* trees in defoliation class 0 was 40.5%. The share of damaged trees was 12.1%.
- 49.8% of all *Pinus pinaster* were not defoliated and 8.3% were damaged.
- Of all *Quercus ilex* trees, only 13.7% showed no symptoms of defoliation, whereas the rate of damaged trees was 32.9%

In the previous years, the forest condition has been considerably deteriorated. From 1990 to 1995, the rate of not defoliated trees has been continuously decreasing from 78.4% to 28.7%. In the same period, the proportion of damaged trees has been increasing from 4.6% to 23.5%. In 1995, the rate of trees in defoliation class 0 decreased by 9.7 percent points and the proportion of damaged trees increased by 4.1 percent points. For conifers, the percentage of trees in defoliation classes 2-4 decreased by 1.5 percent points, whereas the corresponding share for broadleaves increased by 9.4 percent points.

Drought is assumed to be the major factor for the observed forest decline. In the previous years, the vegetation had already suffered by a continuing lack of precipitation. After a winter and a spring nearly without any precipitation, the summer 1995 was quite dry in the middle and south of the peninsular. Thus, vegetation showed only very low increment and foliage was reduced to a minimum. On the other hand, the lack of water seems to have hindered the growth of grass which is indispensable for fire spreading.

An additional climatic factor affecting forest condition was the late frost period between April and May. A great number of species had already begun leaf sprouting because of the high temperatures at the beginning of spring. Thus, the damage was important in the middle of the peninsula.

In addition to these factors, the classical damaging agents must be mentioned like insects (*Thaumatopoea pytiocampa* on *Pinus* spp., *Lymantria dispar* on broadleaves and *Lymantria monacha* sporadically), high population of lice, fungi and local high damage by parasitic plants (*Viscum album* and *Arceuthobium oxycedri*).

The influence of air pollution on the development of the forest health status cannot be quantified directly being one damaging factor among others which are more obvious. However, there is no doubt that air pollution together with other agents is of importance for the process of forest decline. The continuation of the forest condition survey is an effective and useful method for the knowledge of the forest health status. Defoliation seems to be an useful indicator, whereas the evaluation if discolouration seems to be of minor importance.

3.2.4.5 Turkey

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

3.2.5 Western Europe

3.2.5.1 Belgium

Flanders

Until 1994, the forest condition survey in the Flemish region was based on a 8x8 km grid. In 1995, 30 new plots were established and assessed for the first time to include more broadleaves in the inventory. The selection was based on a 4x4 km grid. In all 1 728 trees on 72 plots were assessed in 1995, compared with 1 008 trees on 42 plots in 1994.

In 1995, the proportion of trees classified as defoliation class 0 was 10.9%. 55.9% of all trees were slightly and 32.6% moderately defoliated. The remaining 0.6% were severely defoliated trees. The rate of damaged trees for conifers and broadleaves was 24.1% and 37.6%, respectively.

Compared to 1994, the proportion of damaged trees increased by 11.0 percent points. If only the common sample trees of 1994 and 1995 are considered, the respective share has risen by 8.4 percent points. Especially in broadleaves, defoliation and discolouration have been increasing since 1994.

For the main tree species, the development of defoliation was as follows:

- In *Pinus sylvestris* stands, the share of damaged trees was 21.0% in 1995, compared with 20.4% in 1994. Defoliation increased in trees younger than 60 years.

- The proportion of damaged *Pinus nigra* trees increased from 27.5% in 1994 to 36.7% in 1995. The deterioration occurred in all age classes. Infections by the fungus *Sphaeropsis sapinea* caused dieback of shoots and branches.
- The condition of *Quercus* spp. was less favourable than in the previous years. In 1995, 42.1% were in defoliation classes 2-4. A remarkable shift from slightly defoliated to moderately defoliated trees has been observed.
- *Fagus sylvatica* was the most affected tree species. The level of damaged trees sharply increased to 44.4% in 1995. Drought stress during the summers of 1994 and 1995, very high fructification and biotic agents (*Apoignomonia errabunda, Rhynchaenus fagi*) were important factors influencing this result.

Unfavourable weather conditions during the last summers with high temperatures and drought may partly explain the deterioration of forest condition in 1995. The occurrence of important insect damage and fungal diseases was low in most tree species, except in *Fagus sylvatica*. During summer several periods with very high ozone levels occurred. Sensitive plant species, used as indicators, showed symptoms of ozone damage. However, it remains unclear to what extent the forest condition was influenced by these high ozone concentrations. In general, the interaction between unfavourable weather conditions, natural stress and air pollution might be the cause of the weakening of the forests.

Monitoring of the forest ecosystem in the plots of Level II will be continued and research will be carried out on *Sphaeropsis*-attack, dieback in *Quercus* spp. and ozone damage. In 1994, a measuring tower was constructed near one Level II plot. In 1995, the first measurements of concentrations of air pollutants (SO_2, NO_x, NH_3 and O_3) were carried out.

Wallonia

In 1995, 63.9% of all trees assessed showed no signs of defoliation and 21.3% were in defoliation class 1. 13.5% were slightly and 1.2% moderately defoliated. The proportion of dead trees was 0.1%. The rate of damaged trees was 18.4% for conifers and 12.2% for broadleaves.

Compared to 1994, the share of not defoliated trees was almost constant (-0.9 percent points). The rate of damaged trees slightly increased by 1.5 percent points. After a remarkable improvement in 1993, health status in conifers and broadleaves has been developing differently. For conifers the improvement has been maintained, whereas the condition of broadleaves has been continuously deteriorating since 1993.

For the main tree species, the development of defoliation was as follows:

- Compared to 1994, the rate of damaged *Picea abies* trees slightly decreased by 1.3 percent points to 19.2%.
- The improvement of *Pinus sylvestris* continued. In 1995, the proportion of trees classified as damaged decreased by 9.0 percent points to 20.0%.
- In 1995, 13.8% all *Quercus* spp. trees were damaged, which is an increase by 6.2 percent points compared to 1994.
- The rate of *Fagus sylvatica* trees in defoliation classes 2-4 increased by 4.4 percent points to 14.8% in 1995.

Investigations about defoliation in connection with identified damage causes revealed the following: Only insects (*Ips* spp., *Orchestes fagi* and some caterpillars) seem to have contributed to defoliation in 1995. However, because these cases represent only 14% of all trees with symptoms of defoliation, evidence is given of the complexity of the phenomenon.

Native *Quercus* spp. were exhaustively observed (report under preparation). In 1995, in some regions the two native oak species suffered from various kinds of caterpillars, especially from *Erannis defoliaria Cl.* and *Operophtera brumata L.*).

After some heavy windthrows in 1990, the attacks by bark beetles, especially *Ips typographus*, forced the installation of pheromone traps and partly the use of pyrethrinoides. However, damage was observed after the second flight in 1995.

Wallonia currently gives financial support to research in the following fields:

- Effects of different kinds of Ca-Mg fertiliser on the nutrient status of young stands
- Silvicultural risks in *Pseudotsuga menziesii* and *Larix* spp. stands with specific problems such as lack of copper or intoxication by manganese
- Characterization of the development of deterioration symptoms in *Fagus sylvatica* and *Picea* spp. and determination of thresholds for nutrient shortage
- Eco-physiology of *Fagus sylvatica* and *Picea* spp. in respect to climate change.

Finally, Wallonia has assigned the Department of Water and Forests of the Catholic University of Leuven to install and to survey eight plots for intensive monitoring of forest ecosystems (EC-Regulation 1091/94), which are representative for the main tree species.

3.2.5.2 Denmark

In 1995, 34.3% of all assessed trees were classified as defoliation class 0. The rate of trees slightly defoliated was 29.1%, whereas 36.6% were damaged.

The proportion of trees without symptoms of defoliation was 42.0% for the conifers, but only 21.1% for the broadleaves. 34.8% of the conifers and 39.7% of the broadleaves were damaged. 3.2% of all coniferous and no broad-leaved trees were dead.

Compared to the survey 1994, the share of trees in defoliation class 0 decreased by 4.4 percent points to the lowest level since the beginning of the time series in 1987. The proportion of damaged trees stabilised on its high level (+ 0.1 percent points). Within the class of damaged trees, the share of severely defoliated and dead trees decreased by 2.6 percent points to 5.0% and is thus back at the pre-1991 level.

Compared to 1994, the rate of damaged *Picea abies* trees decreased by 3.7 percent points to 32.4%. In general, there were still problems with weakened trees in middle-aged and old stands. The proportion of dead trees increased by 0.6 percent points to 3.3%.

After several years of worsening, the condition of *Picea sitchensis* improved in 1995. The proportion of trees in defoliation classes 2-4 sharply decreased from 52.8% to 34.6%. On the other hand, the share of dead trees older than 60 years was 4.0%, whereas not any dead

Picea sitchensis tree had been noted in 1994. Attacks by the green spruce aphid have been increasing since last year.

In 1995, the most damaged tree species was *Fagus sylvatica*. The share of damaged trees strongly increased from 25.3% to 51.9%. Especially the middle-aged and older stands were clearly weakened because of the extensive drought and heathwaves throughout the summer months in 1994 and 1995. Compared to earlier years, the amount of leaves was small, and flowering was vigorous.

From 1994 to 1995, the proportion of damaged *Quercus* spp. trees sharply decreased from 76.6% to 36.2%, mainly due to a remarkable shift from moderately to slightly defoliated trees. The rate of trees in defoliation class 0 only slightly increased by 1.9 percent points to 3.8%. Compared to the two latest years of lacking and dissatisfying bud bursting, *Quercus* spp. showed a satisfying bud bursting in spring 1995.

The National Forest and Nature Agency will continue to survey the condition of the Danish forests. Additionally, the National Forest and Nature Agency will take part in the set up of a more detailed international monitoring programme (Level II), which will contribute to a better description of the condition of forest ecosystems and to a better knowledge on the changes in forest condition. The Level II survey will take place at 16 plots in Denmark, namely at the stations of Klosterhede, Ulborg, Lindet and Frederiksborg forest districts.

3.2.5.3 France

In 1995, 63.0% of all trees assessed were classified as defoliation class 0 and 24.5% as class 1. 11.0% were moderately and 1.3% severely defoliated. 0.2% of the trees were dead. The proportion of damaged conifers was 9.2%, compared with 14.3% of broadleaves.

For the main tree species, the 1995 survey revealed the following:

- 69.6% of all *Pinus* spp. trees showed no symptoms of defoliation. 9.4% were classified as damaged.
- Of all tree species, *Picea abies* had the best health status. 91.4% of the trees were in defoliation class 0. The share of trees in classes 2-4 was 1.7%.
- For *Abies alba*, the rates of not damaged and damaged trees were 62.7% and 10.5%, respectively.
- The proportion of *Quercus* spp. trees without defoliation symptoms was 55.9%, whereas 12.3% were damaged.
- 51.6% of all *Fagus sylvatica* trees showed no symptoms of defoliation and 19.6% had a defoliation of more than 25%. In 1995, the condition of *Fagus sylvatica* extremely deteriorated. To a great extent, this can be explained by the late frost in mid-May.
- 81.9% of all *Castanea sativa* trees were classified as defoliation class 0 and 8.1% as damaged.

Compared to 1994, the forest condition deteriorated. The rate of damaged trees rose by 4.1 percent points to the highest level since the beginning of the time series in 1986. The increase was only 1.0 percent points for conifers, but 5.9 percent points for broadleaves.

In the previous years, *Quercus robur*, *Quercus pubescens* and *Quercus ilex* have been continuously declining. In 1995, the proportion of damaged trees reached new peak values. For *Quercus petraea*, the situation was similar. The interpretation of the deterioration is difficult. However, the very dry period 1989-1991 seemed to be a predisposing factor and weakened the trees over years. In 1995, the degradation can partly be explained by stress due to a late frost in May and the hot and very dry summer.

Since 1989, forest condition has been affected by several years with unfavourable weather: After the two dry years 1989 and 1990, water deficiency lasted until 1992. From the hydrological point of view, the situation improved in 1993 and 1994, but very hot periods caused discolouration and premature leaf-fall. Finally, a late frost happened mid-May 1995, and the summer 1995 was hot and very dry.

3.2.5.4 Ireland

In 1995, 21 plots with 441 trees were assessed. One plot was clear-cut in 1994 and could not be included in the 1995 survey. Three species are represented in the survey: *Picea sitchensis* (214 trees), *Picea abies* (63 trees) and *Pinus contorta* (164 trees). All trees assessed are up to 59 years old.

35.8% of all trees showed no symptoms of defoliation and 37.9% were slightly defoliated. 26.3% were damaged: 24.0% and 2.3% were in defoliation class 2 and 3, respectively. No tree was dead.

All four plots in defoliation class 2 are located in coastal areas of the Southwest, West and Northwest. Three of these plots contain *Pinus contorta* trees only, one contains *Picea sitchensis* only, and the remaining plot contains a mixture of *Picea sitchensis* and *Pinus contorta*. In contrast, plots in the midlands and eastern areas had lower damage levels.

Compared to 1994, the rate of trees without defoliation increased by 2.9 percent points, whereas the proportion of trees slightly defoliated decreased by 9.5 percent points. The share of damaged trees increased by 6.6 percent points to the highest level after 1993.

In 1995, the rate of *Picea sitchensis* trees without symptoms of defoliation increased by 5.6 percent points to 47.2%. However, an increase in the percentage of damaged trees occurred, too. The share rose by 4.7 percent points to 20.6%, which is still under the damage level of 1993. The mean defoliation slightly decreased by 0.3 percent points to 17.3%.

Picea abies improved considerably. From 1994 to 1995, the rate of trees in defoliation class 0 increased from 28.6% to 49.2%, whereas the proportion of damaged trees decreased by 4.7 percent points to 14.3%. As in the previous year, all damaged trees were moderately defoliated. In 1995, the mean defoliation decreased by 3.8 percent points to 14.9%.

The condition of *Pinus contorta* deteriorated remarkably in 1995. The proportion of trees in defoliation class 0 decreased by 7.3 percent points to 15.9%, whereas the rate of damaged trees increased from 25.0% to 38.4%. However, only 3.6% of the trees were severely defoliated. In 1995, the mean defoliation increased by 6.4 percent points to 26.6%. The condition of *Pinus contorta* has been slowly declining since the beginning of the time series in 1988. The percentage of damaged trees reached its highest level in 1995.

In 1995, the discolouration of *Picea sitchensis* and *Picea abies* decreased, whereas the discolouration of *Pinus contorta* increased. 21.3% of all *Pinus contorta* trees were in discolouration class 2. The respective rates for *Picea sitchensis* and *Picea abies* are 5.2% and 3%, respectively.

The overall deterioration in forest condition is attributed mainly to an increased incidence of *Ramichloridium pini* in *Pinus contorta* and to an increase in damage due to nutritional problems in all three species, but especially in *Pinus contorta.* Damage due to exposure and due to *Elatobium abietinum* decreased in the 1995 survey. However, exposure still remained the single greatest cause of damage in the Irish survey. *Neodiprion sertifer* was recorded for the first time since the 1993 survey. None of the damage recorded was due to anthropogenic influences.

3.2.5.5 Luxembourg

The 1995 survey was carried out on 51 plots with 1 166 trees. Concerning the comparison between conifers and broadleaves, it has to be noted, that only 27 of 404 assessed coniferous trees were more than 60 years old. Nearly a quarter of all observations in coniferous stands were derived from trees younger than 10 years. The aim of the assessment merely is to demonstrate the development of forest condition. The results cannot be generally transferred to forest condition in Luxembourg.

In 1995, only 32.1% of all trees showed no symptoms of defoliation. 29.6% were slightly defoliated and 38.3% were classified as damaged.

The results of the 1995 survey confirmed the continuous deterioration of forest condition over the last 10 years, which is mainly due to an increasing percentage of trees in defoliation class 2. The corresponding rate had risen from 3.7% in 1986 to 10.0% in 1989. After the severe windbreaks in 1990, in which no survey had been carried out, the share of trees moderately defoliated has been increasing from 18.0% in 1991 to 35.3% in 1995.

After a continuous worsening in the previous years, the condition of conifers (with *Picea abies* as main species) stabilised in 1995. The proportion of trees without defoliation symptoms increased by 3.0 percent points to 59.4%, whereas the rate of damaged trees has remained nearly unchanged (+0.1 percent points to 12.9%).

The development of the broadleaves (underwood species included) remains alarming. Since 1989, the share of trees in defoliation class 0 has been continuously decreasing. In 1995, only 17.6% of the trees were classified as not defoliated, which was 4.6 percent points less than 1994. The percentage of damaged broadleaves increased by 4.6 percent points to 51.4%. The condition of *Fagus sylvatica* is worse than that of *Quercus* spp. The share of not defoliated *Fagus sylvatica* trees has shown a comparatively more pronounced decrease during the last years. However, this is less obvious in defoliation classes 2-4. Therefore, the different development of both tree species has to be interpreted carefully.

In 1995, the health status of underwood species slightly improved after deterioration in previous years. The rate of undamaged trees decreased from 97.0% in 1984 to 19.2% in 1995, whereas the share of moderately defoliated trees rose from 14.5% in 1993 to 35.2% in the same period.

Since 1992, unusual droughts at the beginning or during the growing season have been recorded. Even if the unusual dry summers probably have influenced the forest condition in an unfavourable way, currently no definite statement can be made as to which extent the deterioration of the forest condition is caused by air pollution and natural stress, respectively.

3.2.5.6 Netherlands

In 1995, the Dutch Ministry of Agriculture, Nature Management and Fisheries established a new network of 200 survey plots representative for forests on sandy soils. These plots are selected from the former 1x1 km grid. The network aims at the monitoring of changes in the condition of the major tree species and changes in the forest ecosystem as a whole. It also aims at providing a better understanding of the causes of such changes. In the plots of the new network, forest health, insect and fungal damage as well as the chemical composition of the soil, leaf composition, soil vegetation and mycorrhizas were intensively monitored. The national Forest Health Survey, carried out in previous years, was not conducted this year.

The number of trees assessed in the 1995 survey was 5 000, as compared with 31 475 trees on 1 259 plots in 1994.

In 1995, 44.5% of all trees showed no symptoms of defoliation. 23.5% were slightly defoliated and the remaining 32.0% were damaged. The rate of trees in defoliation classes 2-4 was 45.4% for the conifers, but only 10.8% for the broadleaves.

Compared to 1994, the forest condition has deteriorated. The share of trees in defoliation class 0 decreased by 16.2 percent points, whereas the rate of damaged trees increased by 12.6 percent points. The extent of the deterioration may be partly a result of the changes in the sample, but a subsample of common plots in 1994 and 1995 showed a decline, too.

In 1995, in particular *Fagus sylvatica* and to a lesser extent *Quercus* spp. and *Larix kaempferi* have deteriorated. The condition of *Pinus* spp., *Pseudotsuga menziesii* and *Picea abies* remained more or less the same.

The deterioration of *Fagus sylvatica* was mainly caused by the combination of drought and a very rich mast. *Quercus* spp. and *Larix kaempferi* were affected by fungal and insect damages. However, none of these factors completely accounts for the decline. Serious damage by insects or fungi was hardly observed. Some *Picea abies* stands showed damage by *Ips* spp. About 40% of the forests with *Pinus* spp. were slightly affected by *Sphaeropsis* spp.

The trend in the development of the forest condition over the period 1984-1995 is clearly negative for *Pseudotsuga menziesii, Picea abies,* and *Pinus nigra.* For *Picea abies* this trend is attributed to a number of warm and dry years and attacks by *Ips* spp. Nitrogen deposition is considered a contributing factor in the continuous deterioration of *Pseudotsuga menziesii* and *Pinus nigra*. Several studies support the hypothesis that nitrogen deposition contributes to the disturbance of the nutrient status and increased susceptibility for detrimental fungi in these two species.

The results of the research on the chemical composition of the soil, leaf composition and soil vegetation will not be available until next year.

3.2.5.7 United Kingdom

In 1995, the rate of trees in defoliation class 0 was 41.7%. 44.7% of all trees were slightly defoliated and 13.6% were damaged. There were no remarkable differences in defoliation between the values for conifers and those for broadleaves.

With the exception of *Fagus sylvatica* there were no major changes in crown condition compared to 1994. *Quercus robur* and *Picea abies* deteriorated slightly but *Pinus sylvestris* maintained an improvement which began in 1993. *Picea sitchensis* has improved continuously since 1988. By contrast, the condition of *Fagus sylvatica* deteriorated to such an extent that an improvement which had taken place over the preceding three years was eliminated. As in an earlier major deterioration in *Fagus sylvatica* (in 1990), the decline was associated with heavy mast production.

No major causes of damage were evident on the other species surveyed but defoliation by *Operophtera brumata*, *Erannis defoliaria* and *Tortrix viridana* were important in some *Quercus robur* plots. Other damaging agents recorded were wind, exposure, *Rhynchaenus fagi* on *Fagus sylvatica*, *Elatobium abietinum* on *Picea sitchensis* and the fungus *Cucurbitaria piceae* on *Picea abies*. Apart from foliage discolouration in a few plots of *Fagus sylvatica*, a severe drought apparently had little effect on woodland trees during the survey period.

3.2.6 South-eastern Europe

3.2.6.1 Bulgaria

In general, on national level, forest health was characterized by a relatively high percentage of damaged trees. Among the conifers a deterioration of health condition in *Pinus nigra* and *Pinus sylvestris* stands were observed. An increase of the share of moderately to severely defoliated and dead trees was registered, compared to the 1994 results. Stands situated up to 700-800 m altitude were more affected. Scots pine stands at 1000-1500 m altitude were in a better condition.

The negative trend in *Pinus sylvestris* condition that started in 1993 was significant in 1995, especially in the central, eastern and south-eastern regions of Bulgaria. Attacks by *Spaerosis sapinea* were registered. A slight recovery was observed in the health status of *Abies alba*, especially in the western regions of the country.

Among the broadleaves *Fagus sylvatica* was in a relatively better condition. Damage caused by *Orchestres fagi* was not so significant but strong attacks by *Nectria detisima* were marked. Health status of *Quercus* spp. remained bad with a negative trend all over the country. On some places the share of severely damaged trees was up to 40%. Intensive attacks by *Ceratocystis* spp. and *Scolitis* spp. were observed.

Special investigations conducted in 1995 showed a correlation between the degree of defoliation in *Pinus sylvestris*, *Pinus nigra* and *Quercus petraea* and heavy metal content in soils with high acidity. A comparative analysis showed that high content of Fe, Pb, Mn, Cu and Zn in indicator plants correspond to high heavy metal content in litter and upper soil layers.

Altogether 180 sample plots on national level (16 x 16 km, 8 x 8 km grid) were observed in 1995, 4 277 coniferous trees and 2 772 broadleaved were assessed. Statistical data air pollution showed that SO_2, CO_2 and NO_x were the most significant pollutants. The main sources of pollution were power stations, traffic and industry. Investigations on rainfall conducted in Central and Southern Bulgaria showed a trend of acidification.

3.2.6.2 Hungary

In 1995 the damage survey covered the entire forest area with 1 104 sample plots and 23 289 sample trees assessed. As a result of continuous afforestation and a revision of the clear-cut areas, 40 new plots were established throughout the country in 1995, for the completion of the representative sample.

The percentage of trees without any visible defoliation was for all trees 43.9%, for broadleaves 42.9% and for conifers 49.3%, while 36.1% of all trees were in the warning stage and the remaining 20% were considerably defoliated or dead. The rate of dead trees still remained rather high with 2.9% closely related to the transition of ownership structure, affecting 40% of the forest area.

The most endangered species were oaks, with 32% of European oak, 28.6% of sessile oak in damage classes 2-4, followed by black locust with 26% in damage classes 2-4. The least symptoms were observed in beech and hornbeam with 6.6% and 9%, respectively.

Discolouration has never been a widely observed symptom in Hungary except the years with low precipitation or long hot summer periods, when the correlation of yellowing and insufficient water supply was evident.

Altogether 87.7% of the trees showed discolouration, and only two important species - black locust and hornbeam - exceeded the 15% by the number of trees affected, with 27% and 17% discoloured trees, respectively. Trees classified as discoloured were dominant in damage class 1, only 1.7% were classified to damage classes 2-3.

Since 1988 it was the second survey in 1995 that the worsening tendency has slightly changed, defoliation and discolouration was lower - like in 1993 - than that of the previous years. The most obvious reason in both years was the higher precipitation and better water supply. It is difficult to identify the role of air pollutants - as a possible predisposing factor - on the sample plots, while abundant appearance of insects and fungi related to extreme weather conditions in the last years was frequently reported.

Slight fluctuation of defoliation during the last three years can be interpreted as stabilisation of the health status. Despite of the stagnation, oaks and black locust are in bad condition and since the first survey nearly continuous worsening of oaks has been observed. Gradual recovery of black locust and Austrian black pine continued while the most intensive recovery resulted by the return of the usually low defoliation of beech after its unexplained bad condition in 1994.

Heavy attacks of different caterpillars on broadleaves in springtime were reported. Due to rain the canopies did not show any damage at the time of the assessment. The favourable weather condition stimulated the oaks to grow secondary shoots as well as the intensive appearance of *Microsphaera quercina.*

The health status of some tree species and the deterioration of forests in certain regions underline the importance of the damage survey and the extension of the work toward the more intensive levels. Until now no clear evidence of large scale effect of air pollution has been observed, however, local damages attributed to air pollution were reported. The installation of the Level II plots was finished in 1995 after a revision of the national system. 14 plots were selected fulfilling all the requirements in the ICP Manual. It is an advantage that the majority of the plots has a long series of observation data since the middle of the eighties.

3.2.6.3 Romania

In the 1995 survey, 8 371 plots with 338 817 sample trees were assessed. 51.9% of all trees showed no symptoms of defoliation, 26.9% were slightly, 16.8% moderately and 2.4% severely defoliated. 2.0% of all trees have died.

The results of the 1995 survey show a relative stabilisation in defoliation classes 2-4 in both, conifers and broadleaves; 21.2% of all assessed trees were in defoliation classes 2-4. Conifers still performed a better forest condition than broadleaves (15.2% of the conifers and 23.0% of the broadleaves being in defoliation classes 2-4).

Among conifers, *Larix decidua* was the most seriously affected species, with 19.4% of the sample trees being in defoliation classes 2-4, followed by *Abies alba* (18.7%). Compared to 1994, *Larix decidua* showed the greatest increase in defoliation classes 2-4 (+9.2 percent points), followed by *Picea abies* (+1,7 percent points), while *Abies alba* and the pines showed a decrease in defoliation, -3.6 percent points for *Abies alba* and -2.7 percent points for pines).

Among broadleaves, the most defoliated species (defoliation classes 2-4) were *Quercus pubescens, Quercus pedunculiflora, Quercus rubra* with 51.8%, *Quercus frainetto* with 42.7%, followed by *Robinia pseudoacacia* with 33.9% and *Populus* spp. with 30.9% trees in these damage classes. The deterioration of these species was caused mainly by excessive drought phenomena and by other climatic and soil stress factors. The less affected species among broadleaves was *Fagus sylvatica* (17.6% of sample trees were in defoliation classes 2-4) followed by *Quercus petraea* (25.2%).

Compared by age, younger trees (up to 60 years) were slightly more defoliated with 21.7% trees in classes 2-4 than the older ones (above 61 years) with 20.7% trees. As to discolouration there was a slight improvement compared to the previous year.

3.2.7 Eastern Europe

3.2.7.1 Belarus

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

3.2.7.2 Republic of Moldova

In 1995 forest condition was assessed on 568 sample plots comprising 16 442 sample trees on the 2x2 km national grid. With 16 376 trees, broadleaves were most represented compared to only 66 conifers.

Of the trees of all species, 40.4% were damaged (classes 2-4), 25.6% were healthy and 1.0% were dead. As to tree species, Black locust was most affected with 52.0% trees in classes 2-4, followed by oak with 43.0% and sessile oak with 27.2%. Poplar also showed a high percentage of damaged trees (75.0% in classes 2-4), but the number of trees assessed was only 124. (Due to their late arrival, crown condition data could not be included in Annex II).

In comparison to 1994, both for all species and for individual species the percentage of trees showing defoliation >25% increased. This situation can be explained by excessive drought during the last 15 years and the effects of air pollution. Special investigations in the main forest ecosystems will identify the factors which affect the health of Moldavian forests. Probably, these studies will be developed next year. In 1995 a part of the soil samples was taken (Level I) which will be analyzed in 1996.

3.2.7.3 Russian Federation

Leningrad region

In 1995 the crown condition assessment was made on the same national grid established and assessed during 1989-1994 by the NFC of northwestern Russia located at Sankt Petersburg State University. The grid density is 32 x 32 km in the whole region, 16 x 16 km in the western and 4 x 4 km in the southwestern part of Leningrad region. The grid comprises 129 sample plots with only pine trees (*Pinus sylvestris*).

In 1995, 42.1% of all pine trees assessed were classified as healthy (defoliation class 0) and 32.0% were in the warning stage (class 1). 10.1% were classified as damaged, with 9.0% being moderately defoliated (class 3), 0.4% severely defoliated (class 4) and 0.7% dead (class 5).

Compared to the survey 1994, the share of healthy trees decreased by 9.0 percent points (from 51.1% to 42.1%). The proportion of damaged trees (classes 2+3+4) increased by 2.5 percent points (from 7.6% to 10.1%). Natural factors (dry summers in 1991 and 1992, severe frost without snow in the winter of 1994/95) together with air pollution weakened the trees, disposing them to insect injury. These factors together are responsible for the defoliation observed in Leningrad region, which is, however, less pronounced than in the other part assessed in Russia, namely Kaliningrad region.

Besides crown condition, heavy metal concentrations in mosses were assessed. These analyses were sponsored by the Nordic Council of Ministers. Moreover, the following studies were initiated in cooperation with Finland:

- analyses of epiphytic lichens as bioindicators of air pollution
- SEM investigations of needle and bark surface
- evaluation of satellite images
- analyses of total and exchangeable cations in soil.

Finally, the Scientific Research Centre for Ecological Safety of the Russian Academy of Sciences has been assigned by the NFC to install and to survey twelve plots for intensive monitoring of forest ecosystems on Level II. By the time of finalization of the present report, 6 plots were already installed.

3.2.7.4 Ukraine

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

3.2.8 North America

3.2.8.1 Canada

The health of Canadian forests 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 sulphates (SO_4), nitrates (NO_3), ozone (O_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 personnel of the Canadian Forest Service.

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 identifying the cause of the observed damage; insects, diseases, weather, air pollution etc. A long term goal is also to monitor changes in vegetation and soils attributable to acid deposition and other pollutants.

An analysis of the data collected from the ARNEWS plots in 1995 indicates that there are no large scale declines in the health of Canadian forests caused by atmospheric pollution. This is the same conclusion resulting from previous years' data. 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 1-2% 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. The effects of insects, diseases, drought and storms were observed frequently, occasionally causing mortality above 2%. Many stands are recovering from the effects of insect defoliation which affected extensive areas of forest over the past two decades. However, some stands along the southern edge of the Canadian Shield do not appear to be recovering from insect damage. While it is not clear that the damage is related to pollutants; these stands are primarily on acid-sensitive soils and in areas where pollution is damaging lakes and rivers.

Although no decline of tree health over extensive areas was observed, there was a decline in the health of two species of white birch, (*Betula papyrifera* and *B. cordifolia*) in eastern Canada around the Bay of Fundy in New Brunswick, and nova Scotia. Trees in this area have been damaged for several years by leaf browning and premature leaf fall. Many trees have died, others have many dead twigs and/or branches. The area of damage is coincident with the presence of acid fogs, at Ph 3.0 or lower, that occur frequently in summer. Similar damage has been induced in the laboratory on leaves, and it is apparent that the damage is caused by pollution. The extent of the damage which covered over 60,000 hectares in 1994 was reduced in 1995. Damage occurred only in isolated areas scattered around the Bay of Fundy.

In New Brunswick flecking on needles was reported on white pine (*Pinus strobus*), red spruce (*Picea rubens*), white spruce (*P. glauca*), black spruce (*P. mariana*), and balsam fir (*Abies balsamea*). The observed damage resembles that caused by ozone, although the cause has not yet been determined. Research is currently underway to determine the causes of this damage.

In addition to the ARNEWS, another network of plots is in operation to assess the condition of sugar maple (*Acer saccharum*). This joint project between Canada and the United States was established in 1988, and measures crown condition in unmanaged stands and in stands managed for the production of maple syrup.

The condition of tree crowns is assessed by measuring crown dieback and crown transparency. Dieback is branch mortality that begins at the terminal portion of the branch and progresses downward and is a result of stress on the tree. Transparency is the amount of skylight visible through the foliated portion of the crown. Results to date show that most of the trees (>90%) are healthy, and the health of sugar maples is similar in stands managed for syrup production, and unmanaged stands. Older trees tended to have more dieback than smaller, younger trees.

When trees in different zones of pollution deposition were compared, it was found that crown dieback was higher in the highest deposition zone of nitrates. Maples on soils of low buffering capacity also had higher dieback than trees on well-buffered soils. Since dieback is closely correlated with tree health, this tendency is cause for concern for the health of sugar maple over the long term if deposition continues at current rates.

Canada's forests are a valuable economic and sociological resource whose sustainability is essential to our well-being. An early warning system to detect and monitor conditions is an essential part of our commitment to the sustainability of Canada's forests.

3.2.8.2 United States of America

No report was received from the United States of America at the time of the completion of this report.

3.3 Interpretation of the results

The results of the crown condition assessments are based on the transnational and national surveys of 1995. The transnational survey comprised a total of 117 305 trees on 5 388 plots in 30 countries, which is the largest transnational database ever due to the completion of the grid in Sweden and Finland and due to the inclusion of the Russian Federation. The national surveys comprised 634 993 trees on 25 170 plots in 30 countries.

In accordance with the objectives of the large-scale transnational and national surveys, their results can be interpreted with respect to the **extent**, **spatial distribution** (climatic regions) and **temporal development** of **forest damage** in terms of **crown condition.** Besides this, the **relationships** between crown condition and further **tree and site related data** are investigated. These investigations, however, do not permit definite conclusions on cause-effect relationships. The reason for this restriction is that **defoliation** and **discolouration**, though key parameters in the centre of the discussion since the beginning of forest damage research and assessment, are by themselves neither specific for recent forest damage in general nor for air pollution damage in particular. This must be taken into account for any interpretation of the survey results.

As regards cause-effect relationships, the national reports contain valuable information which was also utilized for the interpretation of the survey results.

Spatial variation of crown condition over different climatic regions

Of the total transnational tree sample, 25.3% was classified as damaged. Over the various **climatic regions**, the extent of defoliation varied greatly. Defoliation was highest in central Europe, with 42.2% in the Sub-Atlantic, and with 34.7% in the Continental regions, respectively. Lowest defoliation was recorded in the Atlantic (south) region with 7.8%.

The differences in defoliation observed between the various climatic regions, however, are not necessarily explainable as of climatic origin. The reason for this is that the climatic regions may differ also in influences on crown condition other than climate. Moreover, the long term, average climatic conditions should not reveal themselves in defoliation, because the reference trees are normally chosen as to account for these particular climatic conditions.

To some extent, differences in defoliation between climatic regions may partly be due to methodological differences between countries. However, the results of numerous international intercalibration courses hardly permit the conclusion that the considerable differences in crown condition between climatic regions can be largely explained by methodological inconsistencies.

The main purpose of the climatic regions is to examine trends in regions of different climate and vegetation, rather than comparing absolute amounts of defoliation.

As in previous years, weather strongly affected forest condition in several countries. More than one half of the participating countries refer to meteorological patterns as influencing forest health. In most cases, drought (e.g. in the Mediterranean lower and higher regions) or cold winter temperatures (e.g. in the Boreal region) were mentioned as triggering factors of the deterioration of forest health conditions. Hot summer also was regarded as predisposing factor for forest decline. Subsequent pest infestation often was considered as secondary, fostered by weather conditions in 1995 or previous years. Some countries, however, reported on improvements due to higher precipitation in winter or early stages of the growing season.

The development of defoliation, as derived from the transnational survey, is in good agreement with the explanations given in the national reports. Mean plot defoliation significantly deteriorated in all climatic regions except for the Boreal (temperate) region. Improvement in the Boreal (temperate) region coincides with more favourable meteorological conditions in some countries belonging to this region. Many of the national reports of the other climatic regions, in contrast, emphasize that hot, dry summers (or cold winters, respectively) impair forest condition.

Relationships between crown condition and further site factors

The survey also bears evidence that forest condition is related to **water availability**. For the second time, mean plot defoliation was investigated regarding water availability. Last year's evaluation was confirmed that mean plot defoliation better reflects the influence of water availability towards forest condition than tree defoliation. Mean plot defoliation was observed to be lowest, where water supply was sufficient. Reduced water availability, in contrast, influenced plot defoliation negatively. A surplus in water supply, however, seems to over-compensate this trend. This may reflect the well-known fact that water logged soil layers increases defoliation of most trees due to anaerobial conditions in the rhizosphere. The overall tendency again corresponds to the national reports, half of which emphasized the relation between forest decline and weather conditions. Nevertheless, the conclusion that sufficient water availability yields lower defoliation is crucial in view of the rough classification of water availability and the inhomogeneous distribution of plots over the three classes.

Mean plot defoliation was also evaluated in connection with **altitude**. As in previous years, highest mean plot defoliation was recorded for altitudes between 251-500m with 35.2%, and between 501-750m with 38.5%. This can be explained by the concentration of main damage areas in highlands of mid altitude. Above 1 500m, the lowest mean plot defoliation was recorded. However, this result should be interpreted with great care. With only 88 plots assessed at altitudes greater than 1500 m, the data base is rather small, representing only 2.0% of all assessed plots. Moreover, vitality of trees generally decreases with higher altitudes. This may be explained by the fact that defoliation in absolute term is generally higher in mountainous areas due to shallow, stony soils and harsh climate. This is taken into account in the crown condition assessment by means of site adapted reference trees.

On 106 609 trees (90.9% of the total tree sample) **identifiable damage** was assessed. Only the presence of such damages was recorded. All but two countries submitted data on damage types. 28 218 of the assessed trees (26.5%) showed identifiable damages of one or more types. As in previous years, the most abundant damage type reported was caused by insects (8.9% of the trees). Damage caused by abiotic agents was reported for 7.1% of the assessed trees; the third in frequency of identifiable damage was caused by fungi (5.0%).

Other damage and action of man were less abundant (4.7% or 3.5%, respectively). This gives evidence for the multitude of stressors responsible for the defoliation assessed. Damage due to classical smoke damage was reported for a very small percentage of the assessed trees (0.2%). On the remaining 73.5% of the trees, identifiable damage was not present.

A strong positive correlation between forest condition and **stand age** proved significant through all Europe. The 1995 survey showed that the share of damaged trees increased from young trees (12.6%) to 30.1% in trees older than 120 years for EU-member states. For total Europe, the increase in defoliation with age was even larger. This reflects the well-known phenological interdependencies between ageing and decrease of foliar development. Possibly, older trees also react more sensitively to unfavourable environmental conditions as young trees.

Temporal variation of crown condition

The direct comparison of the 1994 and 1995 surveys or longer survey periods refers to different **total tree samples.** Thus the comparison of the overall results obtained for different years may distort the development of the forest condition survey. To avoid bias caused by inhomogeneous tree samples, the actual changes are rather derived from the **Common Sample Trees (CSTs).** The CSTs are a sub-sample of trees common to the 1995 and 1994 surveys, selected from the total tree sample. It comprises 94 093 trees or 80.2% of the 1995 total sample. This is the largest number of CSTs ever, which gives evidence of an increasing consistency of the data base.

The share of CSTs in the defoliation classes 2, 3 and 4 increased by 1.6 percent points from 25.2% to 26.8%. The highest increase of defoliation was recorded in defoliation class 2 by 1.0 percent point. The deterioration in classes 3 and 4 appeared to be less distinct.

The most severe deterioration was observed in the Mediterranean (lower) region with the share of damaged trees increased by 6.8 percent points from 1994 to 1995. This result is statistically significant, as is the respective change for the Mediterranean (higher) region by 4.3 percent points. The forest condition in the Boreal and in the Atlantic (north) regions also deteriorated significantly by 2.3 percent points or 2.2 percent points, respectively. In the other climatic regions, the recorded changes in forest condition were less than 2 percent points, or deterioration did not prove statistically significant. In the Boreal (temperate) region, on the other hand, the forest condition significantly improved by 3.7 percent points.

In the Atlantic (north and south) climatic regions the overall increase of damaged trees reflects the severe deterioration in *Fagus sylvatica. Fagus sylvatica* was mentioned in national surveys as being the species showing the highest degree of deterioration. The development of the conifers was not as clearly explainable. Although *Picea abies* and *Pinus nigra* showed generally improving health conditions in both regions, deterioration was reported by certain countries at the local scale.

In southern and south-western Europe, the deterioration of forest condition was partly caused by hot and dry summers over several years. Succeeding pest infestation was recorded, e.g. in Spain, Greece and in Portugal. In France and Spain, late frost periods occurred after flushing, causing severe deterioration of forest condition. The species with the highest increase of defoliation were *Eucalyptus* spp., *Quercus ilex* and *Quercus suber*. *Eucalyptus* spp., however, showed the lowest share of damaged trees of all assessed tree species. A high impact of hot and dry summers on forest decline also was observed in the Continental region. The most severe worsening occurred in plots, where the forest condition was already bad.

In the Sub-atlantic region, plot defoliation decreased, mainly in Germany and in parts of Poland. The condition of *Quercus* spp. improved after deterioration during the previous years. The improvement of *Pinus* spp. was notable. This was interpreted especially as caused by the improvement of environmental conditions in certain areas. Favourable weather was regarded as main factor inducing the improvement. The effect of pest as damaging the forest was considered as being negligible. Yet the improvement of the condition of these species was not large enough for an overall improvement of the forest condition in the Sub-atlantic region.

The Boreal (temperate) region was the only climatic region with a pronounced improvement of forest condition. The national surveys especially stressed the high share of *Pinus sylvestris* among the trees showing improving health condition. On the other hand, severe deterioration was recorded for other tree species. The mild winter was considered as an important factor favourable for pests (e.g. Lithuania). Air pollution, too, was partly regarded as impairing forest condition. The partly severe worsening of several tree species and the overall improvement are no contradiction: due to its high share of assessed trees, the condition of *Pinus sylvestris* dominates over the health condition of other tree species with their distinctly smaller shares of the sample.

With respect to the long term comparison between 1988 and 1995, a common sample of trees was defined, as well. This common sample, however, only comprises the Atlantic (north), Atlantic (south), Sub-atlantic, Mountainous (south), Mediterranean (higher) and Mediterranean (lower) regions. Trees common to 1988-1995 representing other climatic regions were not available. The long term comparison is based on a common sample consisting of 19 065 trees for 12 selected species.

69% of the common sample were considered as being healthy in 1988 (defoliation class 0). Their share annually decreased to 39% in 1995. At the same time, the share of damaged trees seriously increased (8.2% in 1988 to 22.2% in 1995). In the Atlantic (north) , in the Sub-atlantic, the Mediterranean (higher) and in the Mountainous (south) regions, a continuous increase in damaged trees was observed. In the Mediterranean (lower), the health of forest condition declined from 1988 to 1992. In the succeeding assessment period, a distinct improvement was recorded. Afterwards, the number of damaged trees rose again. In 1995 a new maximum of damaged trees was recorded.

Picea abies and *Pinus sylvestris*, have the highest share of the common sample (17.6% or 15.9%, respectively). Their shares of damaged trees clearly increased from 1988 to 1995. Thus the overall result is mainly influenced by these two tree species. In the national reports a series of cold winters was considered as partly impairing the forest condition. Also mentioned is the influence of air pollution. Some national reports, however, even explain retardation of forest decline by the reduction of air pollutants, mainly SO_2.

The Atlantic (south) region still shows the lowest share of damaged trees. Due to the small data base for the long term assessment of forest condition, a satisfactory validation by means of statistics is still missing. Nevertheless the comparison of the long term trends as documented by the common sample of the 1988-1995 period gives evidence for the large-scale development of forest condition in Europe.

Main factors influencing forest condition

Definite causes for the deterioration of forest condition are difficult to identify. National surveys offer a variety of explanations for the forest condition development in the respective countries. Adverse weather conditions play a major role as stressing factor. Frost periods and drought have an important impact on the forest condition in the succeeding vegetation period. In consequence, trees might be more susceptible for insect or fungi attacks. The susceptibility of trees towards pest infestation may be intensified by air pollution. Almost one half of the countries participating in the transnational survey of forest condition mentioned air pollution as potentially affecting trees. These countries are mainly situated in central and south-eastern Europe, where the most severe deterioration of forest condition occurs.

While site conditions and natural damaging agents, particularly drought, explain a substantial part of the deterioration in forest condition observed over large areas during the last decade, long-range transboundary air pollution could also be involved in this trend, as stressed by many national reports. This phenomenon clearly deserves particular attention.

4. CONCLUSIONS AND RECOMMENDATIONS

During the last twenty years, sulphur emissions have dramatically reduced over much of Europe. At the same time, forest damage has continued to increase. This apparent contradiction could be the result of many different factors. Sulphur represents only one of several different types of pollutants, the majority of which have not yet been subject to emission reductions. In many areas, the problem caused by sulphur are related to soil effects, and a considerable time lag may occur between the cuts in emissions and reductions in soil sulphur levels. A further factor is that all pollution effects are superimposed on a suite of natural stresses. These natural stresses may be sufficiently great to obscure any changes brought about by changes to the pollution climate. Consequently, a reduction in pollution will not necessarily be immediately apparent in trends in forest health.

The role of air pollution remained difficult to separate from the influence of other stressors so far, as cause effect studies were not possible with crown condition data alone. However, the full range of monitoring data on Level I, i.e. the time series of crown condition data, the soil condition survey data and the foliage analysis data, open many possibilities of cause-effect studies. This holds true especially for interdisciplinary studies of the impact of air pollution on forests and the calculation of critical loads and levels in connection with other monitoring programmes. Such in-depth studies of the comprehensive Level I database have been launched by ICP Forests and EC, the results of which will be presented inter alia in a special overview report in 1997.

For time series analyses and more complex studies linking forest condition and various factors including air pollution, the continuation of the Level I monitoring is indispensable. It will also keep resource managers and policy makers informed on forest health status and trends, and will facilitate the assessment of the effectiveness of air pollution abatement measures in the long term. Moreover, the results of the extensive monitoring on Level I may later be utilized for the large-scale extrapolation of findings derived from the small-scale intensive monitoring (Level II) and ecosystem analysis (Level III). Consequently, whilst Level I is being continued and evaluated, Level II is being strengthened and preparations for Level III have begun.

With about 643 permanent plots for intensive monitoring installed within the Community scheme and ICP Forests, the Level II network is nearing completion. Amendments to the respective guidelines are under preparation, aiming at an improved crown condition assessment and soil analyses on Level II plots. The inclusion of meteorological measurements, soil liquid phase analyses, ground vegetation assessments and application of aerial photography are in a test phase. For the validation, storage and evaluation of Level II data a special forest intensive monitoring coordinating institute (FIMCI) has been established. The FIMCI will be advised by a recently formed Scientific Advisory Group (SAG). Studies on the European level will be possible after the first submission of results to the FIMCI at the end of 1996. Although the first results can be expected during 1997, it will take at least 5 to 10 years before trends can be identified, as for instance increment is surveyed only every 5 years and soil only every 10 years.

Although most European countries have now submitted information, it is felt that a continuing effort is needed from ICP Forests and EU to assist countries participating in the Level II programme. Other interested countries should be encouraged to participate as well.

With respect to the implementation of Level III, ICP Forests is developing a strategy which is intended to include harmonized monitoring activities with the Task Force on Integrated Monitoring on common plots.

In addition, ICP Forests has prepared a document 'Ecological impacts of some heavy metals related to long-range transport' focusing on effects of selected heavy metals on forest ecosystems. The document is based on literature supplied by the participating countries of ICP Forests and on a data base retrieval. It is concluded that single metal concentrations in the humus layer, reported from forest soil condition surveys (i.e. Level I), are not high enough to cause severe effects on forest ecosystems so far. However, risk assessment should preferably be based on soil solution concentrations (Level II) because only elements present as ionic forms in soil solution are taken up by plants. Data on soil solution chemistry, especially concerning heavy metals, are only sparsely available; in the foreseeable future results from intensive monitoring activities may help to close the gap. Such additional work will contribute further to the protocols under the LRTAP convention.

To fulfil the needs of a comprehensive reporting on future results to be expected from the growing forest monitoring activities, it is recommended to develop a new reporting system. In the future, the annual Executive Forest Condition Report could summarize besides the usual results of the crown condition assessment also the progress made in other fields, such as forest soils analyses, foliage analyses, in-depth evaluations of Level I and Level II data and other special topics. Besides this Executive Report, a number of Technical Reports would be issued documenting the results in all fields in detail.

The activities carried out within the Community scheme and ICP Forests are not only of vital importance for the protection of the European forests against atmospheric pollution and for the implementation of the LRTAP Convention. In addition, the activities contribute to the objectives of Resolution S1 of the Strasbourg Ministerial Conference and of Resolution H1 of the Helsinki Ministerial Conference on the protection of forests in Europe. In this context the maintenance of forest ecosystem health has been identified as one of the basic criteria of sustainable forest management in Europe. The common activities of ICP Forests and EU represent the most appropriate framework for providing information on the most suitable quantitative indicators as adopted under the Helsinki process for the monitoring of changes over time of this criterion.

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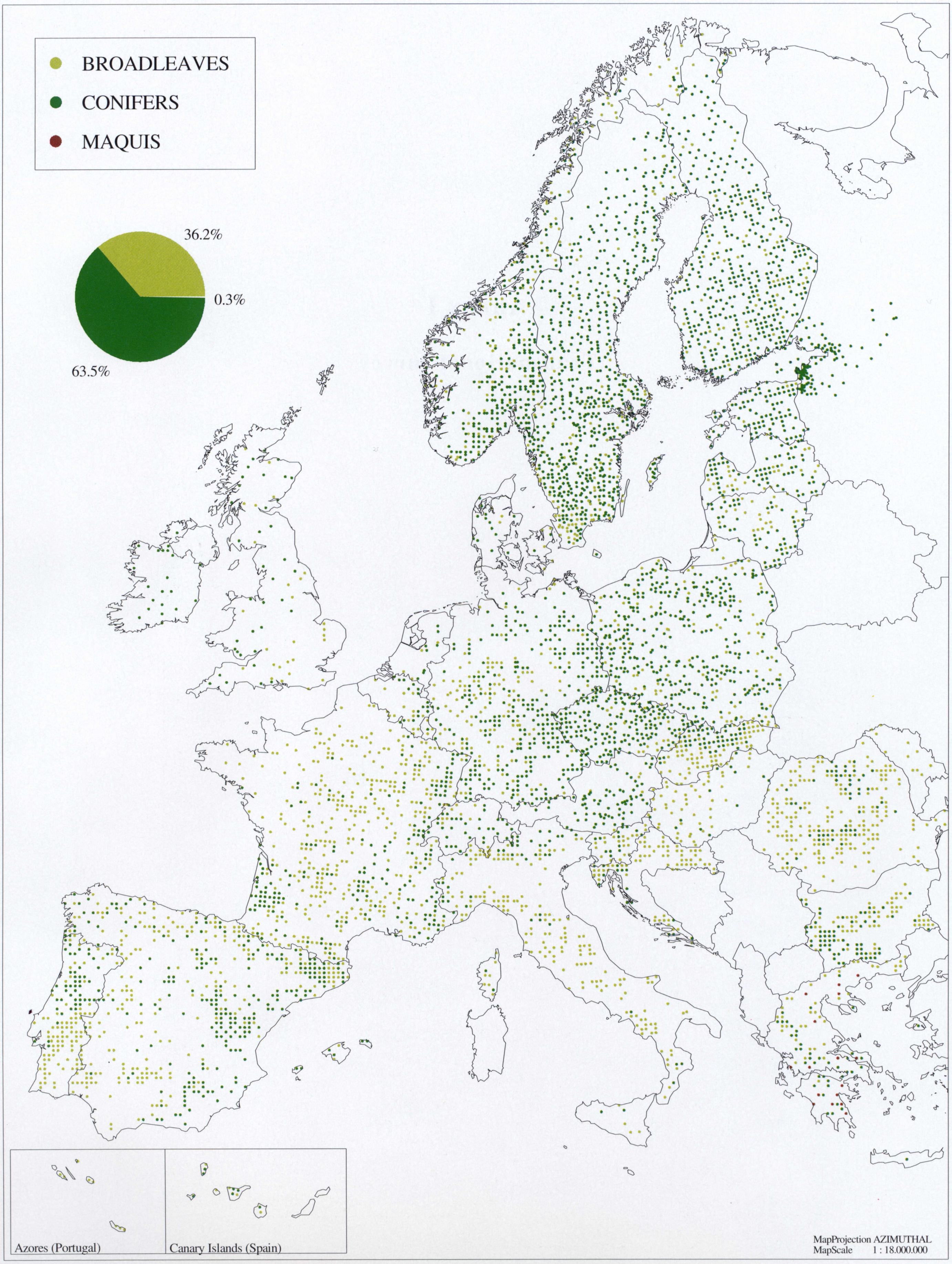
Annex I

Transnational survey

Annex I-1
Broadleaves and conifers (1995)



Annex I-2
Species assessed (1995)

EUROPEAN UNION & ICP	OBSERVED TREES		OBSERVED PLOTS	
	NUMBER	%	NUMBER	%
SPECIES				
Pinus sylvestris	31518	26.87	1563	17.28
Picea abies	24759	21.11	1334	14.75
Fagus sylvatica	10703	9.12	605	6.69
Quercus robur	4626	3.94	410	4.53
Quercus petraea	3583	3.05	332	3.67
Betula pubescens	3330	2.84	578	6.39
Pinus pinaster	3419	2.91	179	1.98
Quercus ilex	3093	2.64	194	2.14
Betula pendula	2218	1.89	444	4.91
Pinus nigra	2507	2.14	139	1.54
Abies alba	1947	1.66	184	2.03
Pinus halepensis	1920	1.64	105	1.16
Quercus pubescens	1812	1.54	171	1.89
Carpinus betulus	1741	1.48	238	2.63
Quercus suber	1522	1.30	92	1.02
Castanea sativa	1438	1.23	153	1.69
Quercus cerris	1327	1.13	121	1.34
Eucalyptus sp.	1180	1.01	59	0.65
Larix decidua	1059	0.90	156	1.72
Fraxinus excelsior	952	0.81	176	1.95
Robinia pseudacacia	877	0.75	77	0.85
Quercus pyrenaica	850	0.72	48	0.53
Quercus frainetto	848	0.72	45	0.50
Populus tremula	626	0.53	185	2.05
Quercus rotundifolia	657	0.56	34	0.38
Alnus glutinosa	577	0.49	96	1.06
Acer pseudoplatanus	462	0.39	131	1.45
Picea sitchensis	558	0.48	32	0.35
Populus hybrides	505	0.43	28	0.31
Pseudotsuga menziesii	435	0.37	41	0.45
Quercus faginea	374	0.32	46	0.51
Ostrya carpinifolia	349	0.30	47	0.52
Other broadleaves	318	0.27	69	0.76
Tilia cordata	307	0.26	66	0.73
Prunus avium	248	0.21	101	1.12
Pinus pinea	287	0.24	29	0.32
Abies cephalonica	269	0.23	13	0.14

EUROPEAN UNION & ICP	OBSERVED TREES		OBSERVED PLOTS	
	NUMBER	%	NUMBER	%
SPECIES				
Acer campestre	200	0.17	72	0.80
Juniperus thurifera	241	0.21	20	0.22
Quercus coccifera	230	0.20	17	0.19
Pinus contorta	219	0.19	15	0.17
Alnus incana	159	0.14	35	0.39
Pinus radiata	180	0.15	11	0.12
Abies borisii-regis	179	0.15	10	0.11
Quercus rubra	168	0.14	19	0.21
Fraxinus ornus	128	0.11	40	0.44
Populus alba	134	0.11	12	0.13
Olea europaea	117	0.10	16	0.18
Fagus moesiaca	121	0.10	6	0.07
Pinus uncinata	118	0.10	9	0.10
Tilia platyphyllos	83	0.07	16	0.18
Salix caprea	60	0.05	32	0.35
Larix kaempferi	82	0.07	7	0.08
Fraxinus angustifolia	78	0.07	10	0.11
Salix alba	77	0.07	8	0.09
Platanus orientalis	78	0.07	6	0.07
Populus nigra	74	0.06	10	0.11
Acer platanoides	58	0.05	24	0.27
Pinus brutia	77	0.07	5	0.06
Alnus cordata	76	0.06	5	0.06
Sorbus aria	50	0.04	29	0.32
Juniperus oxycedrus	58	0.05	20	0.22
Pinus strobus	67	0.06	9	0.10
Sorbus aucuparia	56	0.05	19	0.21
Pinus cembra	60	0.05	7	0.08
Ulmus glabra	43	0.04	22	0.24
Phillyrea latifolia	56	0.05	9	0.10
Arbutus unedo	54	0.05	9	0.10
Acer monspessulanum	44	0.04	14	0.15
Juniperus phoenicea	46	0.04	10	0.11
Carpinus orientalis	48	0.04	7	0.08
Juniperus communis	45	0.04	9	0.10
Sorbus torminalis	29	0.02	21	0.23
Salix sp.	36	0.03	10	0.11

EUROPEAN UNION & ICP	OBSERVED TREES		OBSERVED PLOTS	
	NUMBER	%	NUMBER	%
SPECIES				
Populus canescens	43	0.04	3	0.03
Other conifers	32	0.03	13	0.14
Cupressus sempervirens	38	0.03	6	0.07
Quercus trojana	37	0.03	4	0.04
Cedrus atlantica	30	0.03	3	0.03
Corylus avellana	19	0.02	8	0.09
Buxus sempervirens	22	0.02	4	0.04
Pyrus communis	17	0.01	9	0.10
Sorbus domestica	15	0.01	10	0.11
Ulmus minor	16	0.01	9	0.10
Acer opalus	15	0.01	10	0.11
Arbutus andrachne	22	0.02	2	0.02
Quercus macrolepsis	21	0.02	1	0.01
Quercus fruticosa	18	0.02	1	0.01
Pistacia terebinthus	13	0.01	2	0.02
Ilex aquifolium	9	0.01	6	0.07
Rhamnus alaternus	14	0.01	1	0.01
Ulmus laevis	8	0.01	4	0.04
Alnus viridis	9	0.01	3	0.03
Pinus leucodermis	11	0.01	1	0.01
Fagus orientalis	10	0.01	1	0.01
Cercis siliquastrum	9	0.01	2	0.02
Tsuga sp.	9	0.01	1	0.01
Salix fragilis	7	0.01	1	0.01
Cedrus deodara	5	0.00	3	0.03
Thuya sp.	4	0.00	1	0.01
Ceratonia siliqua	3	0.00	2	0.02
Abies grandis	4	0.00	1	0.01
Juglans regia	2	0.00	2	0.02
Prunus serotina	2	0.00	1	0.01
Pistacia lentiscus	2	0.00	1	0.01
Salix cinerea	2	0.00	1	0.01
Juglans nigra	1	0.00	1	0.01
Prunus padus	1	0.00	1	0.01
Phillyrea angustifolia	1	0.00	1	0.01
Abies pinsapo	1	0.00	1	0.01
Salix eleagnos	1	0.00	1	0.01

EUROPEAN UNION & ICP	OBSERVED TREES		OBSERVED PLOTS	
	NUMBER	%	NUMBER	%
SPECIES				
Taxus baccata	1	0.00	1	0.01
Erica manipuliflora	1	0.00	1	0.01
TOTAL SPECIES	117305	100.00	9045	100.00

Annex I-3
Defoliation by species group and climatic region (1995)

TOTAL CLIMATIC REGIONS	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	58.0	25.6	12.4	3.2	0.8
Eucalyptus spp.	76.4	15.9	2.5	0.1	5.1
Fagus spp.	41.5	37.0	20.0	1.2	0.3
Quercus (deciduous) spp.	33.4	35.7	26.7	2.8	1.4
Quercus ilex	20.4	50.8	25.4	2.3	1.1
Quercus suber	22.5	52.1	23.3	2.0	0.1
Betula spp.	52.0	29.8	16.3	1.6	0.2
Carpinus spp.	43.8	33.0	20.5	2.1	0.7
Other broadleaves	42.3	30.2	21.7	4.4	1.4
TOTAL BROADLEAVES	40.1	34.9	21.6	2.4	1.0
Abies spp.	38.7	29.8	27.2	3.3	1.1
Larix spp.	49.4	29.4	18.9	2.0	0.3
Picea spp.	39.7	30.6	25.9	2.8	1.0
Pinus spp.	39.8	37.6	20.5	1.4	0.7
Other conifers	38.7	33.4	24.7	2.8	0.5
TOTAL CONIFERS	39.9	34.6	22.7	2.0	0.8
TOTAL SPECIES	40.0	34.7	22.3	2.2	0.9

ATLANTIC (NORTH)	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	91.7	5.2	3.1	-	-
Fagus spp.	27.6	43.3	27.1	1.8	0.2
Quercus (deciduous) spp.	46.2	38.6	13.8	1.3	0.1
Betula spp.	67.4	25.8	5.0	1.0	0.7
Carpinus spp.	78.9	17.1	2.6	1.3	-
Other broadleaves	72.6	23.6	3.0	0.4	0.4
TOTAL BROADLEAVES	48.7	35.0	14.8	1.2	0.2
Abies spp.	17.9	35.7	46.4	-	-
Larix spp.	31.7	51.2	14.6	2.4	-
Picea spp.	54.3	29.0	15.2	0.9	0.6
Pinus spp.	43.1	41.8	13.6	1.2	0.4
Other conifers	19.0	5.1	73.4	2.5	-
TOTAL CONIFERS	48.4	33.9	16.2	1.1	0.5
TOTAL SPECIES	48.6	34.4	15.5	1.1	0.4

ATLANTIC (SOUTH)	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	78.3	14.7	3.8	2.3	0.9
Eucalyptus spp.	75.8	19.7	3.5	-	1.0
Fagus spp.	66.7	25.6	7.4	0.4	-
Quercus (deciduous) spp.	61.8	28.4	9.2	0.7	0.1
Quercus ilex	39.3	51.7	9.0	-	-
Quercus suber	100.0	-	-	-	-
Betula spp.	77.7	17.4	4.0	-	0.9
Carpinus spp.	92.9	5.7	1.4	-	-
Other broadleaves	67.7	19.3	9.5	2.0	1.5
TOTAL BROADLEAVES	66.6	24.4	7.7	0.9	0.4
Abies spp.	100.0	-	-	-	-
Larix spp.	100.0	-	-	-	-
Picea spp.	100.0	-	-	-	-
Pinus spp.	76.6	18.2	4.8	0.2	0.3
Other conifers	60.2	22.7	12.5	3.9	0.8
TOTAL CONIFERS	76.6	17.6	5.0	0.4	0.3
TOTAL SPECIES	70.2	22.0	6.7	0.7	0.4

BOREAL	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Quercus (deciduous) spp.	33.3	55.6	11.1	-	-
Betula spp.	62.8	24.7	11.0	1.2	0.2
Other broadleaves	66.3	23.4	9.5	0.8	-
TOTAL BROADLEAVES	63.1	24.7	10.8	1.2	0.2
Larix spp.	33.3	44.4	22.2	-	-
Picea spp.	40.1	29.2	25.0	5.7	0.0
Pinus spp.	65.7	28.7	4.9	0.5	0.2
Other conifers	83.3	-	-	16.7	-
TOTAL CONIFERS	56.0	28.9	12.5	2.5	0.1
TOTAL SPECIES	56.9	28.3	12.3	2.3	0.1

BOREAL (TEMPERATE)	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Fagus spp.	50.0	50.0	-	-	-
Quercus (deciduous) spp.	35.6	52.9	10.3	1.1	-
Betula spp.	55.6	33.7	9.8	0.8	0.1
Other broadleaves	45.4	36.1	16.5	1.8	0.4
TOTAL BROADLEAVES	52.0	35.2	11.6	1.1	0.2
Larix spp.	46.7	46.7	6.7	-	-
Picea spp.	54.1	30.9	11.3	1.1	2.6
Pinus spp.	39.2	45.2	14.4	0.8	0.3
TOTAL CONIFERS	44.8	39.9	13.3	0.9	1.2
TOTAL SPECIES	45.9	39.1	13.0	0.9	1.0

CONTINENTAL	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	100.0	-	-	-	-
Fagus spp.	52.7	30.6	15.0	1.4	0.4
Quercus (deciduous) spp.	26.0	34.0	33.4	3.4	3.2
Quercus suber	-	68.2	31.8	-	-
Betula spp.	100.0	-	-	-	-
Carpinus spp.	40.9	32.5	23.8	2.3	0.5
Other broadleaves	36.7	16.8	36.7	8.2	1.7
TOTAL BROADLEAVES	37.1	29.2	28.2	3.8	1.8
Abies spp.	42.7	36.4	17.5	0.7	2.8
Picea spp.	54.0	34.0	10.5	1.5	-
Pinus spp.	27.1	21.2	40.5	4.9	6.3
Other conifers	100.0	-	-	-	-
TOTAL CONIFERS	34.7	25.8	31.3	3.6	4.5
TOTAL SPECIES	36.7	28.6	28.7	3.8	2.2

MOUNTAINOUS (SOUTH)	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	44.8	36.0	12.8	2.5	3.9
Fagus spp.	47.8	36.2	14.4	1.2	0.4
Quercus (deciduous) spp.	23.8	34.6	33.5	4.7	3.4
Quercus ilex	18.4	49.3	19.1	1.3	11.8
Betula spp.	36.0	44.1	18.0	1.8	-
Carpinus spp.	36.9	44.1	17.9	0.8	0.3
Other broadleaves	40.2	29.7	24.1	5.5	0.5
TOTAL BROADLEAVES	39.9	35.5	20.5	2.8	1.4
Abies spp.	46.1	30.8	19.2	2.8	1.1
Larix spp.	58.2	27.8	13.0	0.7	0.2
Picea spp.	51.2	29.1	17.3	1.7	0.6
Pinus spp.	31.8	38.5	26.0	2.1	1.6
Other conifers	26.1	44.1	24.9	4.6	0.4
TOTAL CONIFERS	43.5	32.9	20.6	2.0	1.0
TOTAL SPECIES	42.0	34.0	20.6	2.3	1.2

MOUNTAINOUS (NORTH)	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Betula spp.	37.0	30.6	27.7	4.5	0.1
TOTAL BROADLEAVES	37.0	30.6	27.7	4.5	0.1
Picea spp.	45.5	22.5	22.0	9.9	0.1
Pinus spp.	53.8	33.2	12.2	0.7	-
TOTAL CONIFERS	49.9	28.1	16.8	5.1	0.1
TOTAL SPECIES	44.9	29.1	21.0	4.9	0.1

MEDITERRANEAN (HIGHER)	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	39.4	26.0	29.5	5.1	-
Eucalyptus spp.	-	100.0	-	-	-
Fagus spp.	50.9	33.8	14.1	1.2	-
Quercus (deciduous) spp.	36.4	35.3	22.8	4.7	0.8
Quercus ilex	24.0	47.5	23.6	4.1	0.8
Quercus suber	95.1	3.3	1.6	-	-
Betula spp.	44.4	44.4	11.1	-	-
Carpinus spp.	76.3	13.2	10.5	-	-
Other broadleaves	29.4	34.5	26.8	8.5	0.8
TOTAL BROADLEAVES	36.3	35.8	22.6	4.7	0.6
Abies spp.	32.5	31.5	29.5	5.1	1.4
Larix spp.	53.0	23.0	18.0	6.0	-
Picea spp.	27.3	52.9	18.2	0.8	0.8
Pinus spp.	42.3	41.0	13.3	1.8	1.6
Other conifers	18.4	47.1	29.9	2.9	1.7
TOTAL CONIFERS	39.9	40.4	16.0	2.3	1.5
TOTAL SPECIES	37.7	37.6	19.9	3.7	1.0

MEDITERRANEAN (LOWER)	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	47.3	41.3	7.3	4.0	-
Eucalyptus spp.	76.7	15.1	2.2	0.1	5.9
Fagus spp.	73.4	18.0	7.7	0.8	-
Quercus (deciduous) spp.	31.4	39.5	26.4	2.1	0.6
Quercus ilex	18.2	52.3	27.4	1.7	0.4
Quercus suber	19.4	54.2	24.2	2.1	0.1
Betula spp.	67.9	17.9	10.7	3.6	-
Carpinus spp.	84.0	10.6	5.3	-	-
Other broadleaves	40.5	38.8	15.5	2.7	2.5
TOTAL BROADLEAVES	38.6	39.5	18.7	1.8	1.4
Abies spp.	31.8	38.3	26.2	2.8	0.9
Larix spp.	73.4	10.2	14.1	2.3	-
Picea spp.	64.0	9.0	23.4	3.6	-
Pinus spp.	37.9	43.7	15.5	2.3	0.6
Other conifers	26.4	49.4	24.1	-	-
TOTAL CONIFERS	39.2	41.7	16.1	2.3	0.6
TOTAL SPECIES	38.8	40.2	17.9	2.0	1.1

SUB-ATLANTIC	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	81.0	19.0	-	-	-
Fagus spp.	21.2	45.1	32.3	1.2	0.2
Quercus (deciduous) spp.	16.8	39.4	40.1	2.4	1.3
Betula spp.	19.1	39.4	40.4	0.7	0.3
Carpinus spp.	21.2	41.8	31.1	4.2	1.7
Other broadleaves	36.0	32.1	26.2	3.9	1.7
TOTAL BROADLEAVES	22.4	40.3	34.2	2.2	0.9
Abies spp.	28.8	24.8	41.5	4.1	0.7
Larix spp.	29.4	37.9	29.6	2.6	0.5
Picea spp.	20.7	33.3	42.5	2.4	1.1
Pinus spp.	15.8	40.5	41.2	1.9	0.7
Other conifers	69.2	20.2	10.1	0.5	-
TOTAL CONIFERS	19.1	36.7	41.2	2.2	0.8
TOTAL SPECIES	20.0	37.8	39.1	2.2	0.9

Annex I-4
Discolouration by species group and climatic region (1995)

TOTAL CLIMATIC REGIONS	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	82.8	12.3	3.1	1.5	0.4
Eucalyptus spp.	89.2	5.7	-	-	5.1
Fagus spp.	89.9	7.7	1.9	0.3	0.2
Quercus (deciduous) spp.	84.7	10.9	3.3	0.4	0.7
Quercus ilex	90.5	7.5	0.8	0.1	1.1
Quercus suber	92.7	6.2	0.3	0.7	0.1
Betula spp.	96.5	2.8	0.4	0.1	0.1
Carpinus spp.	87.4	9.5	2.4	0.5	0.3
Other broadleaves	88.2	8.1	2.3	0.5	0.9
TOTAL BROADLEAVES	88.7	8.2	2.1	0.4	0.6
Abies spp.	81.7	15.4	2.4	0.2	0.3
Larix spp.	94.9	2.7	2.3	0.1	0.1
Picea spp.	92.9	5.1	1.5	0.4	0.1
Pinus spp.	89.8	7.9	1.8	0.2	0.4
Other conifers	77.9	16.9	4.2	0.4	0.5
TOTAL CONIFERS	90.4	7.3	1.8	0.3	0.3
TOTAL SPECIES	89.7	7.6	1.9	0.3	0.4

ATLANTIC (NORTH)	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	90.6	8.3	1.0	-	-
Fagus spp.	79.3	13.1	6.1	1.3	0.2
Quercus (deciduous) spp.	88.3	8.7	2.7	0.2	0.1
Betula spp.	91.6	7.4	0.7	-	0.3
Carpinus spp.	96.1	2.6	-	1.3	-
Other broadleaves	96.6	1.5	1.3	0.2	0.4
TOTAL BROADLEAVES	87.4	8.7	3.2	0.5	0.2
Abies spp.	96.4	3.6	-	-	-
Larix spp.	100.0	-	-	-	-
Picea spp.	91.1	5.8	2.5	0.6	0.1
Pinus spp.	76.6	17.6	5.4	0.1	0.1
Other conifers	83.5	6.3	7.6	2.5	-
TOTAL CONIFERS	85.3	10.4	3.7	0.4	0.1
TOTAL SPECIES	86.3	9.6	3.5	0.5	0.1

ATLANTIC (SOUTH)	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	91.0	6.5	0.7	0.9	0.9
Eucalyptus spp.	99.0	-	-	-	1.0
Fagus spp.	83.7	12.4	3.5	0.4	-
Quercus (deciduous) spp.	96.4	3.3	0.3	-	0.1
Quercus ilex	97.8	2.2	-	-	-
Quercus suber	100.0	-	-	-	-
Betula spp.	87.9	9.4	1.8	-	0.9
Carpinus spp.	87.1	12.9	-	-	-
Other broadleaves	91.0	5.5	1.1	0.9	1.5
TOTAL BROADLEAVES	93.7	4.9	0.7	0.2	0.4
Abies spp.	91.7	8.3	-	-	-
Larix spp.	100.0	-	-	-	-
Picea spp.	100.0	-	-	-	-
Pinus spp.	91.9	7.3	0.6	-	0.3
Other conifers	66.4	26.6	5.5	0.8	0.8
TOTAL CONIFERS	90.6	8.2	0.9	0.0	0.3
TOTAL SPECIES	92.6	6.1	0.8	0.2	0.4

BOREAL	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Quercus (deciduous) spp.	88.9	-	11.1	-	-
Betula spp.	99.5	0.4	-	0.2	-
Other broadleaves	99.2	0.8	-	-	-
TOTAL BROADLEAVES	99.4	0.4	0.0	0.1	-
Larix spp.	88.9	11.1	-	-	-
Picea spp.	90.2	6.8	2.6	0.4	-
Pinus spp.	94.9	4.6	0.3	0.0	0.2
Other conifers	100.0	-	-	-	-
TOTAL CONIFERS	93.1	5.4	1.2	0.2	0.1
TOTAL SPECIES	94.0	4.7	1.0	0.2	0.1

BOREAL (TEMPERATE)	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Fagus spp.	100.0	-	-	-	-
Quercus (deciduous) spp.	87.4	8.0	1.1	3.4	-
Betula spp.	97.0	2.6	0.3	-	0.1
Other broadleaves	99.5	0.5	-	-	-
TOTAL BROADLEAVES	97.3	2.2	0.2	0.1	0.1
Larix spp.	100.0	-	-	-	-
Picea spp.	93.5	4.3	1.6	0.5	0.1
Pinus spp.	94.4	5.1	0.3	0.0	0.1
TOTAL CONIFERS	94.1	4.8	0.8	0.2	0.1
TOTAL SPECIES	94.6	4.4	0.7	0.2	0.1

CONTINENTAL	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	100.0	-	-	-	-
Fagus spp.	90.0	8.7	1.0	0.1	0.2
Quercus (deciduous) spp.	84.7	10.5	4.3	0.2	0.3
Quercus suber	22.7	63.6	13.6	-	-
Betula spp.	100.0	-	-	-	-
Carpinus spp.	87.3	10.3	2.4	-	-
Other broadleaves	77.8	17.0	4.9	0.3	-
TOTAL BROADLEAVES	84.6	11.7	3.4	0.1	0.2
Abies spp.	95.6	4.4	-	-	-
Picea spp.	97.8	2.2	-	-	-
Pinus spp.	81.6	9.0	9.0	0.2	0.2
Other conifers	100.0	-	-	-	-
TOTAL CONIFERS	86.6	7.1	6.1	0.1	0.1
TOTAL SPECIES	84.9	10.9	3.8	0.1	0.2

MOUNTAINOUS (SOUTH)	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	82.3	10.8	4.4	2.5	-
Fagus spp.	91.1	7.3	1.4	0.1	0.0
Quercus (deciduous) spp.	81.0	13.7	2.5	-	2.9
Quercus ilex	85.5	2.0	-	-	12.5
Betula spp.	97.3	2.7	-	-	-
Carpinus spp.	90.7	6.3	2.5	0.5	-
Other broadleaves	85.6	10.3	3.6	0.5	-
TOTAL BROADLEAVES	87.7	9.1	2.1	0.2	0.9
Abies spp.	82.1	15.8	1.8	0.1	0.2
Larix spp.	91.2	4.2	4.6	-	-
Picea spp.	94.5	5.1	0.3	0.1	0.0
Pinus spp.	76.8	15.9	6.4	0.2	0.7
Other conifers	75.5	20.7	3.4	-	0.4
TOTAL CONIFERS	86.3	10.4	2.9	0.1	0.3
TOTAL SPECIES	86.8	9.9	2.6	0.2	0.5

MOUNTAINOUS (NORTH)	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Betula spp.	96.3	3.1	0.2	0.4	-
TOTAL BROADLEAVES	96.3	3.1	0.2	0.4	-
Picea spp.	88.9	6.0	3.1	1.9	0.1
Pinus spp.	94.9	3.4	1.3	0.4	-
TOTAL CONIFERS	92.0	4.6	2.2	1.1	0.1
TOTAL SPECIES	93.7	4.0	1.4	0.8	0.0

MEDITERRANEAN (HIGHER)	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	73.4	16.1	7.3	2.7	0.5
Eucalyptus spp.	-	100.0	-	-	-
Fagus spp.	82.2	11.1	4.0	1.0	1.7
Quercus (deciduous) spp.	83.6	10.1	4.3	0.8	1.1
Quercus ilex	95.9	3.2	0.1	-	0.8
Quercus suber	68.9	31.1	-	-	-
Betula spp.	100.0	-	-	-	-
Carpinus spp.	50.0	36.8	7.9	-	5.3
Other broadleaves	81.2	12.2	4.8	1.0	0.9
TOTAL BROADLEAVES	83.9	10.3	3.8	0.8	1.1
Abies spp.	68.1	25.8	4.7	-	1.4
Larix spp.	99.0	1.0	-	-	-
Picea spp.	79.3	14.0	6.6	-	-
Pinus spp.	85.1	9.5	3.5	0.4	1.6
Other conifers	74.1	20.1	4.0	-	1.7
TOTAL CONIFERS	83.2	11.4	3.6	0.3	1.5
TOTAL SPECIES	83.6	10.8	3.7	0.6	1.2

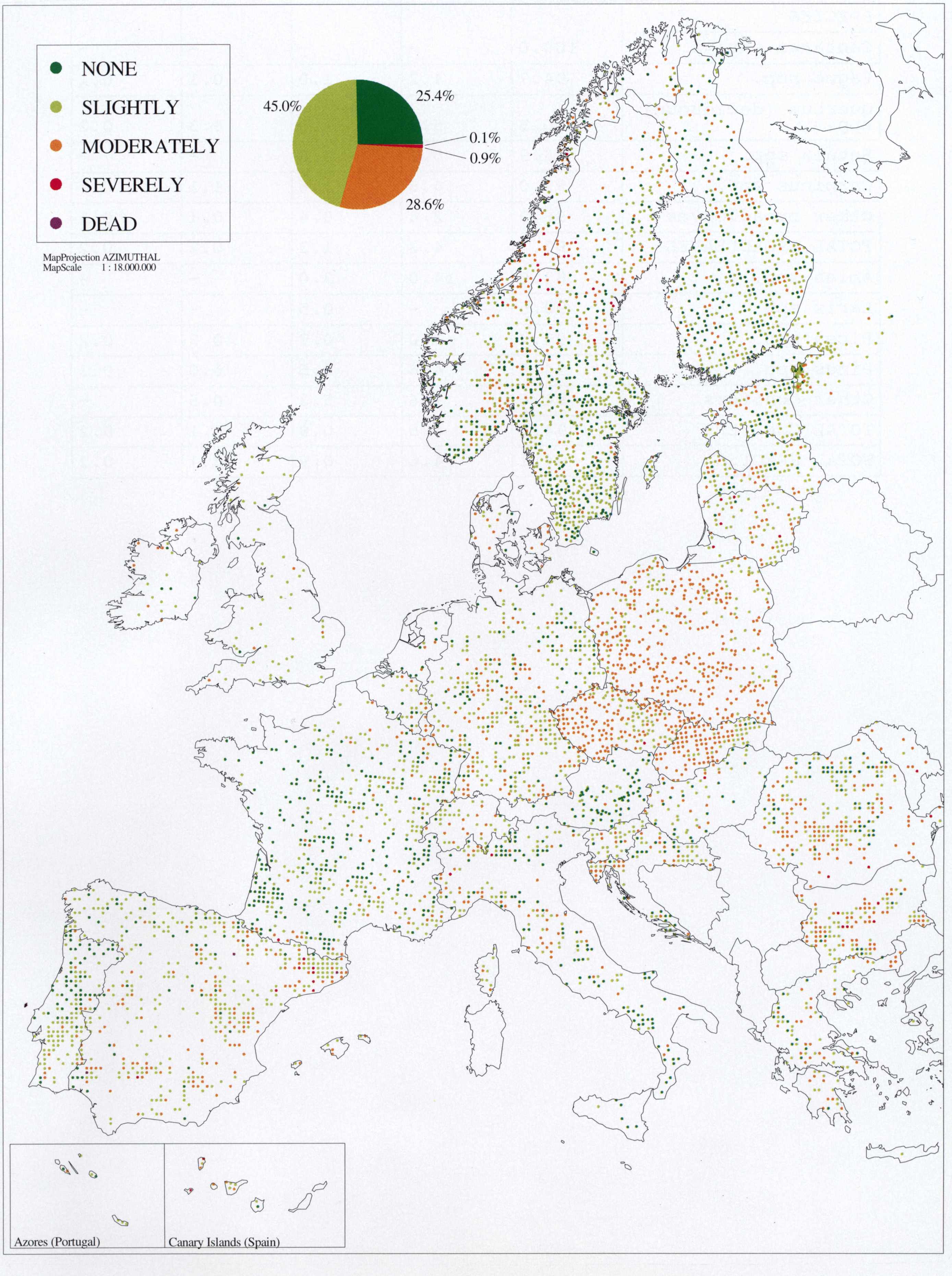
MEDITERRANEAN (LOWER)	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	79.0	19.0	1.3	0.7	-
Eucalyptus spp.	87.4	6.7	-	-	5.9
Fagus spp.	87.7	9.7	2.0	0.4	0.1
Quercus (deciduous) spp.	60.7	28.9	8.4	1.8	0.2
Quercus ilex	88.3	10.0	1.2	0.2	0.4
Quercus suber	94.8	4.3	0.1	0.8	0.1
Betula spp.	60.7	17.9	21.4	-	-
Carpinus spp.	74.5	20.7	4.8	-	-
Other broadleaves	85.5	9.2	1.6	0.6	3.0
TOTAL BROADLEAVES	83.4	12.2	2.4	0.6	1.4
Abies spp.	83.2	9.3	3.7	2.8	0.9
Larix spp.	93.0	4.7	0.8	0.8	0.8
Picea spp.	62.2	29.7	5.4	0.9	1.8
Pinus spp.	77.6	17.0	3.5	1.3	0.7
Other conifers	86.2	13.8	-	-	-
TOTAL CONIFERS	78.0	16.7	3.4	1.2	0.7
TOTAL SPECIES	81.7	13.6	2.7	0.8	1.2

SUB-ATLANTIC	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	100.0	-	-	-	-
Fagus spp.	94.7	4.2	1.0	0.1	0.1
Quercus (deciduous) spp.	90.9	6.9	1.8	0.3	0.2
Betula spp.	93.9	5.2	0.8	-	-
Carpinus spp.	92.0	4.6	1.6	1.1	0.7
Other broadleaves	96.9	2.4	0.4	0.1	0.1
TOTAL BROADLEAVES	93.7	4.8	1.2	0.2	0.2
Abies spp.	83.0	14.0	3.0	-	-
Larix spp.	99.5	-	0.5	-	-
Picea spp.	95.7	3.0	0.7	0.3	0.2
Pinus spp.	94.5	4.6	0.5	0.0	0.3
Other conifers	84.6	9.6	5.3	0.5	-
TOTAL CONIFERS	94.3	4.5	0.8	0.1	0.2
TOTAL SPECIES	94.1	4.6	0.9	0.1	0.2

Annex I-5

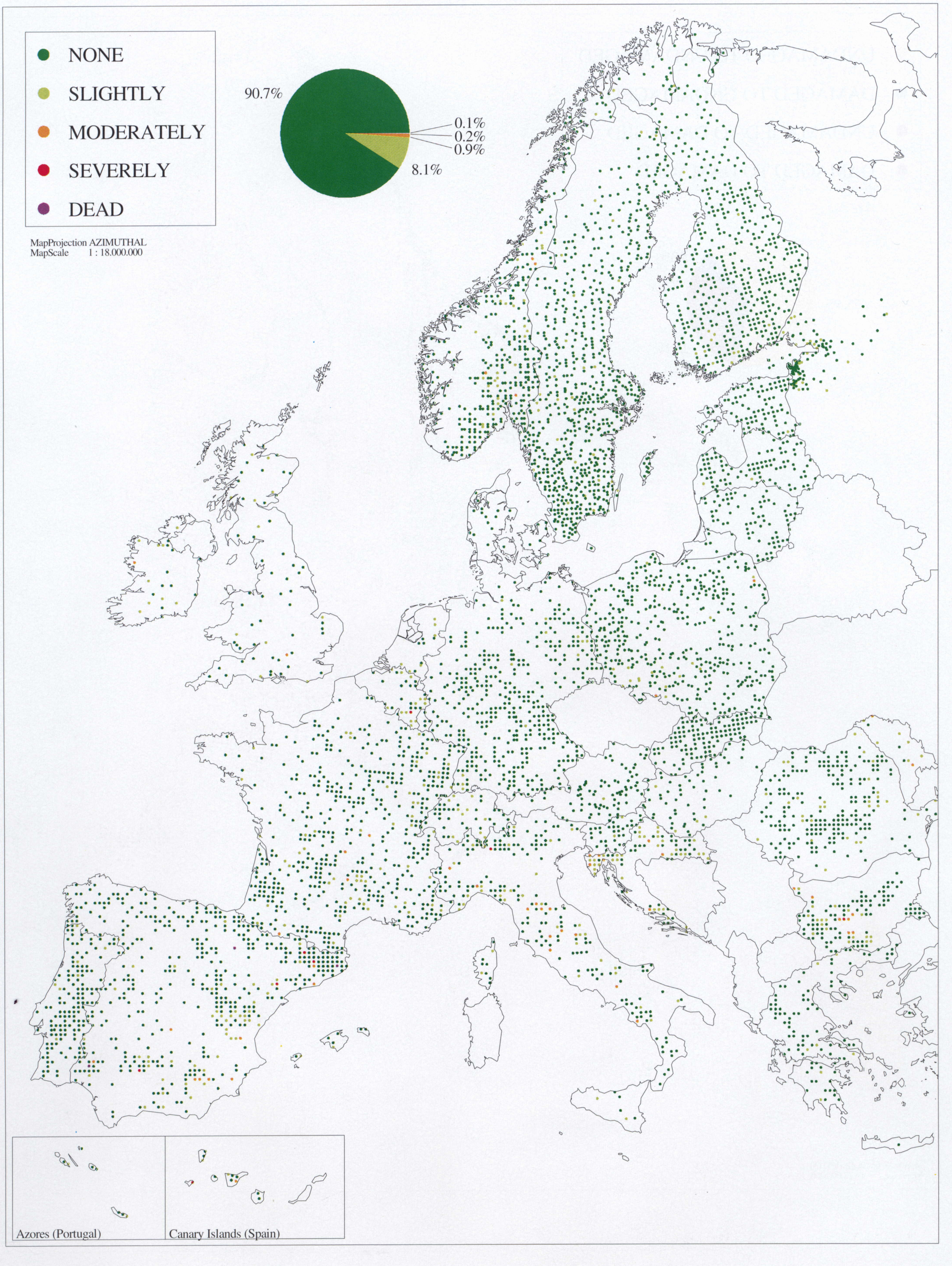
Plot defoliation (1995)

For proper interpretation of the map see Chapter 2.1.1.5

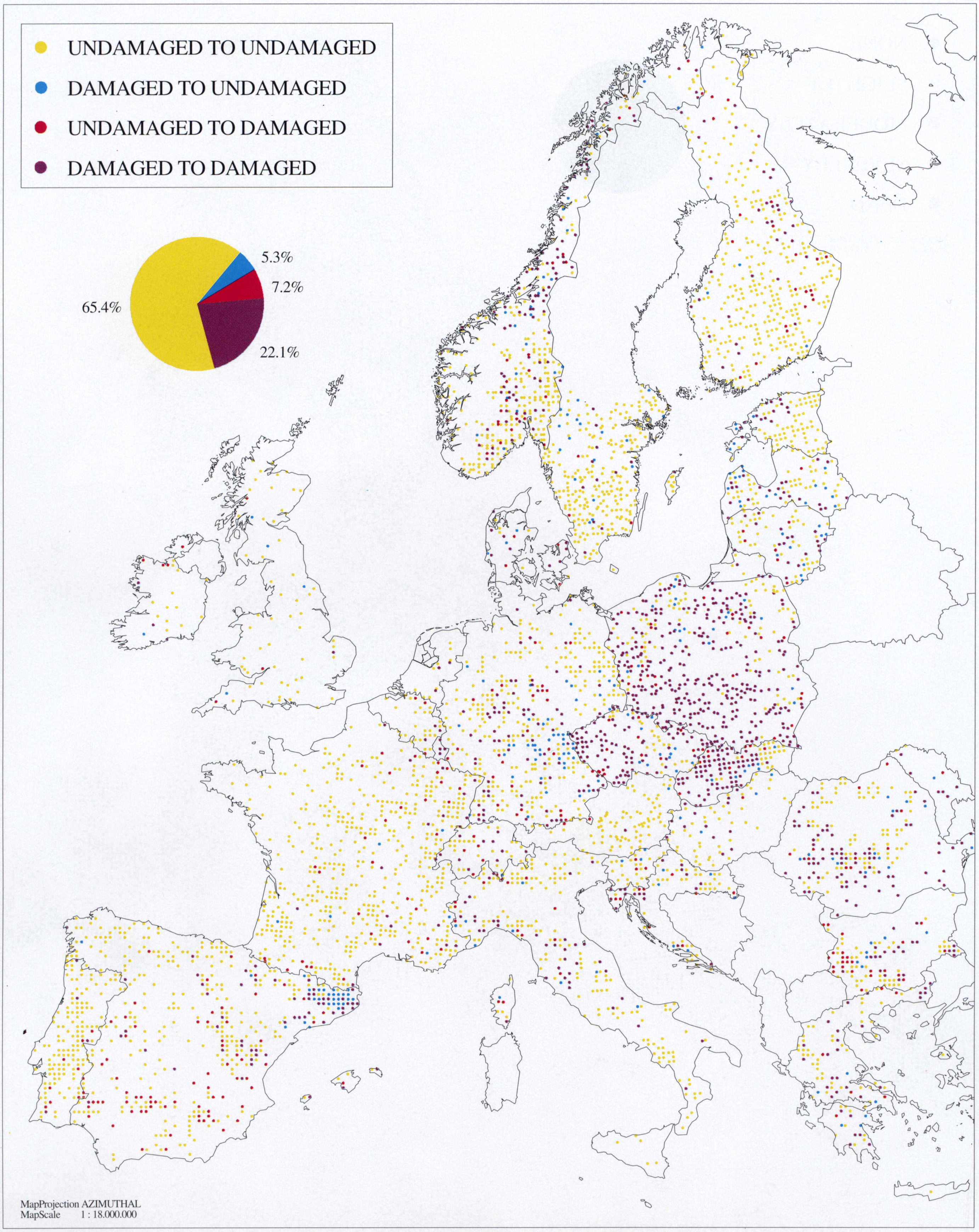


Annex I-6
Plot discolouration (1995))

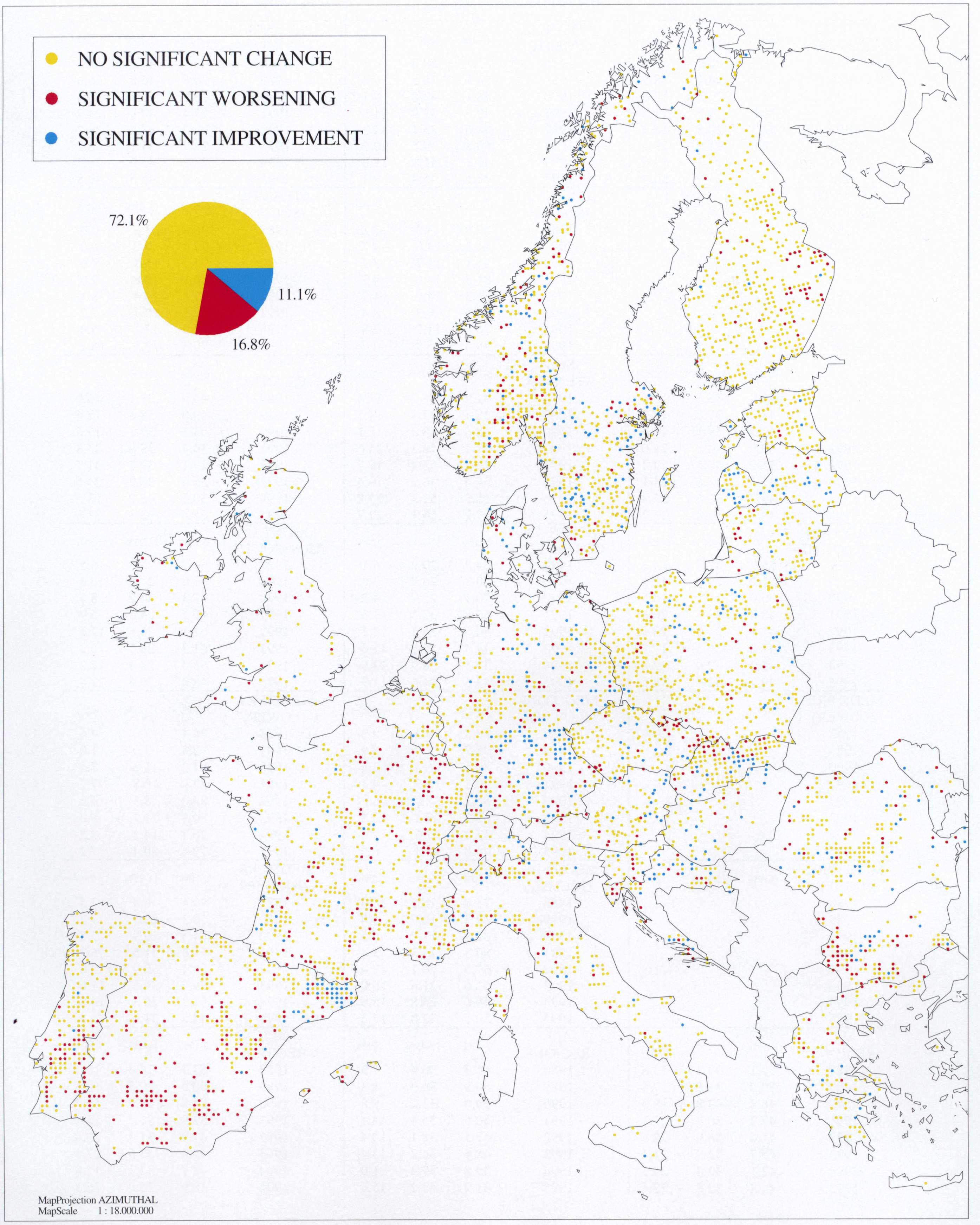
For proper interpretation of the map see Chapter 2.1.1.5



Annex I-7
Changes in plot defoliation classes (1994-1995)



Annex I-8
Changes in plot defoliation (1994-1995)



Annex I-9
Defoliation of most common species (1988-1995)

Picea abies				**Pinus sylvestris**				**Fagus sylvatica**			
ATLANTIC (NORTH)	0-10%	11-25%	>25%	ATLANTIC (NORTH)	0-10%	11-25%	>25%	ATLANTIC (NORTH)	0-10%	11-25%	>25%
1988	58.5	26.0	15.5	1988	65.1	28.8	6.1	1988	41.1	44.3	14.6
1989	56.8	24.7	18.5	1989	54.9	36.5	8.6	1989	26.6	46.8	26.6
1990	55.5	26.5	18.0	1990	48.1	43.8	8.1	1990	16.8	46.9	36.3
1991	56.8	21.5	21.7	1991	49.4	39.0	11.6	1991	27.4	47.9	24.7
1992	52.3	28.8	18.9	1992	54.6	33.1	12.3	1992	23.2	47.6	29.2
1993	48.6	21.9	29.5	1993	50.3	39.5	10.2	1993	24.7	47.1	28.2
1994	42.2	24.2	33.6	1994	46.1	41.9	12.0	1994	28.7	45.0	26.3
1995	41.7	27.9	30.4	1995	45.5	45.4	9.1	1995	13.7	45.5	40.8
ATLANTIC (SOUTH)	0-10%	11-25%	>25%	ATLANTIC (SOUTH)	0-10%	11-25%	>25%	ATLANTIC (SOUTH)	0-10%	11-25%	>25%
1988				1988	87.9	9.3	2.8	1988	96.4	3.6	0.0
1989				1989	81.3	14.0	4.7	1989	97.3	2.7	0.0
1990				1990	85.1	11.2	3.7	1990	75.7	15.3	9.0
1991				1991	81.3	14.0	4.7	1991	80.2	10.8	9.0
1992				1992	81.3	14.0	4.7	1992	77.5	14.4	8.1
1993				1993	82.3	9.3	8.4	1993	72.1	20.7	7.2
1994				1994	86.0	11.2	2.8	1994	77.5	17.1	5.4
1995				1995	79.4	15.9	4.7	1995	70.3	13.5	16.2
SUB-ATLANTIC	0-10%	11-25%	>25%	SUB-ATLANTIC	0-10%	11-25%	>25%	SUB-ATLANTIC	0-10%	11-25%	>25%
1988	46.8	36.6	16.6	1988	42.9	45.7	11.4	1988	44.9	39.1	16.0
1989	45.3	37.5	17.2	1989	38.1	47.4	14.5	1989	49.0	38.6	12.4
1990	42.5	39.1	18.4	1990	38.6	43.3	18.1	1990	43.3	39.1	17.6
1991	40.6	34.8	24.6	1991	23.1	52.3	24.6	1991	36.4	39.8	23.8
1992	35.2	40.5	24.3	1992	24.9	55.4	19.7	1992	29.1	39.2	31.7
1993	41.1	35.8	23.1	1993	34.4	46.2	19.4	1993	36.6	38.9	24.5
1994	36.7	36.5	26.8	1994	18.9	51.3	29.8	1994	30.5	46.2	23.3
1995	40.4	35.9	23.7	1995	27.2	50.1	22.7	1995	25.4	43.3	31.3
MOUNTAIN-OUS (SOUTH)	0-10%	11-25%	>25%	MOUNTAIN-OUS (SOUTH)	0-10%	11-25%	>25%	MOUNTAIN-OUS (SOUTH)	0-10%	11-25%	>25%
1988	54.2	32.7	13.1	1988	64.7	29.2	6.1	1988	66.7	24.8	8.5
1989	51.2	29.6	19.2	1989	70.3	26.7	3.0	1989	66.0	27.5	6.5
1990	50.0	31.5	18.5	1990	70.1	25.7	4.2	1990	67.3	24.2	8.5
1991	48.8	30.6	20.6	1991	56.2	32.5	11.3	1991	69.7	24.6	5.7
1992	41.8	34.9	23.3	1992	50.7	36.2	13.1	1992	62.1	25.5	12.4
1993	47.8	34.5	17.7	1993	47.3	37.1	15.6	1993	61.3	28.5	10.2
1994	45.2	32.0	22.8	1994	37.5	38.9	23.6	1994	63.4	24.4	12.2
1995	49.2	32.3	18.5	1995	43.5	44.6	11.9	1995	48.0	29.6	22.4
MEDITERR. (LOWER)	0-10%	11-25%	>25%	MEDITERR. (LOWER)	0-10%	11-25%	>25%	MEDITERR. (LOWER)	0-10%	11-25%	>25%
1988				1988	94.8	4.3	0.9	1988	88.4	7.0	4.6
1989				1989	95.7	3.4	0.9	1989	92.0	7.0	1.0
1990				1990	81.1	15.5	3.4	1990	81.2	11.3	7.5
1991				1991	80.2	15.5	4.3	1991	82.0	10.8	7.2
1992				1992	55.2	38.8	6.0	1992	84.0	8.5	7.5
1993				1993	61.3	28.4	10.3	1993	80.1	11.9	8.0
1994				1994	53.4	27.6	19.0	1994	76.3	14.2	9.5
1995				1995	44.8	48.3	6.9	1995	72.4	20.4	7.2
MEDITERR. (HIGHER)	0-10%	11-25%	>25%	MEDITERR. (HIGHER)	0-10%	11-25%	>25%	MEDITERR. (HIGHER)	0-10%	11-25%	>25%
1988				1988	75.8	16.2	8.0	1988	90.1	6.4	3.5
1989				1989	83.3	10.9	5.8	1989	70.3	22.5	7.2
1990				1990	81.8	11.7	6.5	1990	74.3	19.9	5.8
1991				1991	80.3	14.3	5.4	1991	61.6	31.5	6.9
1992				1992	67.5	20.1	12.4	1992	56.1	30.9	13.0
1993				1993	62.6	21.6	15.8	1993	49.7	39.3	11.0
1994				1994	59.6	24.8	15.6	1994	55.2	30.3	14.5
1995				1995	50.5	32.0	17.5	1995	42.8	31.8	25.4
ALL REGIONS	0-10%	11-25%	>25%	ALL REGIONS	0-10%	11-25%	>25%	ALL REGIONS	0-10%	11-25%	>25%
1988	52.1	33.3	14.6	1988	61.7	30.4	7.9	1988	63.7	26.0	10.3
1989	50.7	31.8	17.5	1989	60.8	30.9	8.3	1989	60.0	29.5	10.5
1990	48.2	33.8	18.0	1990	59.0	31.2	9.8	1990	54.8	29.9	15.3
1991	47.2	30.7	22.1	1991	50.5	35.4	14.1	1991	52.9	31.7	15.4
1992	41.4	36.0	22.6	1992	47.5	38.1	14.4	1992	47.9	31.3	20.8
1993	45.7	32.9	21.4	1993	48.4	36.2	15.4	1993	49.0	33.5	17.5
1994	42.1	32.4	25.5	1994	39.6	39.4	21.0	1994	48.1	34.1	17.8
1995	44.8	32.6	22.6	1995	41.2	43.2	15.6	1995	38.9	35.0	26.1

Quercus petraea

ATLANTIC (NORTH)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
ATLANTIC (SOUTH)	**0-10%**	**11-25%**	**>25%**
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
SUB-ATLANTIC	**0-10%**	**11-25%**	**>25%**
1988	59.8	27.8	12.4
1989	57.3	31.5	11.2
1990	59.7	30.5	9.8
1991	52.0	30.7	17.3
1992	52.6	31.7	15.7
1993	47.5	30.3	22.2
1994	39.8	35.2	25.0
1995	31.7	37.4	30.9
MOUNTAIN-OUS (SOUTH)	**0-10%**	**11-25%**	**>25%**
1988	27.9	46.9	25.2
1989	43.5	44.3	12.2
1990	41.5	43.5	15.0
1991	41.5	40.8	17.7
1992	40.8	37.4	21.8
1993	27.9	36.7	35.4
1994	44.3	33.3	22.4
1995	29.9	36.8	33.3
MEDITERR. (LOWER)	**0-10%**	**11-25%**	**>25%**
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
MEDITERR. (HIGHER)	**0-10%**	**11-25%**	**>25%**
1988	60.2	23.9	15.9
1989	67.3	22.1	10.6
1990	59.3	29.2	11.5
1991	54.8	25.7	19.5
1992	40.7	37.2	22.1
1993	40.7	35.4	23.9
1994	14.2	56.6	29.2
1995	15.9	48.7	35.4
ALL REGIONS	**0-10%**	**11-25%**	**>25%**
1988	60.2	26.6	13.2
1989	58.5	31.3	10.2
1990	59.5	30.5	10.0
1991	53.0	30.0	17.0
1992	49.2	33.5	17.3
1993	44.3	32.4	23.3
1994	40.5	36.1	23.4
1995	33.4	38.7	27.9

Picea sitchensis

ATLANTIC (NORTH)	0-10%	11-25%	>25%
1988	77.8	19.8	2.4
1989	46.3	32.9	20.8
1990	71.8	24.7	3.5
1991	54.1	27.7	18.2
1992	53.2	30.3	16.5
1993	38.5	32.5	29.0
1994	37.2	42.0	20.8
1995	42.9	34.6	22.5
ATLANTIC (SOUTH)	**0-10%**	**11-25%**	**>25%**
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
SUB-ATLANTIC	**0-10%**	**11-25%**	**>25%**
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
MOUNTAIN-OUS (SOUTH)	**0-10%**	**11-25%**	**>25%**
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
MEDITERR. (LOWER)	**0-10%**	**11-25%**	**>25%**
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
MEDITERR. (HIGHER)	**0-10%**	**11-25%**	**>25%**
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
ALL REGIONS	**0-10%**	**11-25%**	**>25%**
1988	77.6	20.0	2.4
1989	46.6	32.9	20.5
1990	72.2	24.4	3.4
1991	54.7	27.4	17.9
1992	53.9	29.9	16.2
1993	39.3	32.1	28.6
1994	38.0	41.5	20.5
1995	43.6	34.2	22.2

Abies alba

ATLANTIC (NORTH)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
ATLANTIC (SOUTH)	**0-10%**	**11-25%**	**>25%**
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
SUB-ATLANTIC	**0-10%**	**11-25%**	**>25%**
1988	54.8	17.4	27.8
1989	56.9	19.6	23.5
1990	60.0	17.8	22.2
1991	58.2	12.2	29.6
1992	55.2	19.6	25.2
1993	54.7	18.3	27.0
1994	54.8	20.9	24.3
1995	53.5	18.7	27.8
MOUNTAIN-OUS (SOUTH)	**0-10%**	**11-25%**	**>25%**
1988	45.7	25.4	28.9
1989	47.0	29.2	23.8
1990	47.0	27.4	25.6
1991	47.3	29.9	22.8
1992	42.0	32.4	25.6
1993	39.9	25.6	34.5
1994	43.4	29.2	27.4
1995	45.6	29.5	24.9
MEDITERR. (LOWER)	**0-10%**	**11-25%**	**>25%**
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
MEDITERR. (HIGHER)	**0-10%**	**11-25%**	**>25%**
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
ALL REGIONS	**0-10%**	**11-25%**	**>25%**
1988	53.5	20.1	26.4
1989	51.4	24.9	23.7
1990	52.7	22.8	24.5
1991	52.2	21.4	26.4
1992	50.0	26.3	23.7
1993	46.3	23.3	30.4
1994	50.4	25.4	24.2
1995	49.9	24.7	25.4

Quercus robur

Region / Year	0-10%	11-25%	>25%
ATLANTIC (NORTH)	0-10%	11-25%	>25%
1988	37.3	40.5	22.2
1989	45.0	45.0	10.0
1990	55.7	30.6	13.7
1991	43.0	40.5	16.5
1992	26.1	58.1	15.8
1993	24.7	42.3	33.0
1994	35.1	29.9	35.0
1995	39.5	35.4	25.1
ATLANTIC (SOUTH)	0-10%	11-25%	>25%
1988	70.7	21.3	8.0
1989	80.9	8.5	10.6
1990	76.6	15.4	8.0
1991	80.3	9.6	10.1
1992	75.0	15.4	9.6
1993	77.1	14.4	8.5
1994	75.0	17.6	7.4
1995	66.0	22.3	11.7
SUB-ATLANTIC	0-10%	11-25%	>25%
1988	73.8	19.7	6.5
1989	66.7	27.2	6.1
1990	64.0	25.5	10.5
1991	56.4	29.3	14.3
1992	45.2	36.4	18.4
1993	39.1	32.3	28.6
1994	29.3	46.2	24.5
1995	29.6	39.4	31.0
MOUNTAIN-OUS (SOUTH)	0-10%	11-25%	>25%
1988	49.6	39.7	10.7
1989	47.2	38.8	14.0
1990	30.6	50.4	19.0
1991	37.2	47.9	14.9
1992	52.9	36.4	10.7
1993	27.3	55.3	17.4
1994	30.6	51.2	18.2
1995	20.7	49.5	29.8
MEDITERR. (LOWER)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
MEDITERR. (HIGHER)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
ALL REGIONS	0-10%	11-25%	>25%
1988	59.1	28.5	12.4
1989	59.4	29.7	10.9
1990	58.3	27.6	14.1
1991	53.4	30.2	16.4
1992	45.8	37.3	16.9
1993	39.7	34.8	25.5
1994	40.0	35.4	24.6
1995	37.5	36.3	26.2

Quercus suber

Region / Year	0-10%	11-25%	>25%
ATLANTIC (NORTH)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
ATLANTIC (SOUTH)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
SUB-ATLANTIC	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
MOUNTAIN-OUS (SOUTH)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
MEDITERR. (LOWER)	0-10%	11-25%	>25%
1988	91.9	7.4	0.7
1989	63.9	28.8	7.3
1990	37.3	20.2	42.5
1991	25.2	31.3	43.5
1992	26.1	38.6	35.3
1993	47.1	43.8	9.1
1994	38.8	49.3	11.9
1995	19.9	55.9	24.2
MEDITERR. (HIGHER)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
ALL REGIONS	0-10%	11-25%	>25%
1988	92.1	7.2	0.7
1989	62.5	28.1	9.4
1990	36.9	19.9	43.2
1991	25.3	30.8	43.9
1992	26.0	38.1	35.9
1993	48.4	42.6	9.0
1994	40.4	47.9	11.7
1995	21.9	54.5	23.6

Pinus nigra

Region / Year	0-10%	11-25%	>25%
ATLANTIC (NORTH)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
ATLANTIC (SOUTH)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
SUB-ATLANTIC	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
MOUNTAIN-OUS (SOUTH)	0-10%	11-25%	>25%
1988	67.7	28.1	4.3
1989	75.7	22.5	1.8
1990	70.8	26.0	3.2
1991	67.4	20.0	12.6
1992	56.9	27.0	16.1
1993	61.0	31.6	7.4
1994	63.1	28.8	8.1
1995	50.9	39.6	9.5
MEDITERR. (LOWER)	0-10%	11-25%	>25%
1988	70.7	24.2	5.1
1989	73.0	22.7	4.3
1990	43.8	36.3	19.9
1991	49.6	34.8	15.6
1992	30.5	47.2	22.3
1993	40.6	44.9	14.5
1994	53.1	36.7	10.2
1995	42.9	34.4	22.7
MEDITERR. (HIGHER)	0-10%	11-25%	>25%
1988	72.2	24.5	3.3
1989	74.0	24.1	1.9
1990	70.4	24.6	5.0
1991	52.8	31.6	15.6
1992	44.9	33.0	22.1
1993	42.7	41.4	15.9
1994	45.4	40.7	13.9
1995	41.6	37.2	21.2
ALL REGIONS	0-10%	11-25%	>25%
1988	72.0	24.1	3.9
1989	74.1	23.5	2.4
1990	65.3	27.1	7.6
1991	56.2	29.5	14.3
1992	45.4	34.7	19.9
1993	47.6	39.3	13.1
1994	51.1	37.4	11.5
1995	44.4	37.1	18.5

Pinus pinaster

ATLANTIC (NORTH)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
ATLANTIC (SOUTH)	0-10%	11-25%	>25%
1988	83.9	14.7	1.4
1989	78.5	12.9	8.6
1990	53.4	14.7	31.9
1991	49.1	26.2	24.7
1992	63.8	26.9	9.3
1993	63.1	29.4	7.5
1994	62.8	29.7	7.5
1995	57.0	35.8	7.2
SUB-ATLANTIC	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
MOUNTAIN-OUS (SOUTH)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
MEDITERR. (LOWER)	0-10%	11-25%	>25%
1988	79.7	12.2	8.1
1989	81.7	12.5	5.8
1990	71.8	21.1	7.1
1991	67.6	25.4	7.0
1992	66.6	26.1	7.3
1993	71.0	21.9	7.1
1994	65.4	27.4	7.2
1995	54.1	36.3	9.6
MEDITERR. (HIGHER)	0-10%	11-25%	>25%
1988	89.7	7.4	2.9
1989	84.2	12.5	3.3
1990	77.9	17.3	4.8
1991	78.0	18.0	4.0
1992	79.0	16.2	4.8
1993	72.7	21.0	6.3
1994	65.1	26.1	8.8
1995	53.7	36.0	10.3
ALL REGIONS	0-10%	11-25%	>25%
1988	82.6	11.5	5.9
1989	81.6	12.5	5.9
1990	70.0	19.1	10.9
1991	66.2	24.0	9.8
1992	67.9	24.0	8.1
1993	69.5	22.8	7.7
1994	64.1	27.6	8.3
1995	54.4	35.5	10.1

Quercus ilex

ATLANTIC (NORTH)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
ATLANTIC (SOUTH)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
SUB-ATLANTIC	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
MOUNTAIN-OUS (SOUTH)	0-10%	11-25%	>25%
1988	79.0	18.1	2.9
1989	86.6	10.5	2.9
1990	25.7	49.5	24.8
1991	49.5	41.0	9.5
1992	27.6	41.0	31.4
1993	21.0	60.9	18.1
1994	10.5	56.2	33.3
1995	15.2	51.5	33.3
MEDITERR. (LOWER)	0-10%	11-25%	>25%
1988	61.1	34.4	4.5
1989	66.8	30.0	3.2
1990	77.6	20.0	2.4
1991	57.0	39.2	3.8
1992	44.0	51.4	4.6
1993	39.4	55.6	5.0
1994	27.7	61.0	11.3
1995	11.1	56.2	32.7
MEDITERR. (HIGHER)	0-10%	11-25%	>25%
1988	62.1	28.8	9.1
1989	80.3	17.0	2.7
1990	82.8	16.3	0.9
1991	61.0	35.6	3.4
1992	49.3	39.9	10.8
1993	36.6	54.0	9.4
1994	34.1	48.1	17.8
1995	24.3	43.3	32.4
ALL REGIONS	0-10%	11-25%	>25%
1988	62.2	31.8	6.0
1989	72.1	24.8	3.1
1990	76.3	20.5	3.2
1991	57.6	38.3	4.1
1992	44.7	47.3	8.0
1993	37.5	55.4	7.1
1994	28.3	57.3	14.4
1995	15.2	52.5	32.3

Pinus halepensis

ATLANTIC (NORTH)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
ATLANTIC (SOUTH)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
SUB-ATLANTIC	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
MOUNTAIN-OUS (SOUTH)	0-10%	11-25%	>25%
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
MEDITERR. (LOWER)	0-10%	11-25%	>25%
1988	64.8	29.5	5.7
1989	75.4	21.6	3.0
1990	70.7	25.2	4.1
1991	69.8	27.2	3.0
1992	46.7	42.3	11.0
1993	45.6	43.7	10.7
1994	34.0	46.2	19.8
1995	15.9	57.8	26.3
MEDITERR. (HIGHER)	0-10%	11-25%	>25%
1988	72.6	22.0	5.4
1989	75.5	18.7	5.8
1990	70.5	27.8	1.7
1991	74.3	24.5	1.2
1992	58.9	38.2	2.9
1993	57.3	39.0	3.7
1994	44.8	51.1	4.1
1995	10.0	72.2	17.8
ALL REGIONS	0-10%	11-25%	>25%
1988	66.4	28.0	5.6
1989	75.6	20.9	3.5
1990	70.7	25.6	3.7
1991	70.5	26.8	2.7
1992	48.9	41.5	9.6
1993	47.8	42.7	9.5
1994	35.9	47.2	16.9
1995	14.8	60.4	24.8

Annex II

National surveys

Annex II-1
Forests and surveys in European countries (1995)

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	3878	2683	798	3481	8.7 x 8.7	216	6349
Belarus	20760	7028	4757	2271	6001	16 x 16	415	10016
Belgium	3057	602	302	300	602	4^2 / 8^2	139	3281
Bulgaria	11100	3314	1172	2142	3314	16^2 / 8^2	180	7049
Croatia	5654	2061	321	1740	no survey in 1995			
Czech Republic	7886	2630	2051	579	2630	$8^2/16^2$	199	12889
Denmark	4300	466	308	158	411	$7^2/16^2$	53	1272
Estonia	4510	1815	1135	680	1135	16 x 16	91	2184
Finland	30464	20059	18484	1575	15304	16^2 / 24x32	455	8754
France	54919	14002	5040	8962	13100	16 x 16	543	10851
Germany	35562	10190	6913	3277	10190	16^2 / 4^2	3539	80684
Greece a)	13204	2034	954	1080	2034	16 x 16	79	1864
Hungary	9300	1719	267	1452	1609	4 x 4	1104	23289
Ireland	6889	370	326	44	326	16 x 16	21	441
Italy	30126	8675	1735	6940	7699	16 x 16	210	4549
Latvia	6450	2797	1633	1164	2642	8 x 8	399	9131
Liechtenstein	16	8	6	2	no survey in 1995			
Lithuania	6520	1823	1073	750	1823	$8^2/16^2$	317	7750
Luxembourg	259	89	30	54	84	4 x 4	51	1166
Rep. of Moldova	3050	1141		1141	no survey in 1995			
Netherlands	4147	311	208	103	228	1 x 1	200	5000
Norway	30686	13700	7000	6700	13700	$9^2/18^2$	928	8429
Poland	31270	8654	6895	1759	8654	16 x 16	1174	23480
Portugal	8800	3370	1338	2032	3370	16 x 16	141	4230
Romania	23750	6244	1929	4315	6244	2x2/2x4	8371	338817
Russian Fed. b)	10040	6022	4052	1970	6022	varying	138	3224
Slovak Republic	4901	1910	816	1069	1910	16 x 16	111	4284
Slovenia	2006	1009	182	303	1009	4 x 4	712	16172
Spain	50471	11792	5637	6155	11792	16 x 16	454	10896
Sweden	40800	23500	19729	3771	20009	varying	4386	15948
Switzerland	4129	1186	818	368	1186	16 x 16	47	1072
Turkey	77945	20199	9426	10773	no survey in 1995			
Ukraine	60370	6151	2931	3220	2021	16 x 16	134	3210
United Kingdom	24100	2200	1550	650	2200	random	363	8712
Yugoslavia c)	25600	6100	900	5200	no survey in 1995			
TOTAL	661426	197049	112601	83497	150730	varying	25170	634993

a) Excluding maquis. b) Only Kaliningrad and Leningrad Regions.
c) Former Yugoslavia excluding Croatia and Slovenia.

Annex II-2
Defoliation of all species by classes and class aggregates (1995)

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 a)	3481	6349	67.1	26.3	5.9	0.7	6.6
Belarus	6001	10016	15.7	46.0	35.9	2.4	38.3
Belgium	602	3281	36.0	39.5	23.6	0.9	24.5
Bulgaria	3314	7049	26.6	35.4	29.6	8.4	38.0
Croatia			no survey in 1995				
Czech Republic	2630	12889	6.4	35.1	55.4	3.1	58.5
Denmark	411	1272	34.3	29.1	31.6	5.0	36.6
Estonia	1135	2184	50.5	35.9	12.5	1.1	13.6
Finland	15304	8754	61.3	25.4	12.2	1.1	13.3
France	13100	10851	63.0	24.5	11.0	1.5	12.5
Germany	10207	80684	38.9	39.0	20.2	1.9	22.1
Greece b)	2034	1864	38.1	36.8	20.8	4.3	25.1
Hungary	1609	23289	43.9	36.1	14.5	5.5	20.0
Ireland	326		only conifers assessed				
Italy	7699	4549	56.2	24.9	15.9	3.0	18.9
Latvia	2642	9131	31.0	49.0	19.0	1.0	20.0
Liechtenstein			no survey in 1995				
Lithuania	1823	7750	19.4	55.7	20.3	4.6	24.9
Luxembourg	84	1166	32.1	29.6	35.3	3.0	38.3
Rep. of Moldova			no survey in 1995				
Netherlands	228	5000	44.5	23.5	28.6	3.4	32.0
Norway	13700	8429	35.0	36.2	23.4	5.4	28.8
Poland	8654	23480	5.7	41.7	50.0	2.6	52.6
Portugal	3370	4230	52.4	38.5	8.8	0.3	9.1
Romania	6244	338817	51.9	26.9	16.8	4.4	21.2
Russian Fed. c)	6022	3224	39.9	47.6	10.7	1.8	12.5
Slovak Republic	1910	4284	13.9	43.5	37.9	4.7	42.6
Slovenia	1009	16172	38.2	37.1	19.4	5.3	20.8
Spain	11792	10896	28.7	47.8	18.9	4.6	23.5
Sweden	20009	15948	61.6	24.2	10.6	3.6	14.2
Switzerland	1186	1072	30.1	45.3	17.9	6.7	24.6
Turkey			no survey in 1995				
Ukraine	2021	3210	23.6	46.8	28.1	1.5	29.6
United Kingdom	2200	8712	41.7	44.7	12.7	0.9	13.6
Yugoslavia d)			no survey in 1995				

a) Only trees 60 years and older assessed. b) Excluding maquis. c) Only Kaliningrad and Leningrad Regions. d) Former Yugoslavia excluding Croatia and Slovenia.

The figures are based on national surveys and not suitable for comparisons between individual countries.

Annex II-3

Defoliation of conifers by classes and class aggregates (1995)

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)	2683	5531	66.8	26.6	5.9	0.7	6.6
Belarus	4122	7354	8.2	47.9	41.4	2.5	43.9
Belgium	302	1229	34.4	44.6	19.4	1.6	21.0
Bulgaria	1172	4277	22.5	36.1	34.9	6.5	41.4
Croatia	321		no survey in 1995				
Czech Republic	2051	11945	5.8	33.5	57.6	3.1	60.7
Denmark	308	803	42.0	23.2	27.5	7.3	34.8
Estonia	1135	2089	48.4	37.4	13.0	1.2	14.2
Finland	18484	7359	60.5	25.8	12.5	1.2	13.7
France	5040	3750	70.4	20.4	8.2	1.0	9.2
Germany	6913	53335	43.7	38.0	17.0	1.3	18.3
Greece b)	954	992	49.3	37.1	11.4	2.2	13.6
Hungary	247	3726	49.3	32.0	14.5	4.2	18.7
Ireland	326	441	35.8	37.9	24.0	2.3	26.3
Italy	1735	1246	61.8	18.8	16.4	3.0	19.4
Latvia	1606	6724	24.0	53.0	22.0	1.0	23.0
Liechtenstein	6		no survey in 1995				
Lithuania	1073	5514	15.5	57.9	20.8	5.8	26.6
Luxembourg	30	404	59.4	27.7	11.9	1.0	12.9
Rep. of Moldova			no survey in 1995				
Netherlands	176	3050	36.1	18.5	40.5	4.9	45.4
Norway	7000	6708	40.5	35.5	19.4	4.6	24.0
Poland	6895	18020	5.1	40.4	51.7	2.8	54.5
Portugal	1338	1487	67.2	26.2	6.5	0.1	6.6
Romania	1929	78796	61.0	23.8	12.2	3.0	15.2
Russian Fed. c)	4052	4052	41.0	47.4	9.9	1.7	11.6
Slovak Republic	816	1781	7.5	40.5	45.5	6.5	52.0
Slovenia	182	6210	24.9	41.5	27.9	5.7	33.6
Spain	5637	5367	32.8	49.1	14.9	3.2	18.1
Sweden	19729	14373	60.9	24.6	11.0	3.5	14.5
Switzerland	818	735	32.1	44.7	18.0	5.2	23.2
Turkey	9426		no survey in 1995				
Ukraine	2931	1467	28.1	46.2	23.9	1.8	25.7
United Kingdom	1550	5232	42.6	44.4	11.9	1.1	13.0
Yugoslavia d)	900		no survey in 1995				

a) Only trees 60 years and older assessed. b) Excluding maquis. c) Only Kaliningrad and Leningrad Regions. d) Former Yugoslavia excluding Croatia and Slovenia.

The figures are based on national surveys and not suitable for comparisons between individual countries.

Annex II-4
Defoliation of broadleaves by classes and class aggregates (1995)

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)	798	818	68.9	24.6	5.5	1.0	6.5
Belarus	1879	2662	36.3	40.8	20.6	2.3	22.9
Belgium	300	2052	36.9	36.5	26.1	0.5	26.6
Bulgaria	2142	2772	33.1	34.2	21.3	11.4	32.7
Croatia	1740		no survey in 1995				
Czech Republic	579	944	14.6	54.8	27.4	3.2	30.6
Denmark	158	469	21.1	39.2	38.6	1.1	39.7
Estonia	680	95	96.8	2.1	1.1	0.0	1.1
Finland	1100	1395	66.0	23.0	10.4	0.6	11.0
France	8962	7101	59.0	26.7	12.5	1.8	14.3
Germany	3277	27349	29.6	40.5	28.3	1.6	29.9
Greece b)	1080	872	25.3	36.5	31.4	6.8	38.2
Hungary	1362	19563	42.9	36.9	14.5	5.7	20.2
Ireland	44		only conifers assessed				
Italy	6940	3303	54.2	27.3	15.6	2.9	18.5
Latvia	1036	2407	49.0	41.0	9.0	1.0	10.0
Liechtenstein	2		no survey in 1995				
Lithuania	750	2236	29.2	50.0	18.9	1.9	20.8
Luxembourg c)	54	762	17.6	31.0	47.6	3.8	51.4
Rep. of Moldova	1141		no survey in 1995				
Netherlands	52	1950	57.9	31.3	9.8	1.0	10.8
Norway d)	6700	1721	13.7	38.9	39.3	8.1	47.4
Poland	1759	5460	7.3	46.0	44.3	2.4	46.7
Portugal	2032	2743	44.5	45.1	10.0	0.4	10.4
Romania	4315	260021	49.1	27.8	18.3	4.8	23.1
Russian Fed. e)	144	128	12.5	53.1	30.5	3.9	34.4
Slovak Republic	1069	2503	18.5	45.7	32.5	3.3	35.8
Slovenia	303	9962	46.4	34.3	14.2	5.1	19.3
Spain	6155	5529	24.8	46.5	22.8	5.9	28.7
Sweden	3771	1575	72.9	19.2	6.1	1.8	7.9
Switzerland	368	337	26.5	46.5	17.6	9.4	27.0
Turkey	10773		no survey in 1995				
Ukraine	3220	1743	19.8	47.2	31.7	1.3	33.0
United Kingdom	650	3480	40.3	45.2	13.9	0.6	14.5
Yugoslavia f)	5200		no survey in 1995				

a) Only trees 60 years and older assessed. b) Excluding maquis. c) Including underwood.
d) Special study on birch. e) Only Kaliningrad Region. f) Former Yugoslavia excluding Croatia and Slovenia.

The figures are based on national surveys and not suitable for comparisons between individual countries.

Annex II-5
Defoliation of all species (1986-1995)

Participating countries	All species										change
	Defoliation classes 2-4										%-points
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1994/1995
Austria				10.8	9.1	7.5	6.9	8.2	7.8	6.6	-1.2
Belarus				67.2	54.0		19.2	29.3	37.4	38.3	0.9
Belgium				14.6	16.2	17.9	16.9	14.8	16.9	24.5	7.6
Bulgaria	8.1	3.6	7.4	24.9	29.1	21.8	23.1	23.2	28.9	38.0	9.1
Croatia							15.6	19.2	28.8		
Czech Republic	only conifers assessed					45.3	56.1	51.8	57.7	58.5	0.8
Denmark		23.0	18.0	26.0	21.2	29.9	25.9	33.4	36.5	36.6	0.1
Estonia	only conifers assessed						28.5	20.3	15.7	13.6	-2.1
Finland		12.1	16.1	18.0	17.3	16.0	14.5	15.2	13.0	13.3	0.3
France a)	8.3	9.7	6.9	5.6	7.3	7.1	8.0	8.3	8.4	12.5	4.1
Germany b)	18.9	17.3	14.9	15.9	15.9	25.2	26.0	24.2	24.4	22.1	-2.3
Greece c)			17.0	12.0	17.5	16.9	18.1	21.2	23.2	25.1	1.9
Hungary			7.5	12.7	21.7	19.6	21.5	21.0	21.7	20.0	-1.7
Ireland	only conifers assessed										
Italy				9.1	14.8	16.4	18.2	17.6	19.5	18.9	-0.6
Latvia					36.0		37.0	35.0	30.0	20.0	-10.0
Liechtenstein	19.0	19.0	17.0	11.8			16.0				
Lithuania			3.0	21.5	20.4	23.9	17.5	27.4	25.4	24.9	-0.5
Luxembourg	5.1	7.9	10.3	12.3		20.8	20.4	23.8	34.8	38.3	3.5
Rep. of Moldova								50.8			
Netherlands	23.3	21.4	18.3	16.1	17.8	17.2	33.4	25.0	19.4	32.0	12.6
Norway	only conifers assessed				18.2	19.7	26.2	24.9	27.5	28.8	1.3
Poland			20.4	31.9	38.4	45.0	48.8	50.0	54.9	52.6	-2.3
Portugal			1.3	9.1	30.7	29.6	22.5	7.3	5.7	9.1	3.4
Romania						9.7	16.7	20.5	21.2	21.2	0.0
Russian Fed. d)	only conifers assessed								10.7	12.5	1.8
Slovak Republic			38.8	49.2	41.5	28.5	36.0	37.6	41.8	42.6	0.8
Slovenia				22.6	18.2	15.9		19.0	16.0	24.7	8.7
Spain			7.6	4.5	4.6	7.3	12.3	13.0	19.4	23.5	4.1
Sweden	only conifers assessed									14.2	
Switzerland	9.6	12.5	8.7	10.4	15.5	16.1	12.8	15.4	18.2	24.6	6.4
Turkey											
Ukraine						6.4	16.3	21.5	32.4	29.6	-2.8
United Kingdom e)		22.0	25.0	28.0	39.0	56.7	58.3	16.9	13.9	13.6	-0.3
Yugoslavia f)						9.8					

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

The figures are based on national surveys and not suitable for comparisons between individual countries.

Annex II-6
Defoliation of conifers (1986-1995)

Participating countries	Conifers										change
	Defoliation classes 2-4										%-points
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1994/1995
Austria				10.1	8.3	7.0	6.6	8.2	7.9	6.6	-1.3
Belarus				76.0	57.0		33.7	33.8	43.0	43.9	0.9
Belgium				20.4	23.6	23.4	23.0	18.3	21.2	21.0	-0.2
Bulgaria	4.7	3.8	7.6	32.9	37.4	26.5	25.5	26.9	25.0	41.4	16.4
Croatia							26.3	33.9	39.3		
Czech Republic	23.2	20.6	37.5		46.9	46.3	57.9	51.5	59.0	60.7	1.7
Denmark		24.0	21.0	24.0	18.8	31.4	28.6	37.0	38.7	34.8	-3.9
Estonia			9.0	28.5	20.0	28.0	29.5	21.2	16.0	14.2	-1.8
Finland		13.5	17.0	18.7	18.0	17.2	15.2	15.6	13.1	13.7	0.6
France a)	12.5	12.0	9.1	7.3	6.6	6.7	7.1	8.2	8.2	9.2	1.0
Germany b)	19.5	15.9	14.0	13.2	15.0	24.8	23.8	21.4	21.6	18.3	-3.3
Greece			7.7	6.7	10.0	7.2	12.3	13.9	13.2	13.6	0.4
Hungary			9.4	13.3	23.3	17.8	20.1	20.1	21.2	18.7	-2.5
Ireland		0.0	4.8	13.2	5.4	15.0	15.7	29.6	19.7	26.3	6.6
Italy				9.2	12.8	13.8	17.2	15.1	15.0	19.4	4.4
Latvia					43.0		45.0	41.0	34.0	23.0	-11.0
Liechtenstein	22.0	27.0	23.0	12.4			18.0				
Lithuania			3.0	24.0	22.9	27.8	17.5	29.2	26.3	26.6	0.3
Luxembourg	4.2	3.8	11.1	9.5		7.9	6.3	9.0	12.8	12.9	0.1
Rep. of Moldova								45.2			
Netherlands	28.9	18.7	14.5	17.7	21.4	21.4	34.7	30.6	27.7	45.4	17.7
Norway			20.8	14.8	17.1	19.0	23.4	20.9	22.4	24.0	1.6
Poland			24.2	34.5	40.7	46.9	50.3	52.5	55.6	54.5	-1.1
Portugal			1.7	9.8	25.7	19.8	11.3	7.1	5.4	6.6	1.2
Romania						6.9	10.9	16.6	15.5	15.2	-0.3
Russian Fed. c)									9.4	11.6	2.2
Slovak Republic			52.7	59.1	55.5	38.5	44.0	49.9	50.3	52.0	1.7
Slovenia					34.6	31.3		27.0	19.0	33.6	14.6
Spain			7.7	4.7	4.4	7.2	13.5	14.7	19.6	18.1	-1.5
Sweden		5.6	12.3	12.9	16.1	12.3	16.9	10.6	16.2	14.5	-1.7
Switzerland	12.2	12.8	10.9	12.8	17.9	18.0	14.1	17.4	19.6	23.2	3.6
Turkey											
Ukraine				1.4	3.0	6.4	13.8	21.7	34.8	25.7	-9.1
United Kingdom d)		23.0	27.0	34.0	45.0	51.5	52.7	16.8	15.0	13.0	-2.0
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) Only Kaliningrad and Leningrad Regions. d) The difference between 1992 and subsequent years 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.

The figures are based on national surveys and not suitable for comparisons between individual countries.

Annex II-7
Defoliation of broadleaves (1986-1995)

Participating countries	Broadleaves										change
	Defoliation classes 2-4										%-points
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1994/1995
Austria				15.7	14.9	11.1	9.3	7.7	7.4	6.5	-0.9
Belarus				33.4	45.0		14.8	16.6	18.6	22.9	4.3
Belgium				8.7	10.0	13.5	11.8	11.7	12.8	26.6	13.8
Bulgaria	4.0	3.1	8.8	16.2	17.3	15.3	18.0	16.6	34.4	32.7	-1.7
Croatia							13.6	15.6	26.4		
Czech Republic	only conifers assessed					37.6	29.2	54.4	48.0	30.6	-17.4
Denmark		20.0	14.0	30.0	25.4	27.3	21.2	27.0	32.4	39.7	7.3
Estonia	only conifers assessed							1.1	2.0	1.1	-0.9
Finland		4.7	7.9	12.6	11.6	7.7	10.1	12.8	12.0	11.0	-1.0
France a)	4.8	6.5	5.3	4.8	7.7	7.4	8.5	8.4	8.4	14.3	5.9
Germany b)	16.8	19.2	16.5	20.4	23.8	26.5	32.0	29.9	30.1	29.9	-0.2
Greece			28.5	18.4	26.5	28.5	25.0	29.8	35.0	38.2	3.2
Hungary			7.0	12.5	21.5	19.9	21.8	21.2	21.8	20.2	-1.6
Ireland	only conifers assessed										
Italy		3.6	2.9	9.5	15.4	17.1	18.5	18.3	20.7	18.5	-2.2
Latvia					27.0		19.0	17.8	15.0	10.0	-5.0
Liechtenstein	10.0	7.0	5.0	9.0			8.0				
Lithuania			1.0	16.0	15.8	14.9	17.6	23.8	23.3	20.8	-2.5
Luxembourg c)	5.6	10.1	12.3	13.9		33.9	30.5	31.0	46.8	51.4	4.6
Rep. of Moldova								50.9	21.9		
Netherlands	13.2	26.5	25.4	13.1	11.5	9.4	31.1	13.1	5.1	10.8	5.7
Norway					18.2	25.1	38.9	42.1	47.6	47.4	-0.2
Poland			7.1	17.7	25.6	34.8	40.4	49.9	51.5	46.7	-4.8
Portugal			0.8	8.6	34.1	36.6	29.1	7.5	5.8	10.4	4.6
Romania						10.4	18.4	21.4	22.9	23.1	0.2
Russian Fed. d)					10.2				39.4	34.4	-5.0
Slovak Republic			28.5	41.8	31.3	21.1	30.0	29.1	35.6	35.8	0.2
Slovenia					4.4	5.8		11.0	13.0	19.3	6.3
Spain			7.4	4.2	4.8	7.4	11.2	11.4	19.3	28.7	9.4
Sweden	only conifers assessed									7.9	
Switzerland	7.2	11.7	5.2	6.9	12.3	13.3	11.1	12.7	16.2	27.0	10.8
Turkey											
Ukraine				1.4	2.7	6.5	20.2	21.6	29.9	33.0	3.1
United Kingdom e)		20.0	20.0	21.0	28.8	65.6	67.8	17.1	12.4	14.5	2.1
Yugoslavia f)		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) Including underwood. d) Only Kaliningrad Region. e) The difference between 1992 and subsequent years is mainly due to a change of assessment method in line with that used in other States.
f) Former Yugoslavia; Croatia and Slovenia excluded from 1991 results.

The figures are based on national surveys and not suitable for comparisons between individual countries.

Annex II-8
10%-defoliation classes

Austria 1995

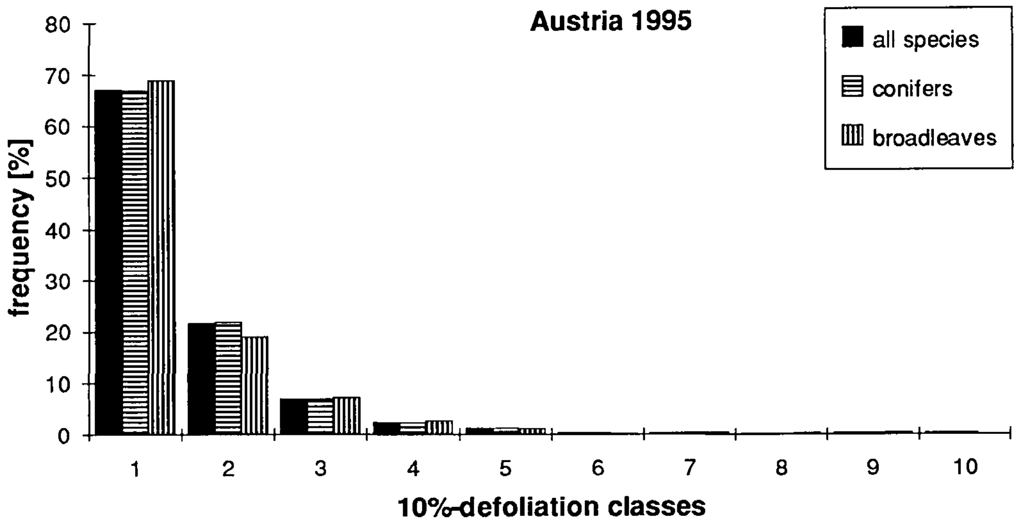
10%-defoliation classes	defoliation-% all species	conifers	broadleaves
0 - 10%	67.1	66.8	68.9
>10 - 20%	21.5	21.8	19.0
>20 - 30%	6.9	6.9	7.2
>30 - 40%	2.3	2.3	2.7
>40 - 50%	1.2	1.2	1.1
>50 - 60%	0.3	0.3	0.1
>60 - 70%	0.2	0.2	0.4
>70 - 80%	0.1	0.1	0.2
>80 - 90%	0.2	0.2	0.4
>90 -100%	0.2	0.2	0.0
total:	100.0	100.0	100.0
mean defoliation	10.4	10.4	10.3

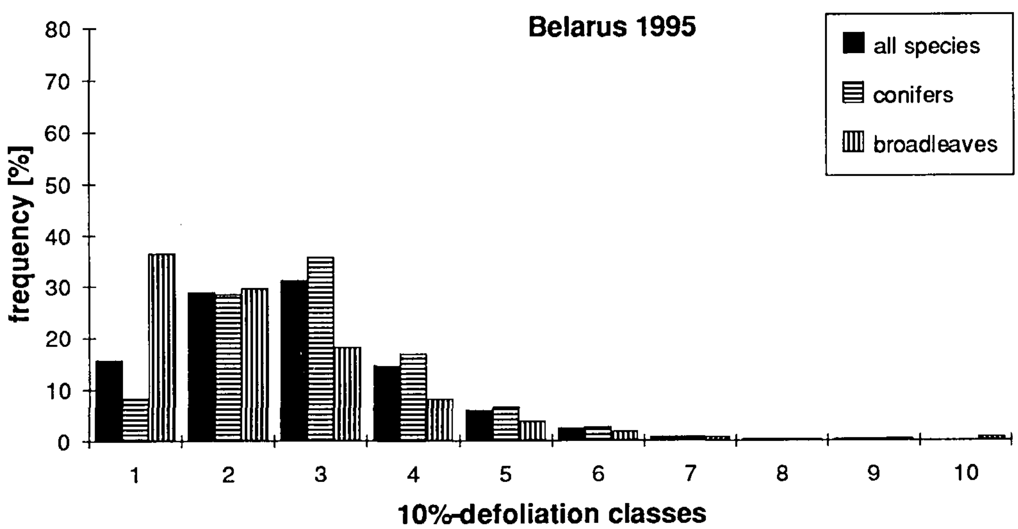
Belarus 1995

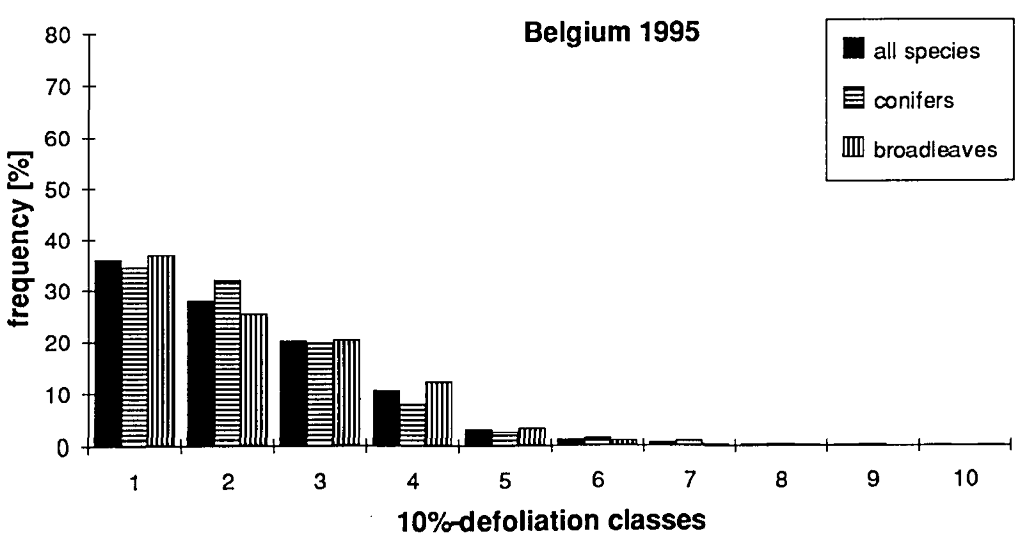
10%-defoliation classes	defoliation-% all species	conifers	broadleaves
0 - 10%	15.7	8.2	36.4
>10 - 20%	28.8	28.5	29.5
>20 - 30%	31.1	35.7	18.1
>30 - 40%	14.6	16.9	8.1
>40 - 50%	5.9	6.6	3.8
>50 - 60%	2.5	2.7	1.9
>60 - 70%	0.8	0.8	0.8
>70 - 80%	0.3	0.3	0.3
>80 - 90%	0.3	0.3	0.4
>90 -100%	0.0	0.0	0.7
total:	100.0	100.0	100.0
mean defoliation	23.0	25.0	18.1

Belgium 1995

10%-defoliation classes	defoliation-% all species	conifers	broadleaves
0 - 10%	36.0	34.5	36.9
>10 - 20%	28.0	32.1	25.5
>20 - 30%	20.2	19.8	20.5
>30 - 40%	10.6	8.0	12.3
>40 - 50%	3.1	2.6	3.3
>50 - 60%	1.2	1.5	1.0
>60 - 70%	0.6	1.0	0.2
>70 - 80%	0.3	0.4	0.2
>80 - 90%	0.1	0.2	0.0
>90 -100%	0.1	0.0	0.1
total:	100.0	100.0	100.0
mean defoliation	17.5	17.4	17.5


Austria 1995
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


Belarus 1995
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


Belgium 1995
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

Bulgaria 1995

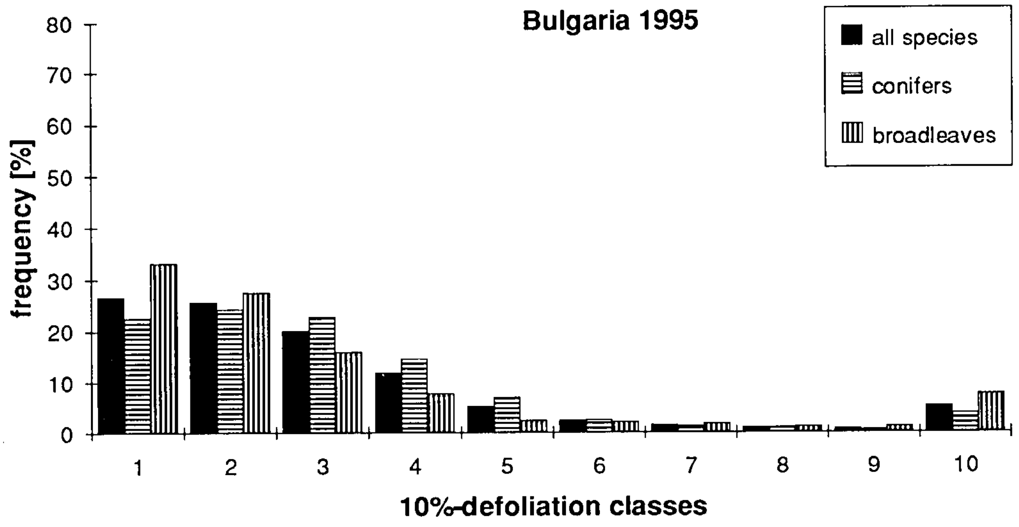
10%-defoliation classes	defoliation-% all species	conifers	broadleaves
0 - 10%	26.6	22.5	33.1
>10 - 20%	25.6	24.3	27.5
>20 - 30%	20.1	22.8	15.9
>30 - 40%	11.8	14.5	7.7
>40 - 50%	5.2	6.9	2.3
>50 - 60%	2.3	2.5	2.1
>60 - 70%	1.5	1.3	1.7
>70 - 80%	1.0	1.0	1.1
>80 - 90%	0.7	0.5	1.1
>90 -100%	5.2	3.7	7.5
total:	100.0	100.0	100.0
mean defoliation	25.2	25.6	24.6

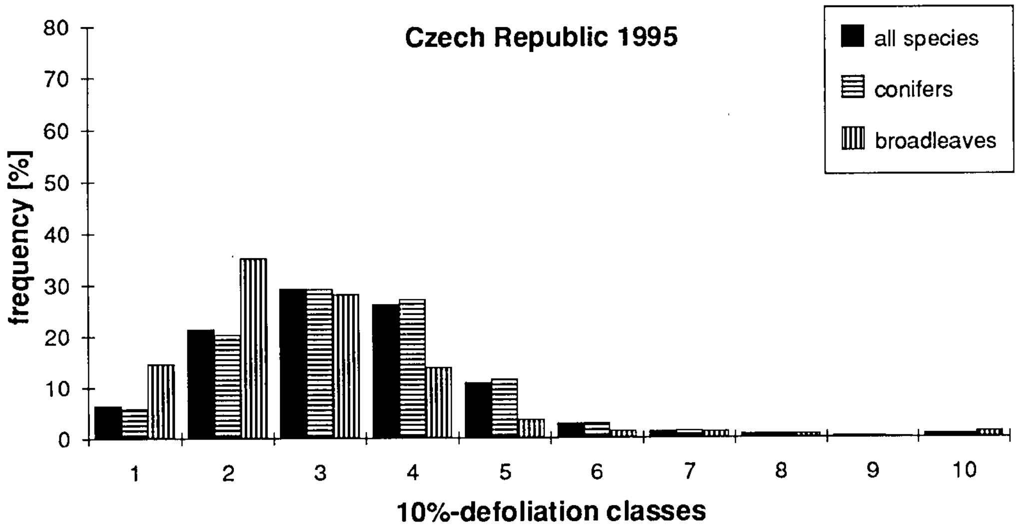
Czech Republic 1995

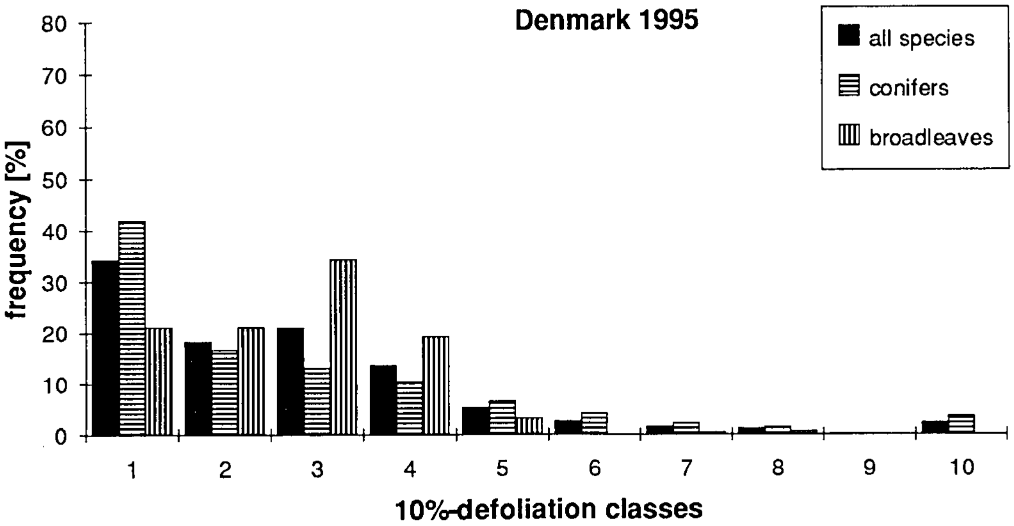
10%-defoliation classes	defoliation-% all species	conifers	broadleaves
0 - 10%	6.4	5.8	14.6
>10 - 20%	21.4	20.3	35.2
>20 - 30%	29.3	29.2	28.2
>30 - 40%	26.2	27.2	13.8
>40 - 50%	10.9	11.5	3.6
>50 - 60%	2.8	2.9	1.4
>60 - 70%	1.3	1.4	1.2
>70 - 80%	0.7	0.7	0.7
>80 - 90%	0.2	0.2	0.1
>90 -100%	0.8	0.8	1.2
total:	100.0	100.0	100.0
mean defoliation	28.8	29.3	22.8

Denmark 1995

10%-defoliation classes	defoliation-% all species	conifers	broadleaves
0 - 10%	34.3	42.0	21.1
>10 - 20%	18.3	16.6	21.1
>20 - 30%	20.9	13.0	34.4
>30 - 40%	13.6	10.3	19.2
>40 - 50%	5.4	6.6	3.2
>50 - 60%	2.7	4.2	0.0
>60 - 70%	1.5	2.2	0.4
>70 - 80%	1.1	1.4	0.6
>80 - 90%	0.1	0.1	0.0
>90 -100%	2.3	3.6	0.0
total:	100.0	100.0	100.0
mean defoliation	22.3	22.7	21.7


Bulgaria 1995
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 1995
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 1995
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

Estonia 1995

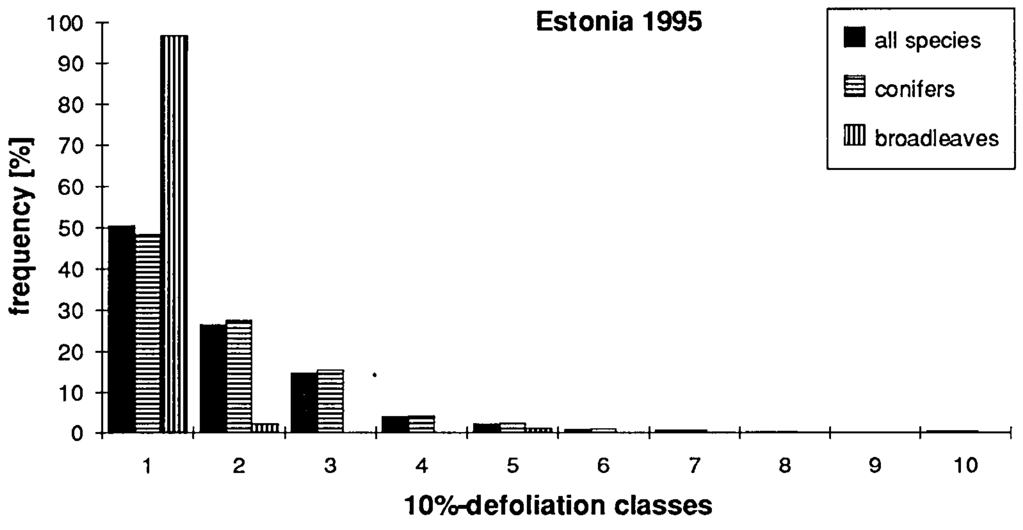
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0 - 10%	50.5	48.3	96.8
>10 - 20%	26.5	27.6	2.1
>20 - 30%	14.8	15.5	0.0
>30 - 40%	4.0	4.2	0.0
>40 - 50%	2.2	2.3	1.1
>50 - 60%	0.8	0.9	0.0
>60 - 70%	0.6	0.6	0.0
>70 - 80%	0.2	0.2	0.0
>80 - 90%	0.0	0.0	0.0
>90 -100%	0.4	0.4	0.0
total:	100.0	100.0	100.0
mean defoliation	14.0	14.4	5.7

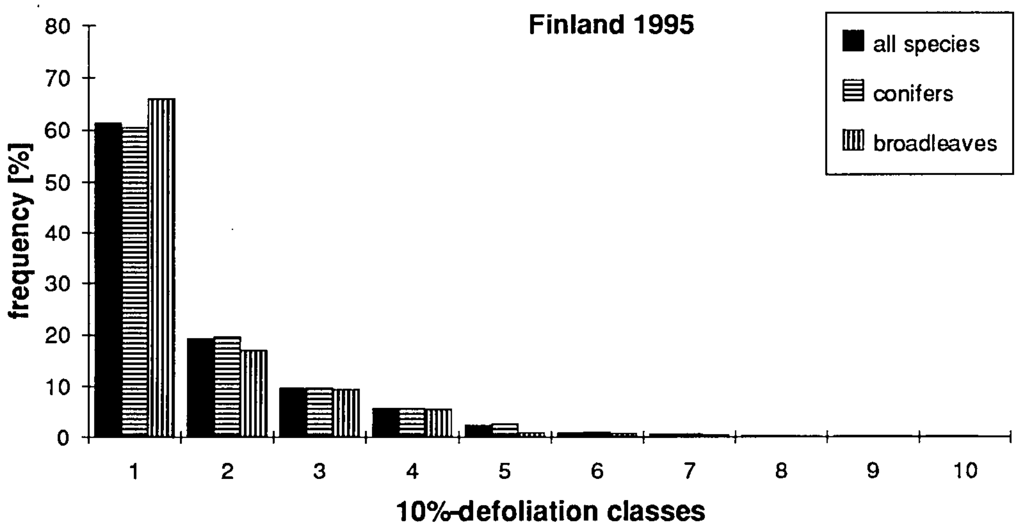
Finland 1995

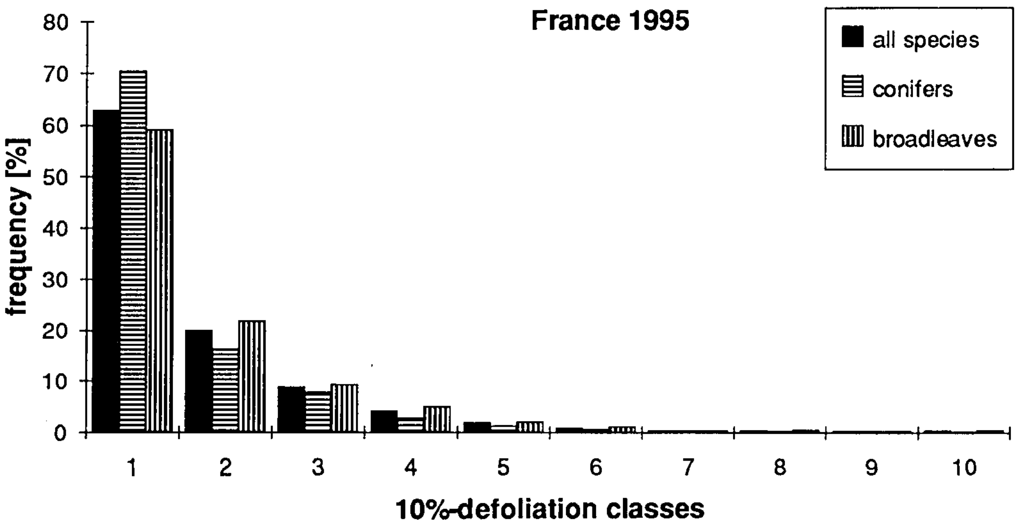
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0 - 10%	61.3	60.5	66.0
>10 - 20%	19.2	19.6	17.0
>20 - 30%	9.6	9.6	9.4
>30 - 40%	5.6	5.6	5.4
>40 - 50%	2.3	2.6	0.9
>50 - 60%	0.9	1.0	0.7
>60 - 70%	0.6	0.6	0.4
>70 - 80%	0.3	0.3	0.1
>80 - 90%	0.1	0.1	0.1
>90 -100%	0.1	0.1	0.0
total:	100.0	100.0	100.0
mean defoliation	12.6	12.8	11.3

France 1995

10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0 - 10%	62.9	70.4	59.1
>10 - 20%	20.0	16.2	21.9
>20 - 30%	8.8	7.8	9.3
>30 - 40%	4.1	2.7	4.9
>40 - 50%	1.8	1.3	2.0
>50 - 60%	0.9	0.6	1.1
>60 - 70%	0.4	0.4	0.4
>70 - 80%	0.4	0.3	0.5
>80 - 90%	0.3	0.2	0.3
>90 -100%	0.4	0.1	0.5
total:	100.0	100.0	100.0
mean defoliation	18.6	17.6	19.1


Estonia 1995
all species
conifers
broadleaves
frequency [%]
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
10%-defoliation classes


Finland 1995
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


France 1995
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

Greece 1995

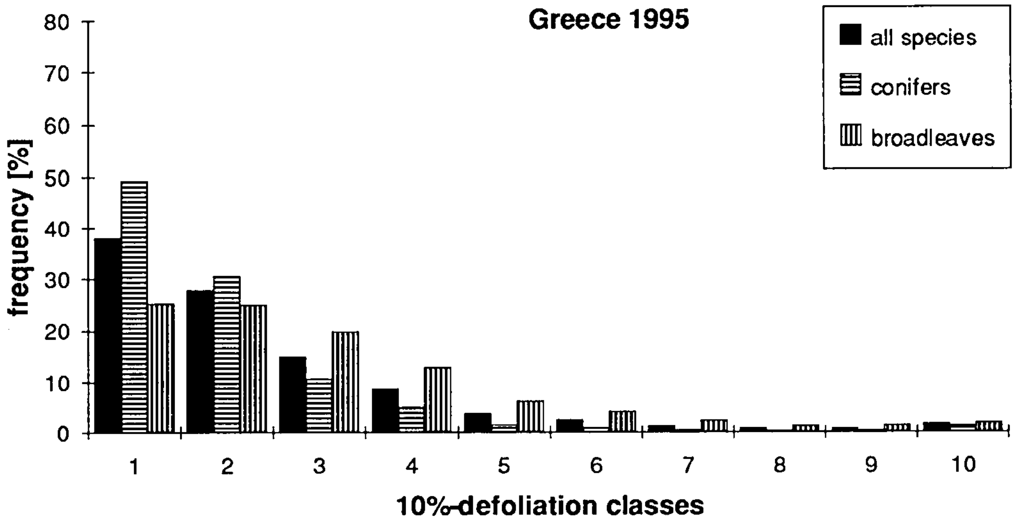
10%-defoliation classes	defoliation-% all species	conifers	broadleaves
0 - 10%	38.1	49.3	25.3
>10 - 20%	27.9	30.6	25.0
>20 - 30%	14.9	10.6	19.8
>30 - 40%	8.6	4.9	12.8
>40 - 50%	3.7	1.5	6.2
>50 - 60%	2.5	0.9	4.1
>60 - 70%	1.2	0.4	2.3
>70 - 80%	0.7	0.3	1.2
>80 - 90%	0.8	0.2	1.4
>90 -100%	1.6	1.3	1.9
total:	100.0	100.0	100.0
mean defoliation	19.4	14.5	24.9

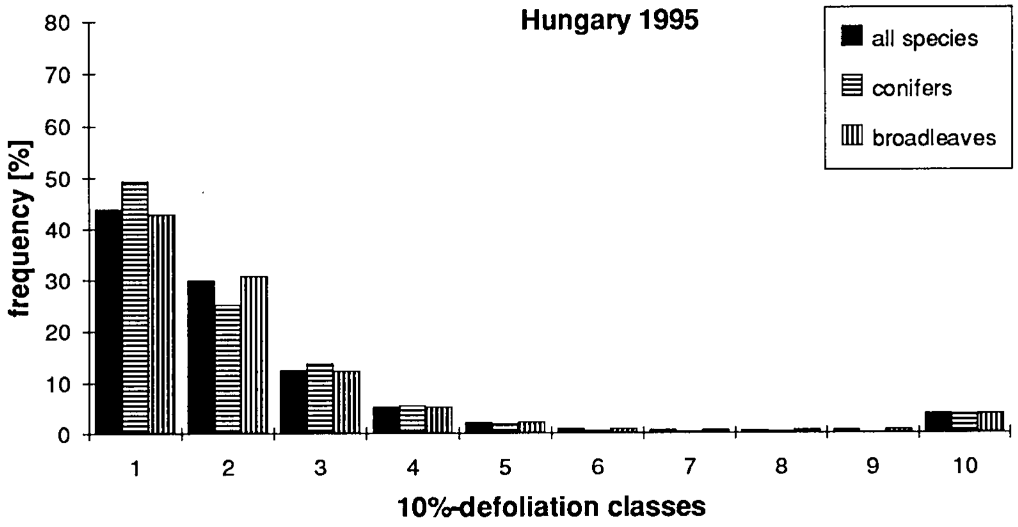
Hungary 1995

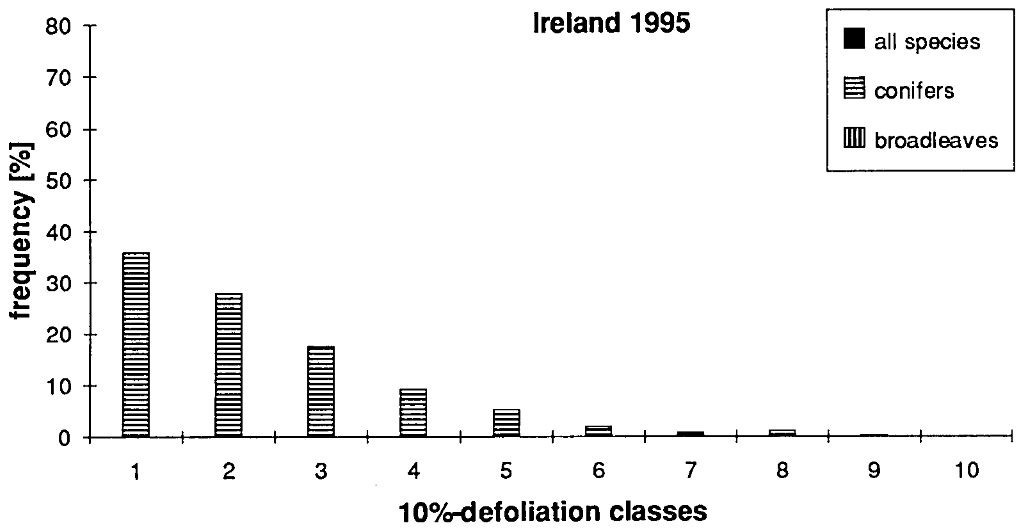
10%-defoliation classes	defoliation-% all species	conifers	broadleaves
0 - 10%	43.9	49.3	42.9
>10 - 20%	29.9	25.1	30.8
>20 - 30%	12.5	13.7	12.3
>30 - 40%	5.2	5.4	5.2
>40 - 50%	2.1	1.8	2.2
>50 - 60%	0.9	0.5	0.9
>60 - 70%	0.6	0.2	0.6
>70 - 80%	0.5	0.2	0.6
>80 - 90%	0.6	0.1	0.7
>90 -100%	3.8	3.7	3.8
total:	100.0	100.0	100.0
mean defoliation	18.0	16.5	18.2

Ireland 1995

10%-defoliation classes	defoliation-% all species	conifers	broadleaves
0 - 10%		35.9	
>10 - 20%		27.9	
>20 - 30%		17.5	
>30 - 40%		9.3	
>40 - 50%		5.2	
>50 - 60%		2.0	
>60 - 70%		0.9	
>70 - 80%		1.1	
>80 - 90%		0.2	
>90 -100%		0.0	
total:		100.0	
mean defoliation:		18.6	


Greece 1995
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 1995
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 1995
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

Latvia 1995

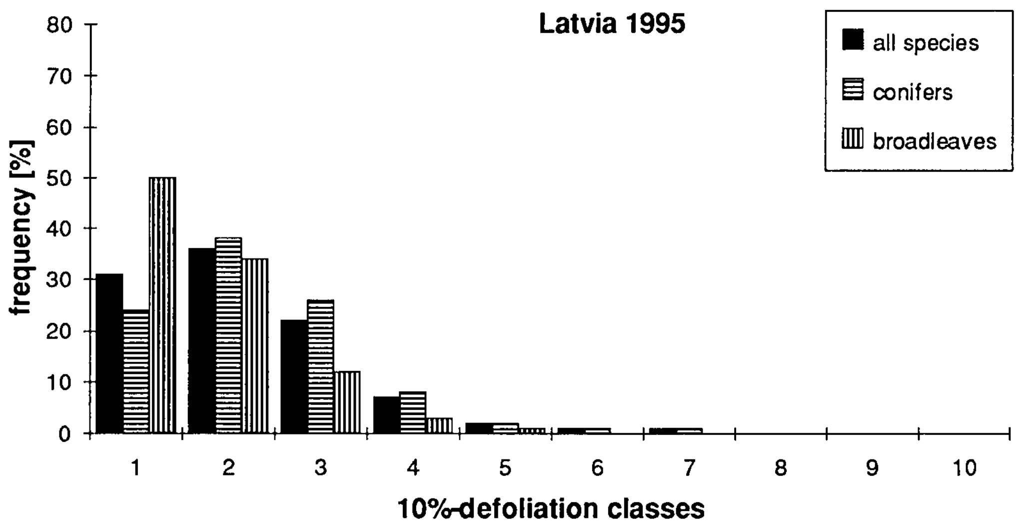
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0 - 10%	31.0	24.0	50.0
>10 - 20%	36.0	38.0	34.0
>20 - 30%	22.0	26.0	12.0
>30 - 40%	7.0	8.0	3.0
>40 - 50%	2.0	2.0	1.0
>50 - 60%	1.0	1.0	0.0
>60 - 70%	1.0	1.0	0.0
>70 - 80%	0.0	0.0	0.0
>80 - 90%	0.0	0.0	0.0
>90 -100%	0.0	0.0	0.0
total:	100.0	100.0	100.0
mean defoliation	17.0	18.3	12.1

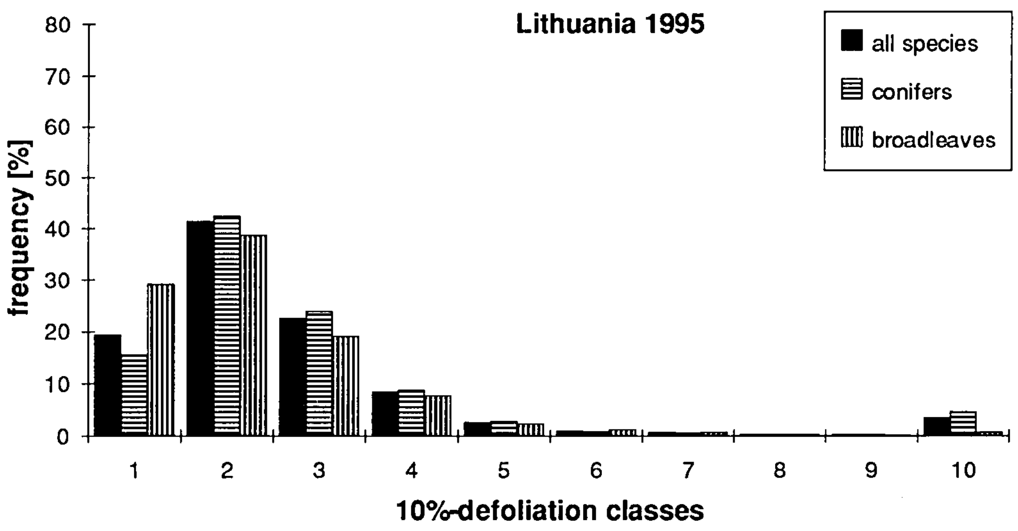
Lithuania 1995

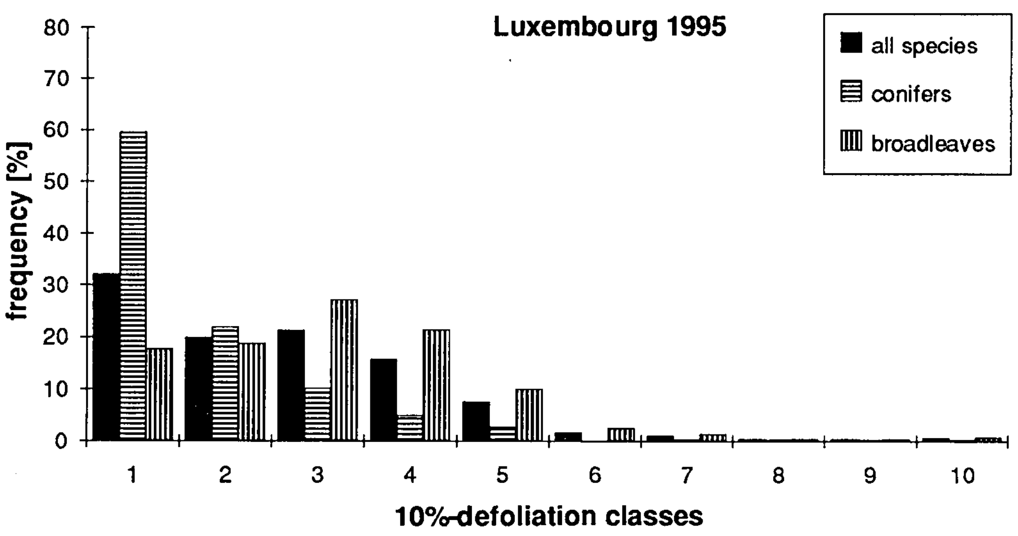
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0 - 10%	19.4	15.5	29.2
>10 - 20%	41.4	42.4	38.7
>20 - 30%	22.5	23.9	19.1
>30 - 40%	8.4	8.8	7.6
>40 - 50%	2.6	2.8	2.3
>50 - 60%	1.0	0.9	1.2
>60 - 70%	0.7	0.6	0.8
>70 - 80%	0.3	0.3	0.3
>80 - 90%	0.2	0.2	0.1
>90 -100%	3.5	4.6	0.7
total:	100.0	100.0	100.0
mean defoliation	21.6	23.1	17.9

Luxembourg 1995

10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0 - 10%	32.1	59.4	17.6
>10 - 20%	19.8	21.8	18.8
>20 - 30%	21.2	10.2	27.0
>30 - 40%	15.6	5.0	21.3
>40 - 50%	7.5	2.7	10.0
>50 - 60%	1.6	0.0	2.5
>60 - 70%	0.9	0.3	1.3
>70 - 80%	0.3	0.3	0.4
>80 - 90%	0.3	0.3	0.4
>90 -100%	0.6	0.3	0.8
total:	100.0	100.0	100.0
mean defoliation	24.5	12.5	26.0


Latvia 1995
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


Lithuania 1995
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


Luxembourg 1995
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

Netherlands 1995

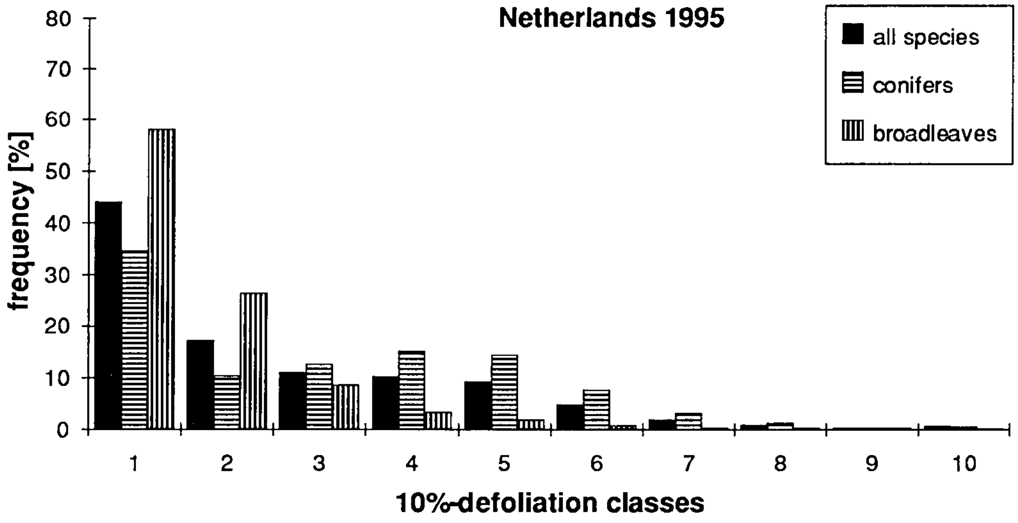
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0 - 10%	44.1	34.6	58.0
>10 - 20%	17.1	10.4	26.5
>20 - 30%	10.9	12.6	8.6
>30 - 40%	10.2	15.2	3.3
>40 - 50%	9.2	14.4	1.9
>50 - 60%	4.8	7.6	0.8
>60 - 70%	1.9	3.1	0.3
>70 - 80%	0.9	1.3	0.3
>80 - 90%	0.3	0.3	0.2
>90 -100%	0.6	0.5	0.1
total:	100.0	100.0	100.0
mean defoliation	20.6	26.1	12.2

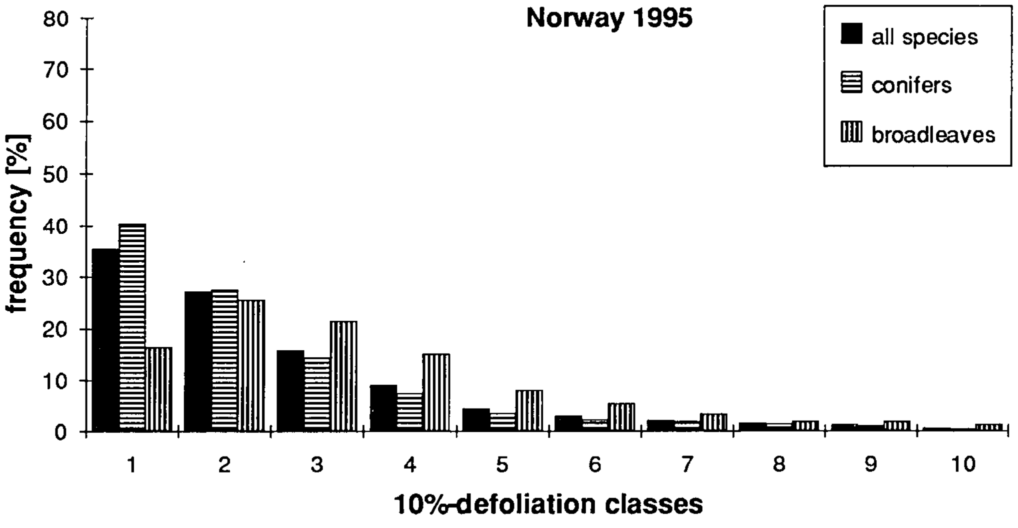
Norway 1995

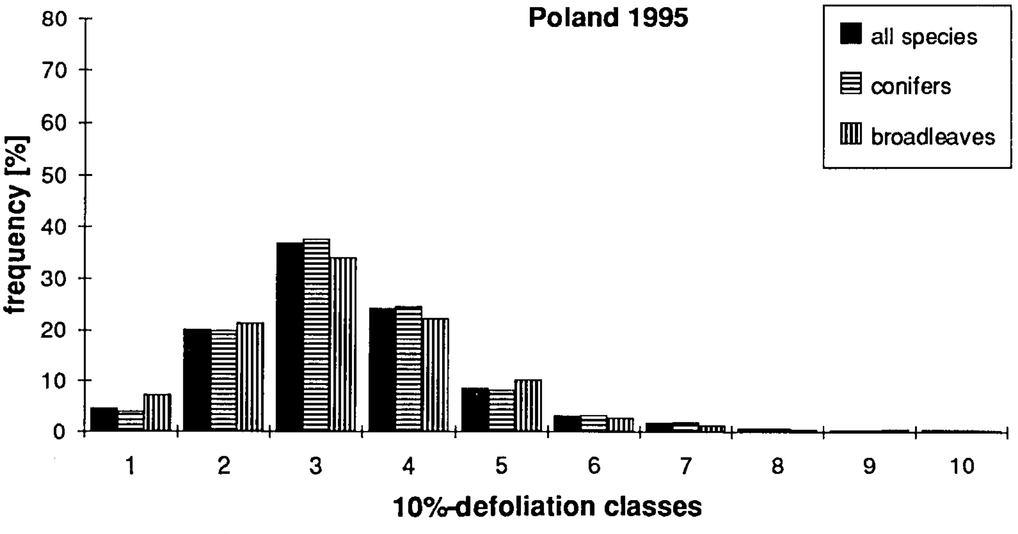
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0 - 10%	35.5	40.4	16.4
>10 - 20%	27.1	27.5	25.5
>20 - 30%	15.8	14.4	21.4
>30 - 40%	9.0	7.4	15.1
>40 - 50%	4.4	3.5	8.0
>50 - 60%	2.9	2.2	5.4
>60 - 70%	2.1	1.8	3.3
>70 - 80%	1.5	1.4	1.9
>80 - 90%	1.2	1.0	1.8
>90 -100%	0.5	0.4	1.2
total:	100.0	100.0	100.0
mean defoliation	20.5	18.6	28.1

Poland 1995

10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0 - 10%	4.6	4.0	7.2
>10 - 20%	20.1	19.8	21.3
>20 - 30%	36.8	37.5	34.0
>30 - 40%	24.1	24.5	22.2
>40 - 50%	8.4	8.0	10.1
>50 - 60%	3.1	3.2	2.7
>60 - 70%	1.7	1.8	1.3
>70 - 80%	0.6	0.6	0.4
>80 - 90%	0.2	0.2	0.5
>90 -100%	0.4	0.4	0.3
total:	100.0	100.0	100.0
mean defoliation	28.5	28.7	27.7


Netherlands 1995
all species
conifers
broadleaves
frequency [%]
10%-defoliation classes
0
10
20
30
40
50
60
70
80
1
2
3
4
5
6
7
8
9
10


Norway 1995
all species
conifers
broadleaves
frequency [%]
10%-defoliation classes
0
10
20
30
40
50
60
70
80
1
2
3
4
5
6
7
8
9
10


Poland 1995
all species
conifers
broadleaves
frequency [%]
10%-defoliation classes
0
10
20
30
40
50
60
70
80
1
2
3
4
5
6
7
8
9
10

Portugal 1995

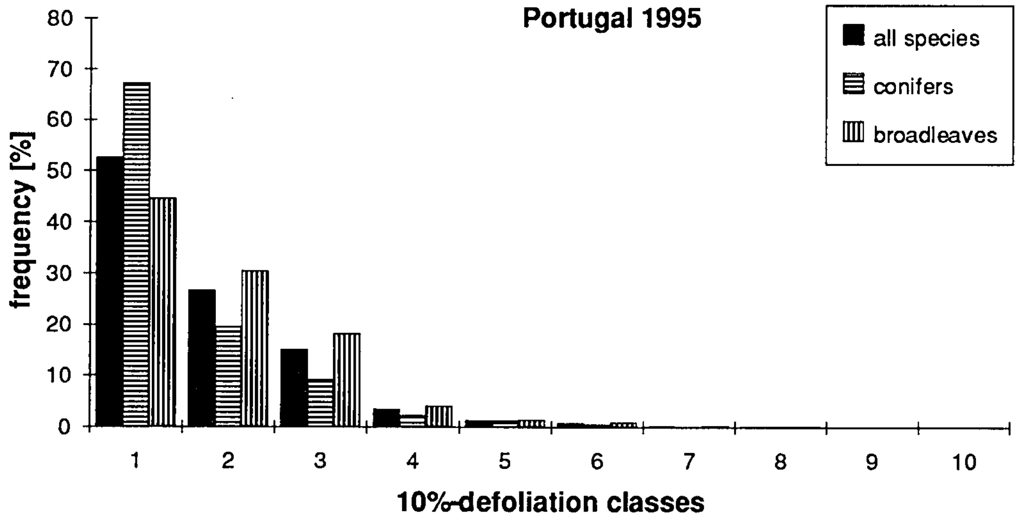
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0 - 10%	52.5	67.2	44.6
>10 - 20%	26.7	19.6	30.5
>20 - 30%	15.0	9.1	18.2
>30 - 40%	3.5	2.2	4.1
>40 - 50%	1.3	1.3	1.4
>50 - 60%	0.8	0.5	0.9
>60 - 70%	0.1	0.0	0.2
>70 - 80%	0.1	0.1	0.1
>80 - 90%	0.0	0.0	0.0
>90 -100%	0.0	0.0	0.0
total:	100.0	100.0	100.0
mean defoliation	12.8	10.3	14.1

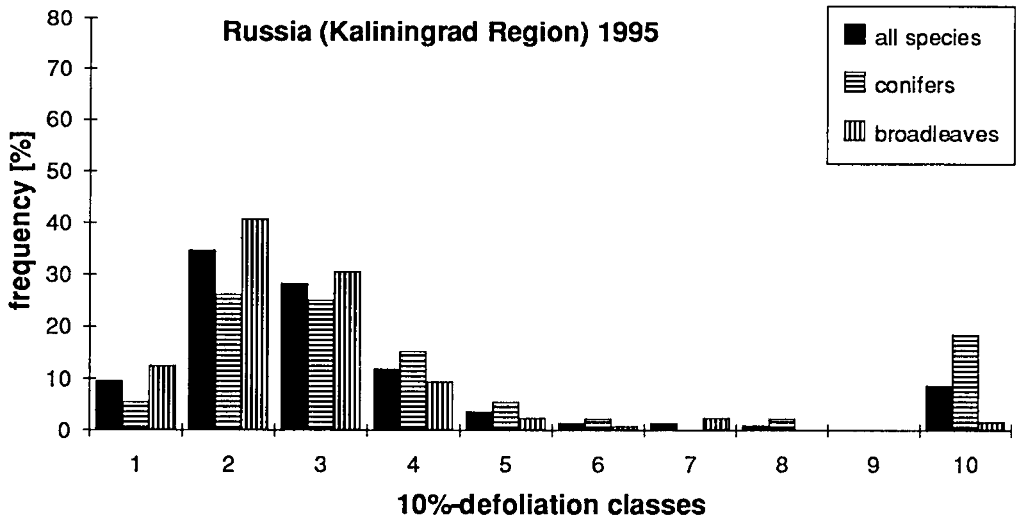
Russia (Kaliningrad Region) 1995

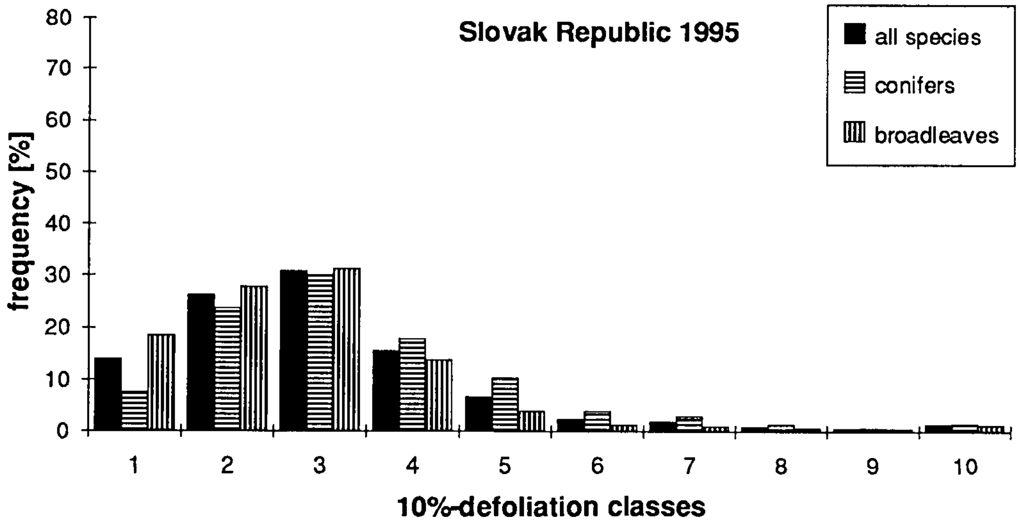
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0 - 10%	9.5	5.4	12.5
>10 - 20%	34.6	26.1	40.6
>20 - 30%	28.2	25.0	30.5
>30 - 40%	11.8	15.2	9.4
>40 - 50%	3.6	5.4	2.3
>50 - 60%	1.4	2.2	0.8
>60 - 70%	1.4	0.0	2.3
>70 - 80%	0.9	2.2	0.0
>80 - 90%	0.0	0.0	0.0
>90 -100%	8.6	18.5	1.6
total:	100.0	100.0	100.0
mean defoliation	29.0	38.6	22.1

Slovak Republic 1995

10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0 - 10%	13.9	7.5	18.5
>10 - 20%	26.2	23.8	27.8
>20 - 30%	30.8	30.0	31.3
>30 - 40%	15.5	17.9	13.8
>40 - 50%	6.7	10.4	4.0
>50 - 60%	2.3	3.9	1.2
>60 - 70%	1.8	3.0	1.0
>70 - 80%	0.9	1.4	0.6
>80 - 90%	0.5	0.6	0.5
>90 -100%	1.4	1.5	1.3
total:	100.0	100.0	100.0
mean defoliation	25.6	29.5	23.0


Portugal 1995
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


Russia (Kaliningrad Region) 1995
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


Slovak Republic 1995
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

Slovenia 1995

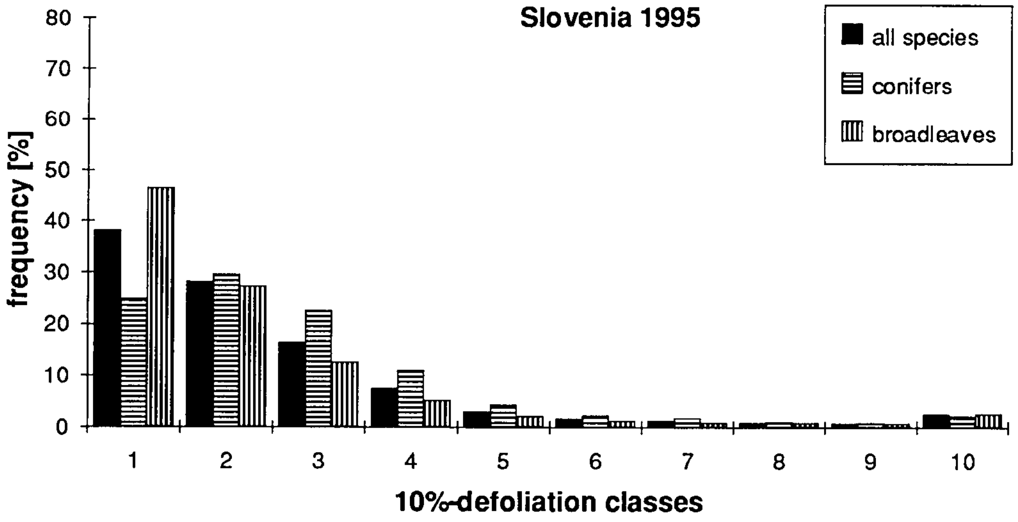
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0 - 10%	38.2	24.9	46.4
>10 - 20%	28.2	29.5	27.4
>20 - 30%	16.4	22.5	12.5
>30 - 40%	7.4	11.0	5.2
>40 - 50%	2.9	4.3	2.1
>50 - 60%	1.6	2.2	1.3
>60 - 70%	1.2	1.7	0.9
>70 - 80%	0.9	1.0	0.8
>80 - 90%	0.8	0.9	0.8
>90 -100%	2.4	2.1	2.6
total:	100.0	100.0	100.0
mean defoliation	19.5	22.8	17.4

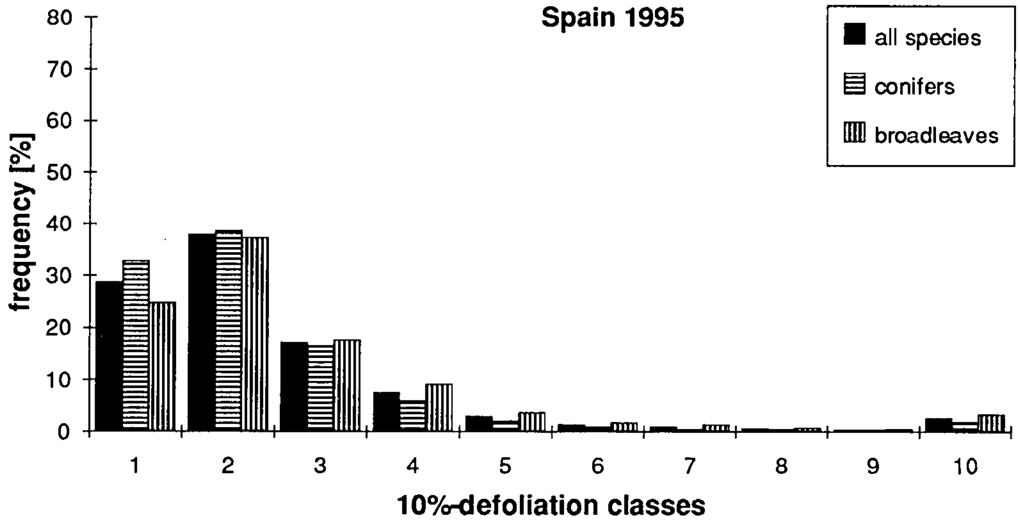
Spain 1995

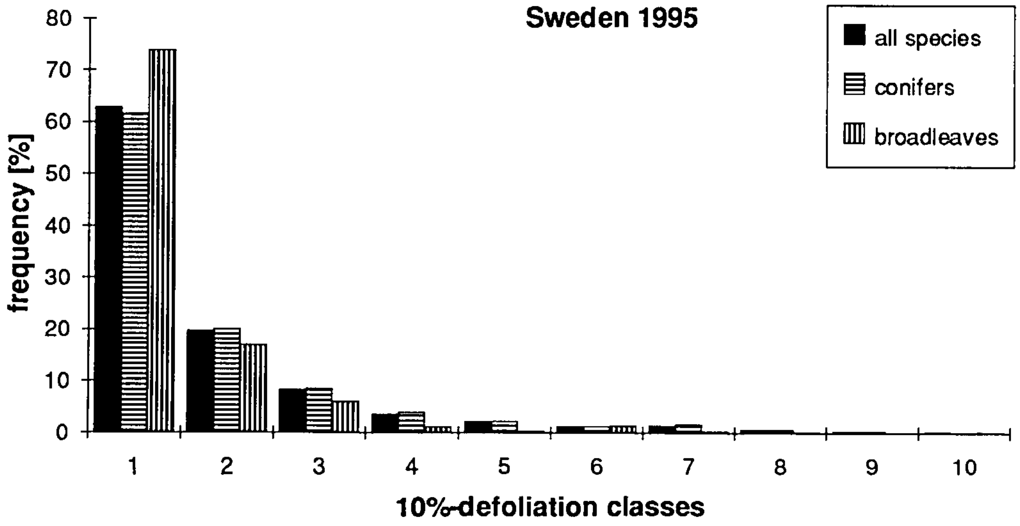
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0 - 10%	28.7	32.7	24.8
>10 - 20%	37.8	38.5	37.2
>20 - 30%	17.1	16.6	17.7
>30 - 40%	7.5	5.9	9.1
>40 - 50%	2.9	2.1	3.7
>50 - 60%	1.4	1.0	1.7
>60 - 70%	1.0	0.5	1.3
>70 - 80%	0.6	0.5	0.7
>80 - 90%	0.4	0.4	0.5
>90 -100%	2.6	1.9	3.3
total:	100.0	100.0	100.0
mean defoliation	20.0	17.9	22.0

Sweden 1995

10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0 - 10%	62.8	61.5	73.9
>10 - 20%	19.7	20.1	16.9
>20 - 30%	8.3	8.5	6.0
>30 - 40%	3.6	4.0	1.1
>40 - 50%	2.1	2.2	0.3
>50 - 60%	1.2	1.2	1.4
>60 - 70%	1.4	1.6	0.2
>70 - 80%	0.6	0.6	0.1
>80 - 90%	0.2	0.3	0.0
>90 -100%	0.1	0.0	0.1
total:	100.0	100.0	100.0
mean defoliation	12.7	13.0	9.3


Slovenia 1995
frequency [%]
10%-defoliation classes
all species
conifers
broadleaves


Spain 1995
frequency [%]
10%-defoliation classes
all species
conifers
broadleaves


Sweden 1995
frequency [%]
10%-defoliation classes
all species
conifers
broadleaves

Switzerland 1995

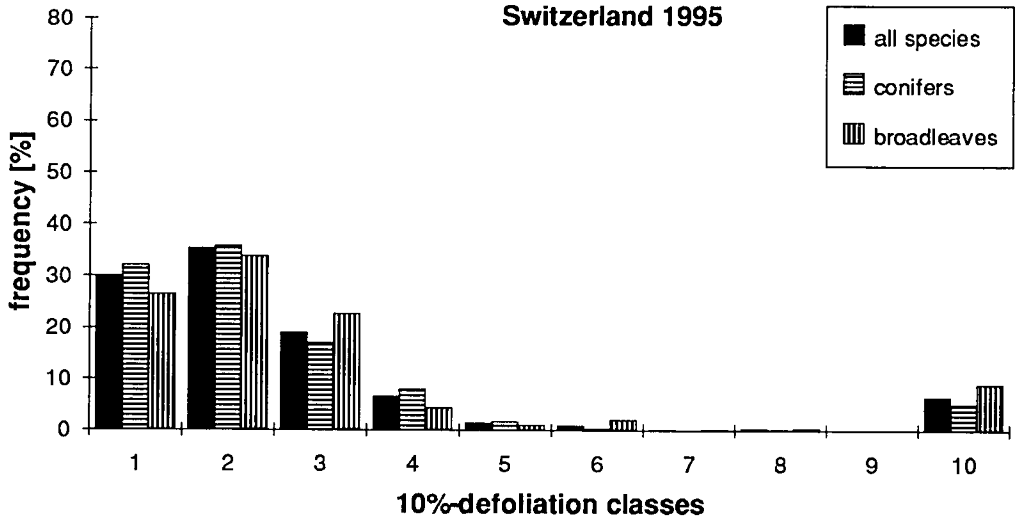
10%-defoliation classes	defoliation-% all species	conifers	broadleaves
0 - 10%	30.1	32.1	26.5
>10 - 20%	35.3	35.9	33.9
>20 - 30%	19.0	17.0	22.8
>30 - 40%	6.6	7.9	4.3
>40 - 50%	1.4	1.6	1.0
>50 - 60%	0.9	0.3	2.0
>60 - 70%	0.1	0.0	0.1
>70 - 80%	0.2	0.1	0.4
>80 - 90%	0.0	0.0	0.0
>90 -100%	6.4	5.1	9.0
total:	100.0	100.0	100.0
mean defoliation	21.3	19.8	24.1

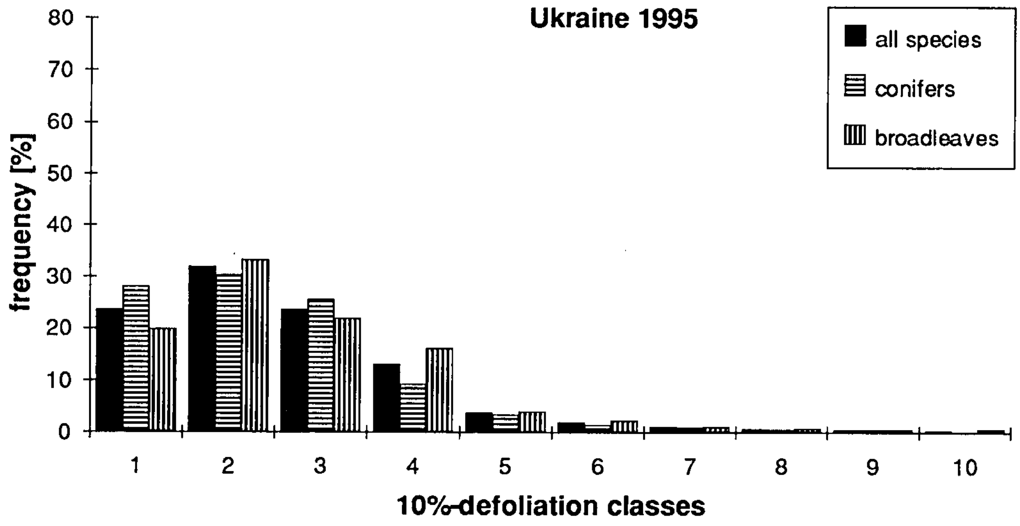
Ukraine 1995

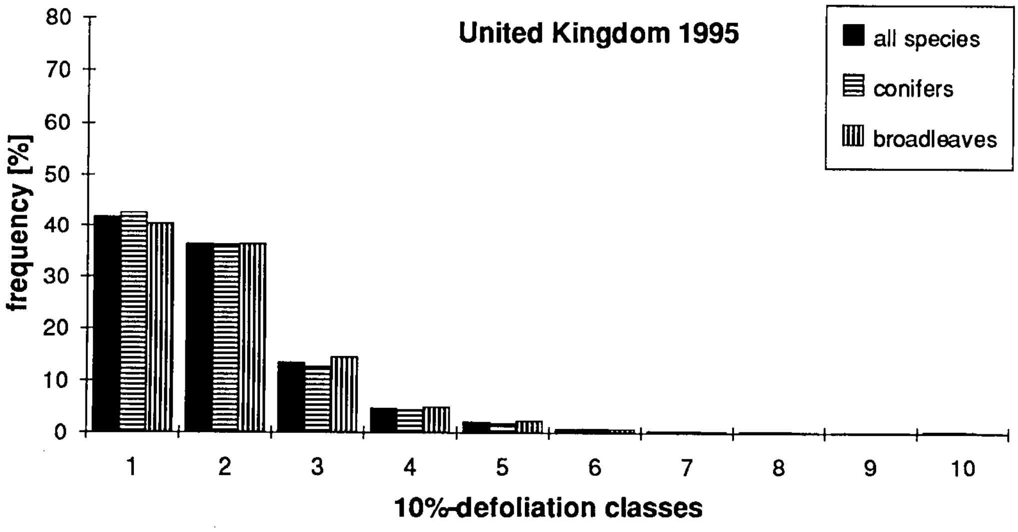
10%-defoliation classes	defoliation-% all species	conifers	broadleaves
0 - 10%	23.6	28.1	19.8
>10 - 20%	31.9	30.3	33.3
>20 - 30%	23.6	25.6	21.9
>30 - 40%	13.0	9.3	16.1
>40 - 50%	3.7	3.4	3.9
>50 - 60%	1.8	1.4	2.2
>60 - 70%	1.0	0.9	1.0
>70 - 80%	0.6	0.5	0.7
>80 - 90%	0.5	0.5	0.5
>90 -100%	0.3	0.0	0.6
total:	100.0	100.0	100.0
mean defoliation	20.9	19.3	22.2

United Kingdom 1995

10%-defoliation classes	defoliation-% all species	conifers	broadleaves
0 - 10%	41.8	42.6	40.3
>10 - 20%	36.4	36.4	36.4
>20 - 30%	13.5	12.7	14.6
>30 - 40%	4.7	4.5	5.0
>40 - 50%	2.1	1.9	2.4
>50 - 60%	0.8	0.9	0.7
>60 - 70%	0.3	0.4	0.3
>70 - 80%	0.2	0.3	0.1
>80 - 90%	0.1	0.1	0.1
>90 -100%	0.2	0.3	0.1
total:	100.0	100.0	100.0
mean defoliation	14.6	14.5	14.8

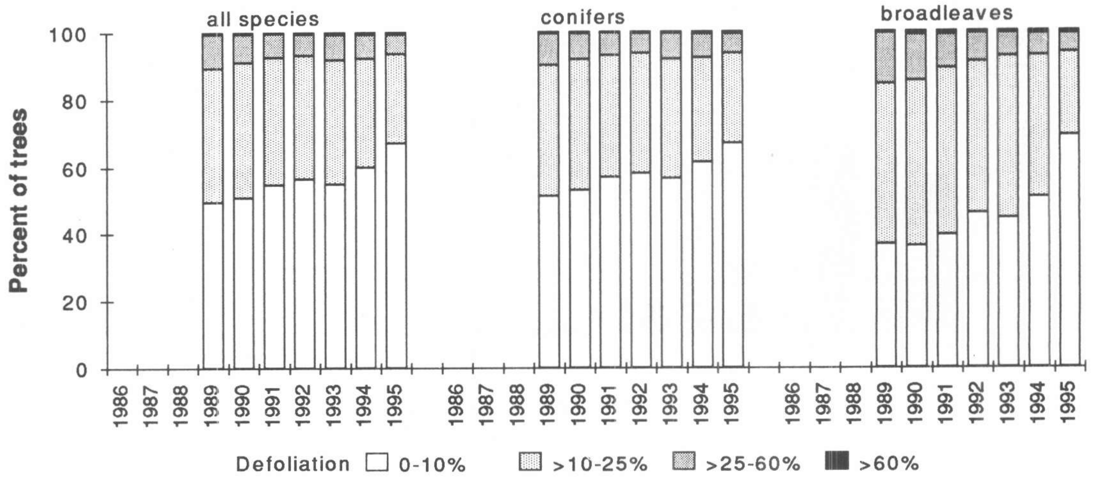

Switzerland 1995
all species
conifers
broadleaves
frequency [%]
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
10%-defoliation classes


Ukraine 1995
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

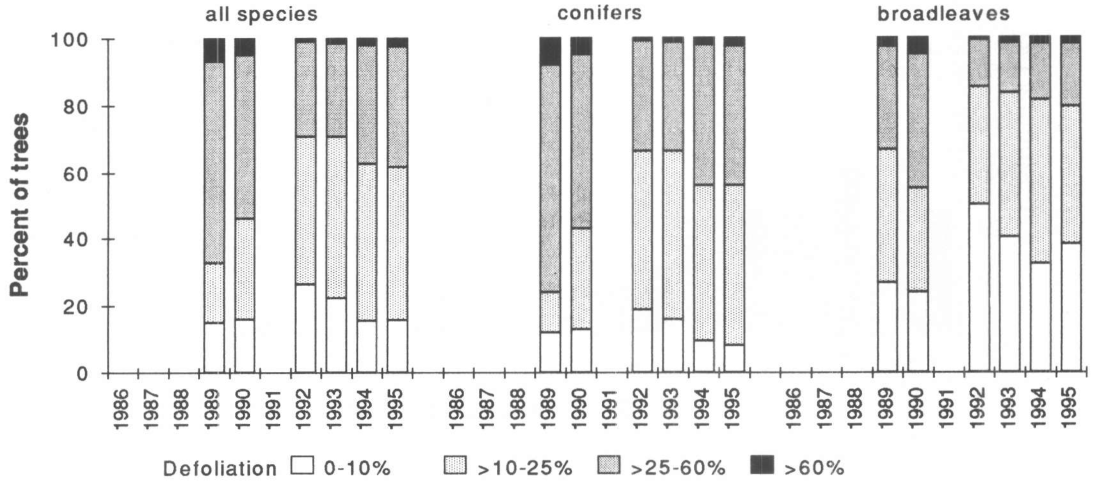

United Kingdom 1995
all species
conifers
broadleaves
frequency [%]
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
10%-defoliation classes

Annex II-9
Changes in defoliation (1986-1995)

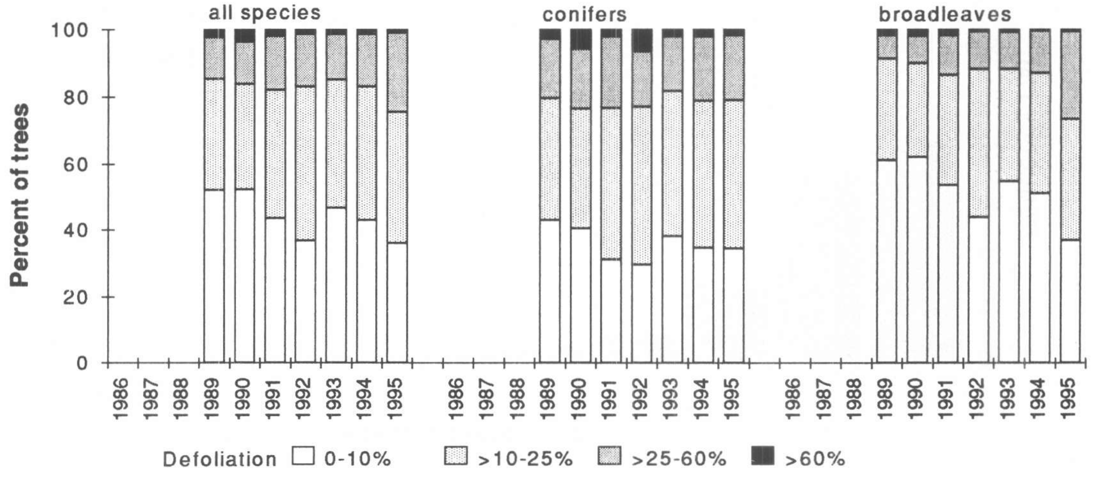
Austria



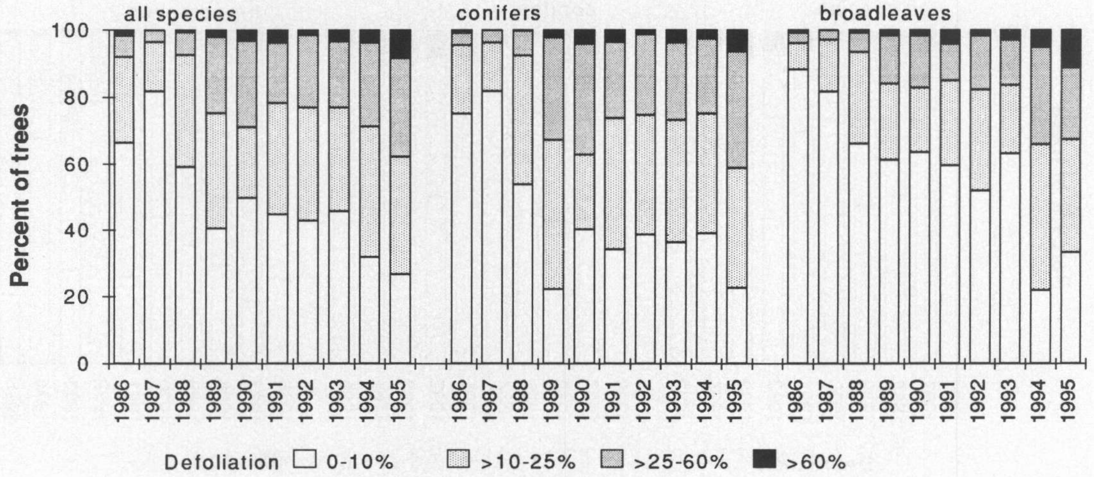
Belarus



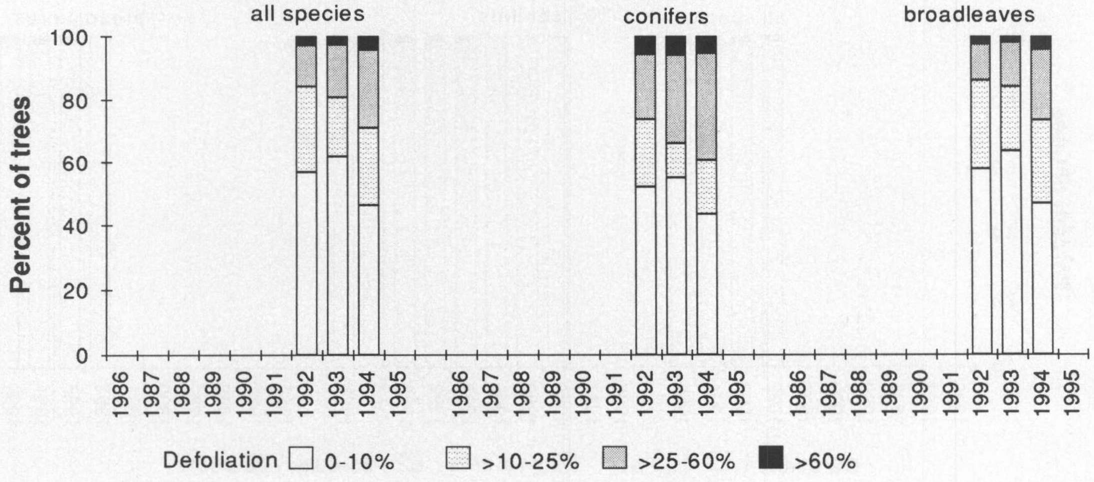
Belgium



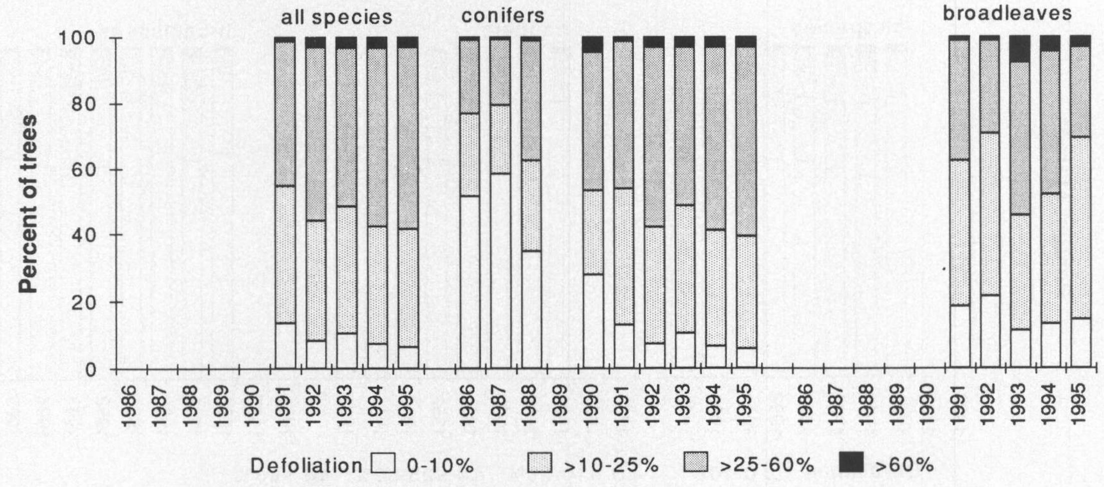
Bulgaria



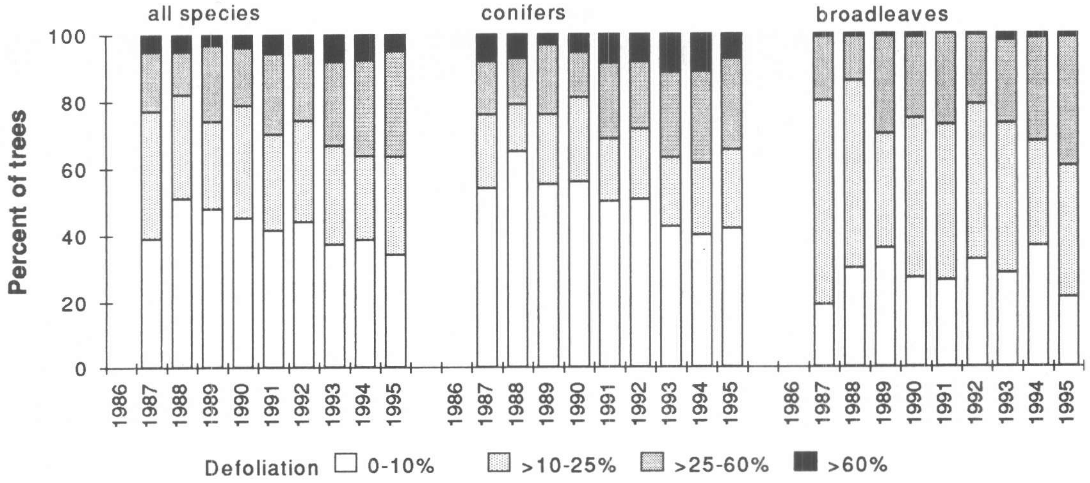
Croatia



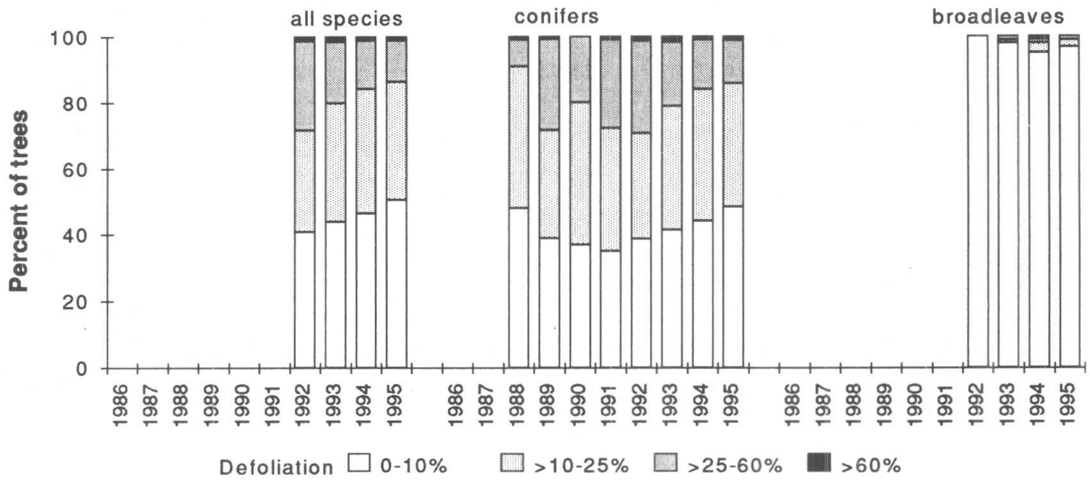
Czech Republic



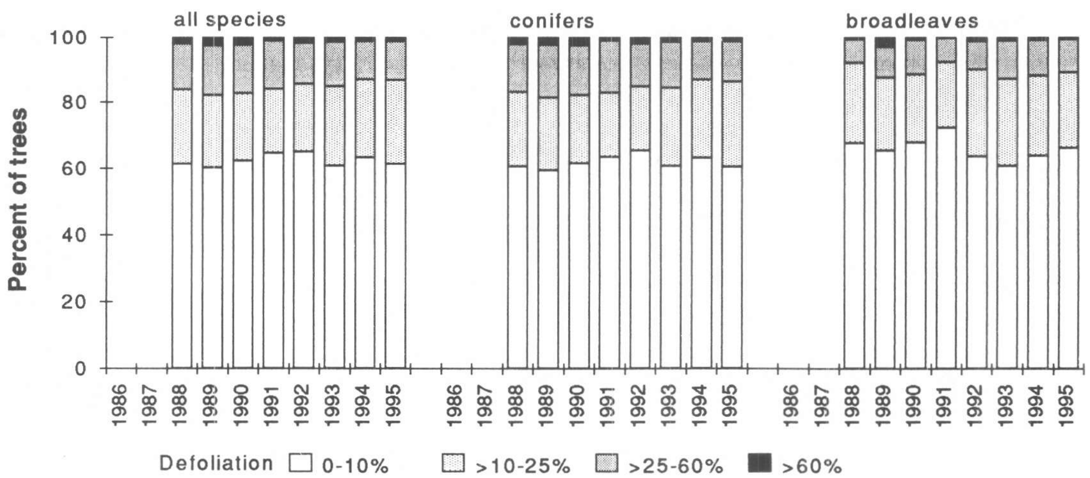
Denmark



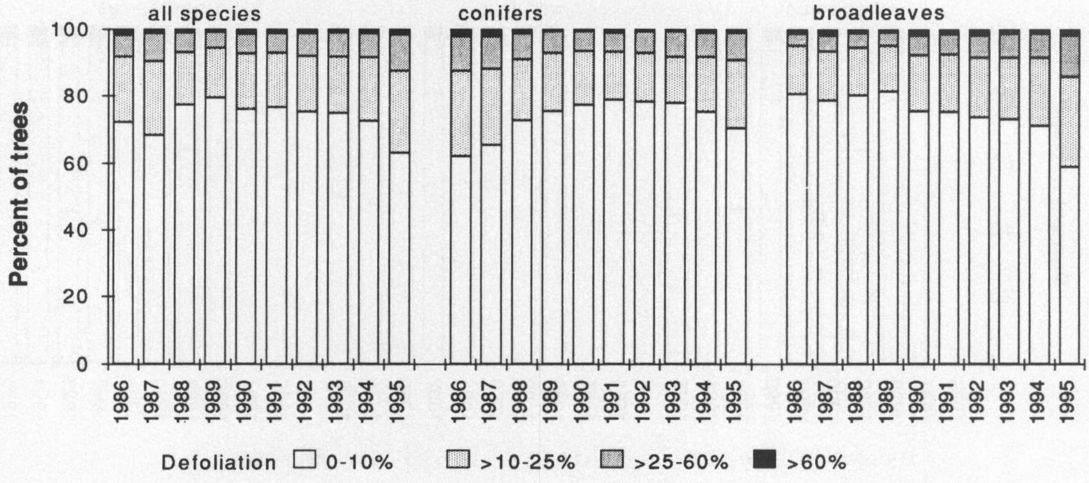
Estonia



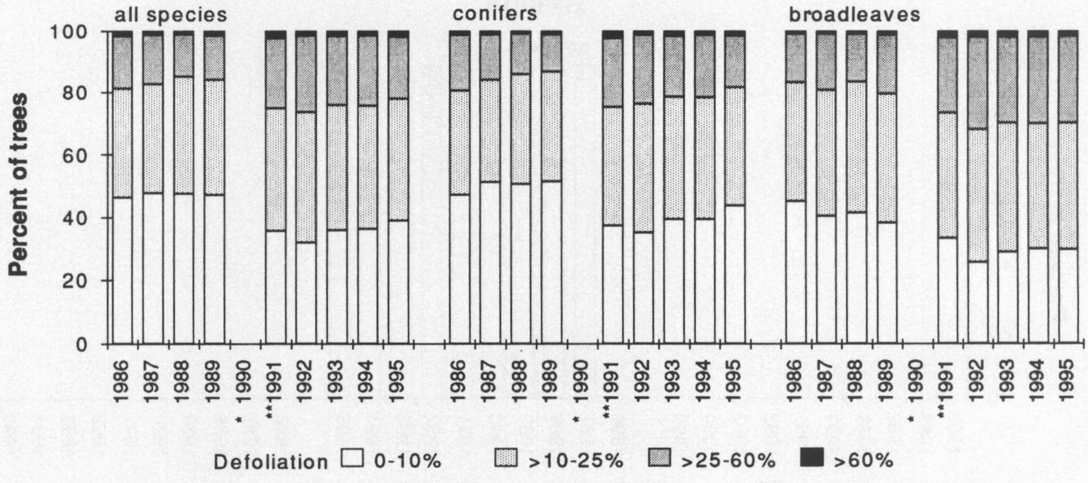
Finland



France

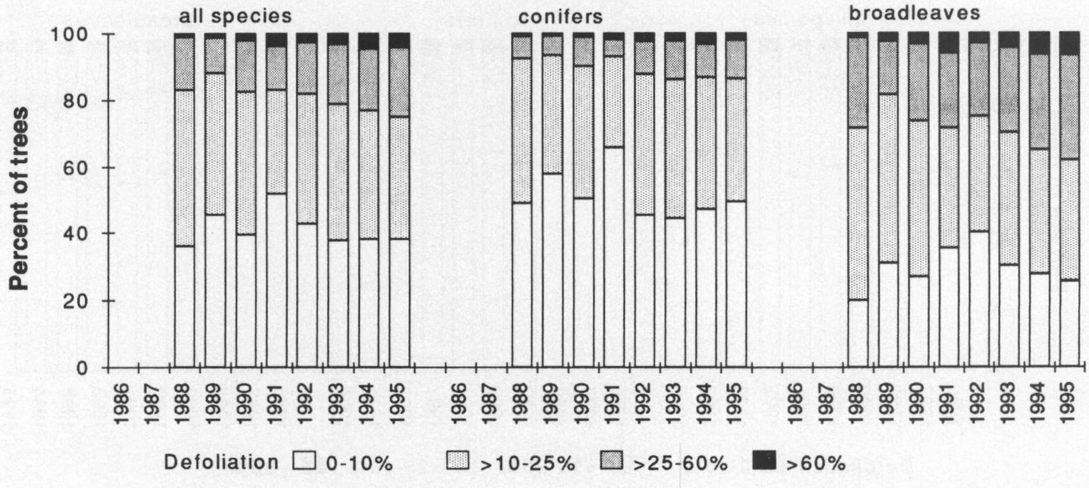


Germany

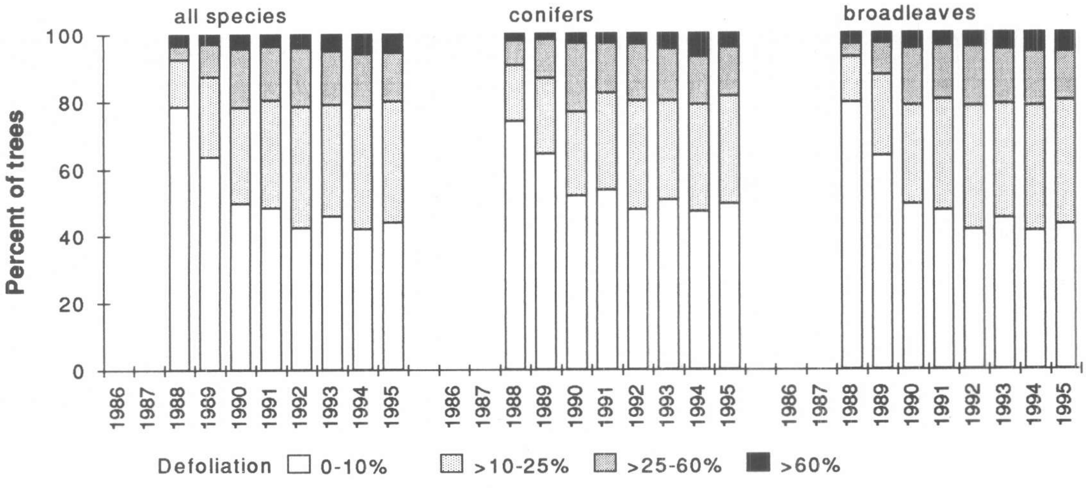


* due to storm damage no results for 1990 ** since 1991 with former GDR

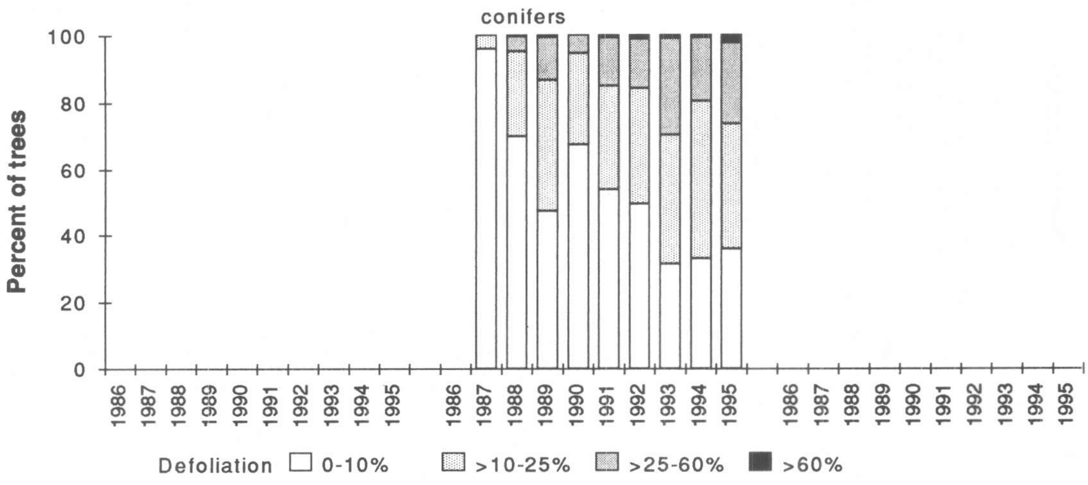
Greece



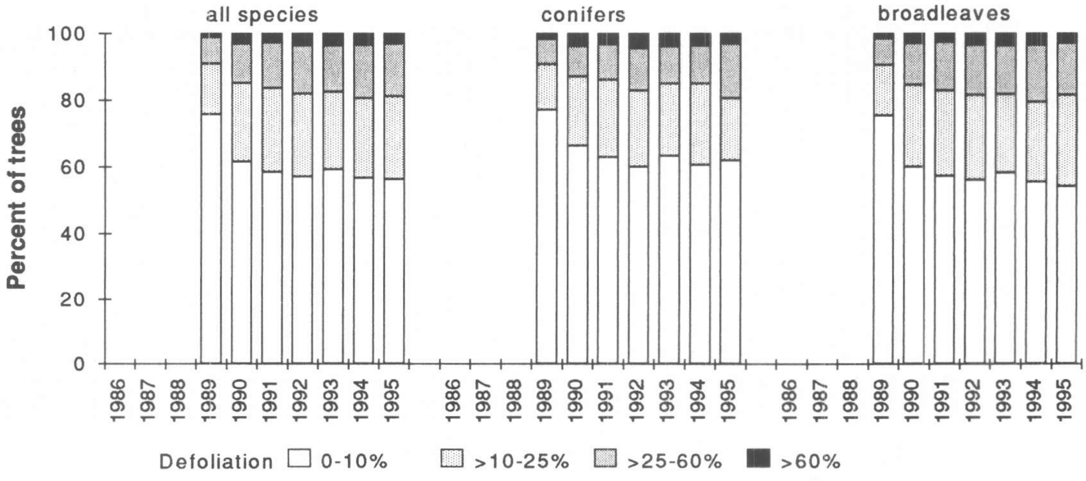
Hungary



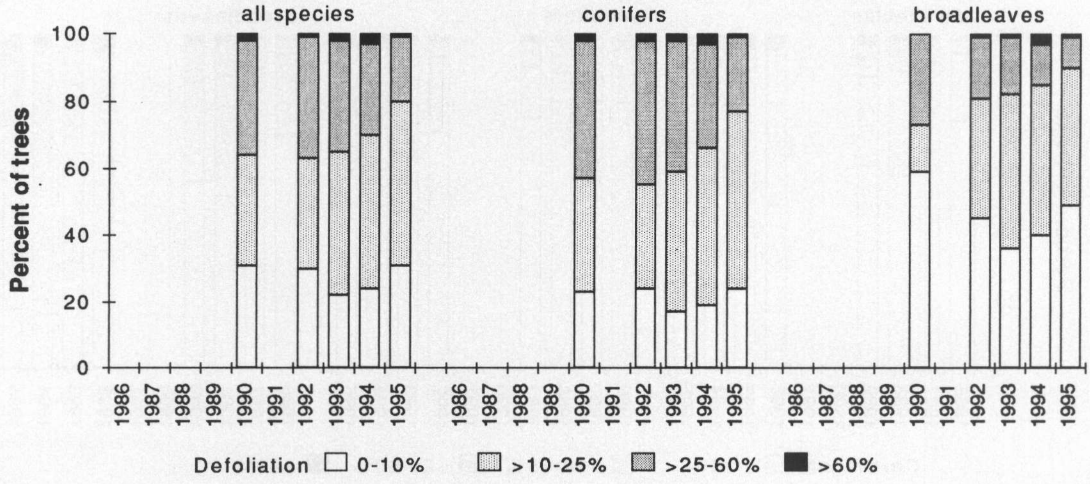
Ireland



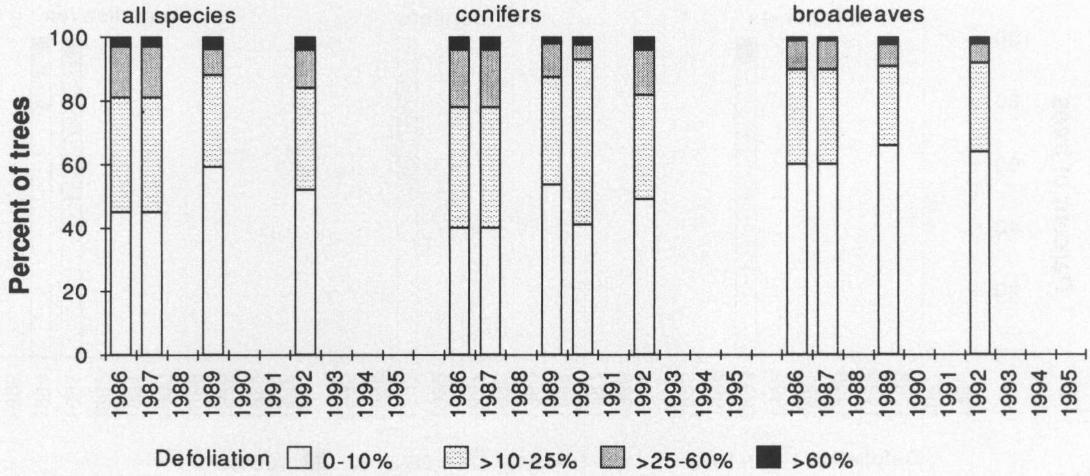
Italy



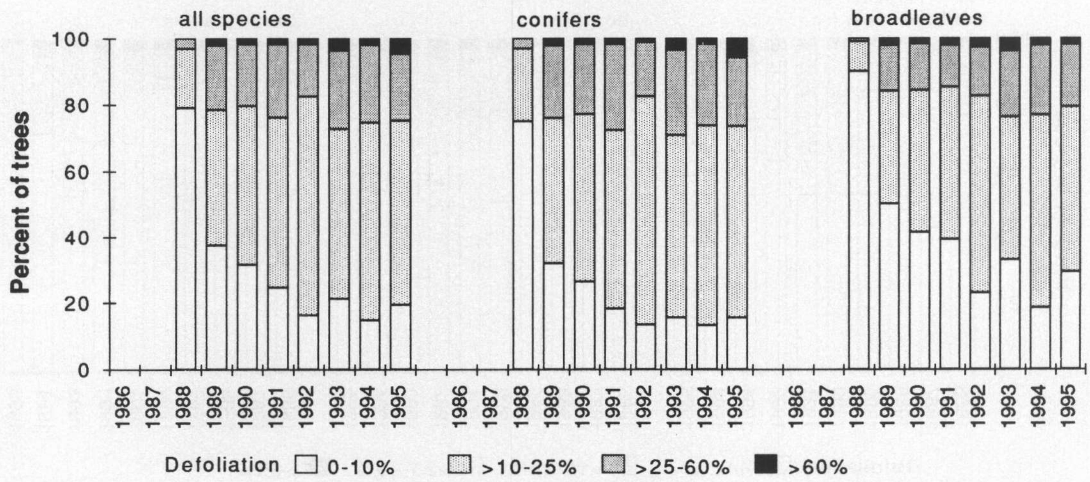
Latvia



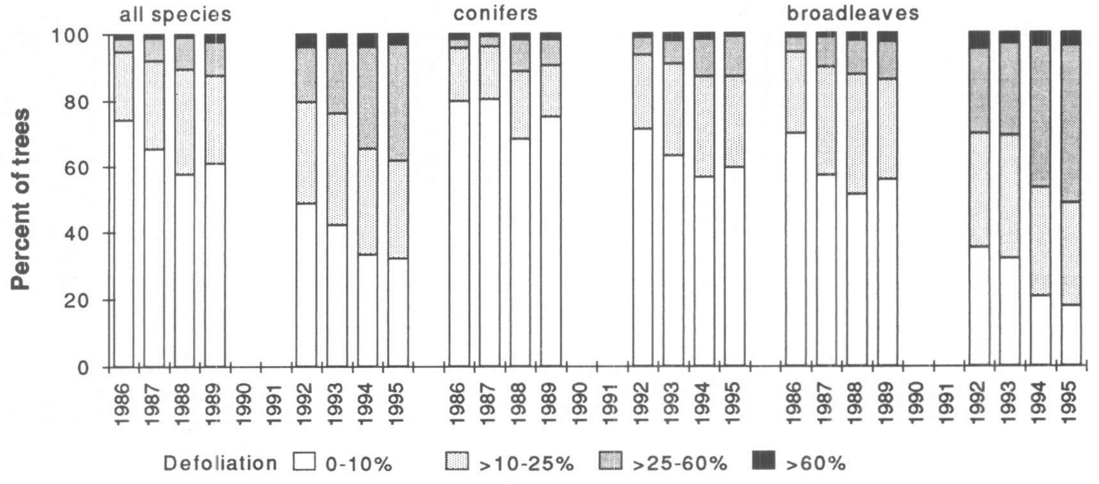
Liechtenstein



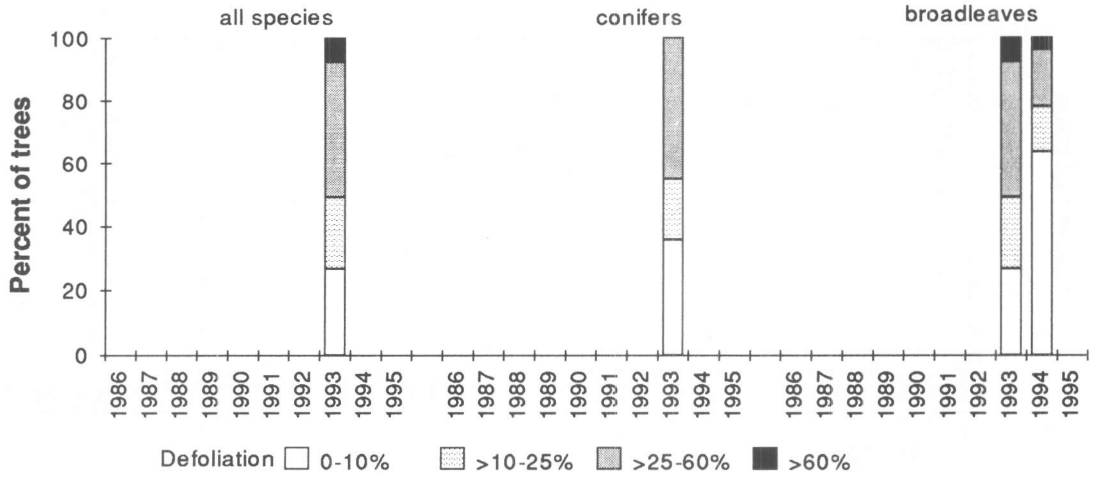
Lithuania



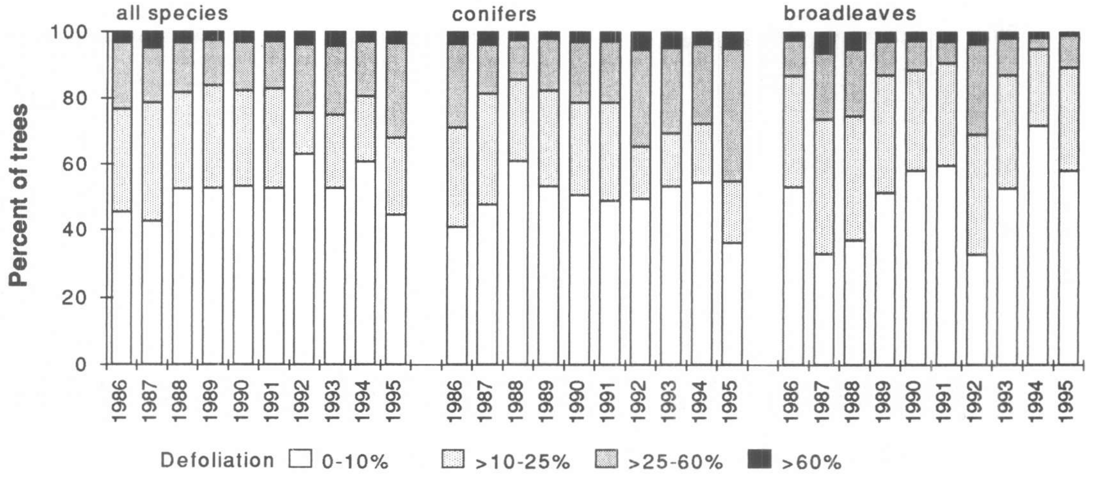
Luxembourg



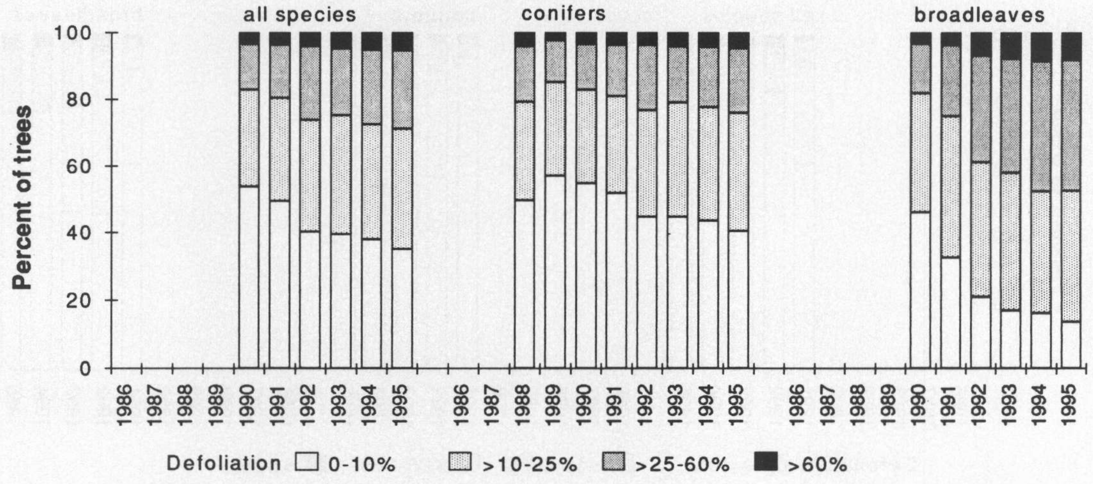
Republic of Moldova



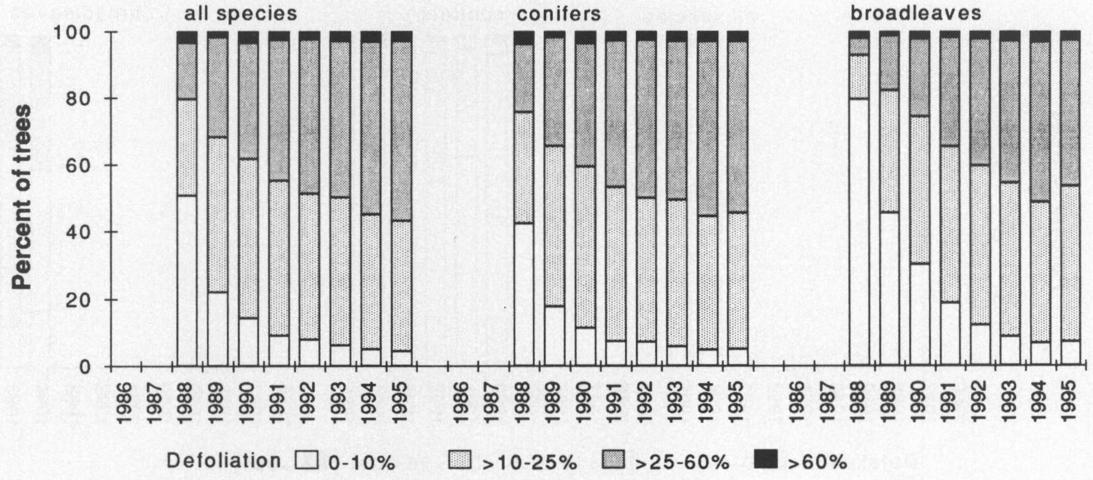
Netherlands



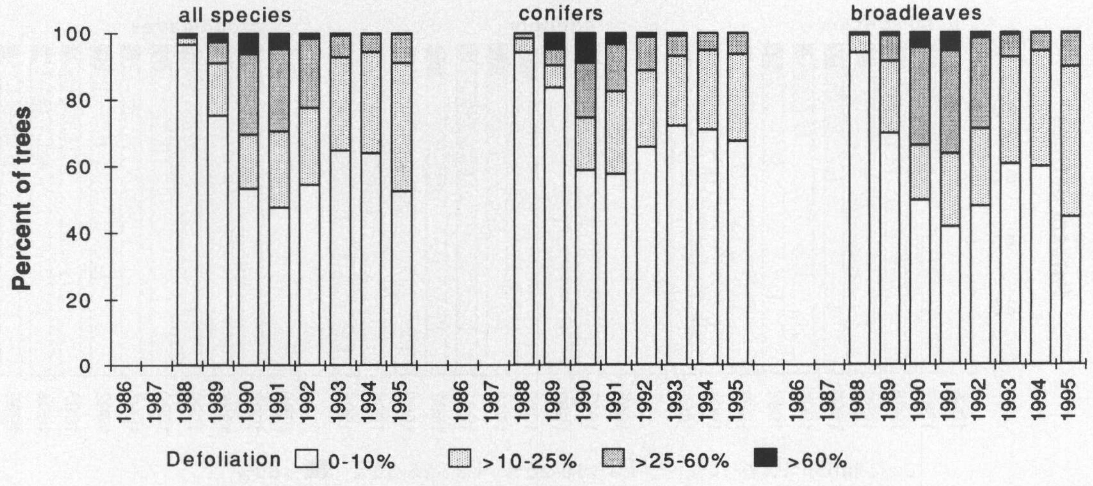
Norway



Poland



Portugal



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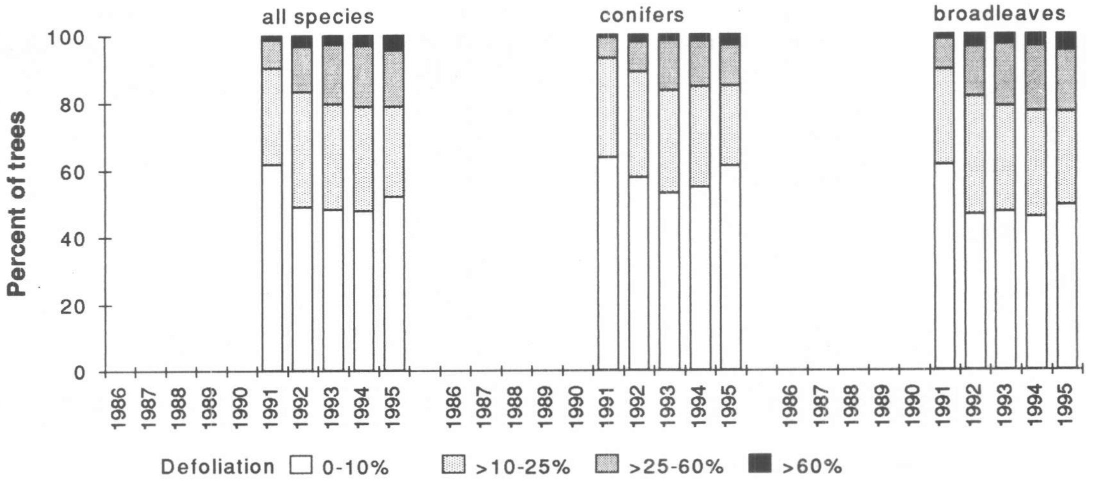

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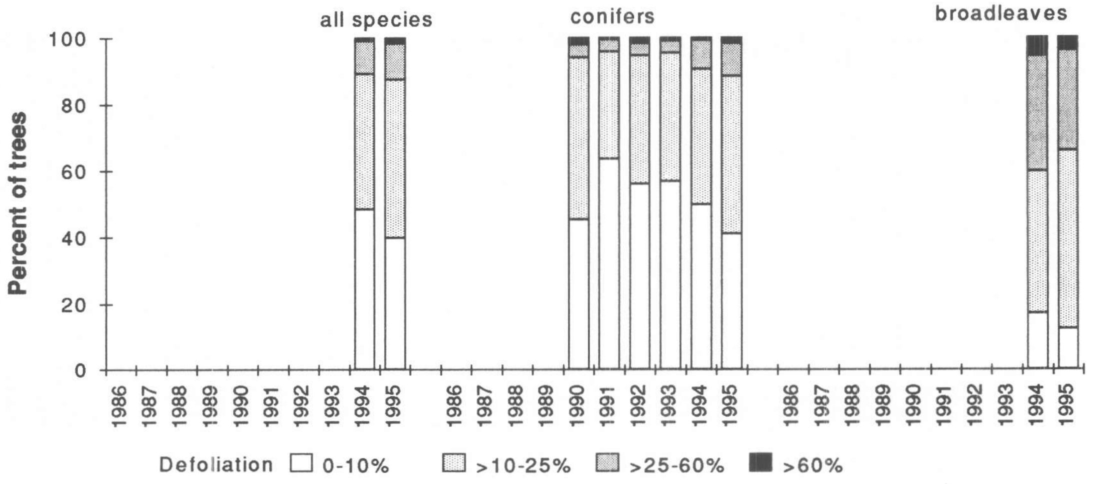

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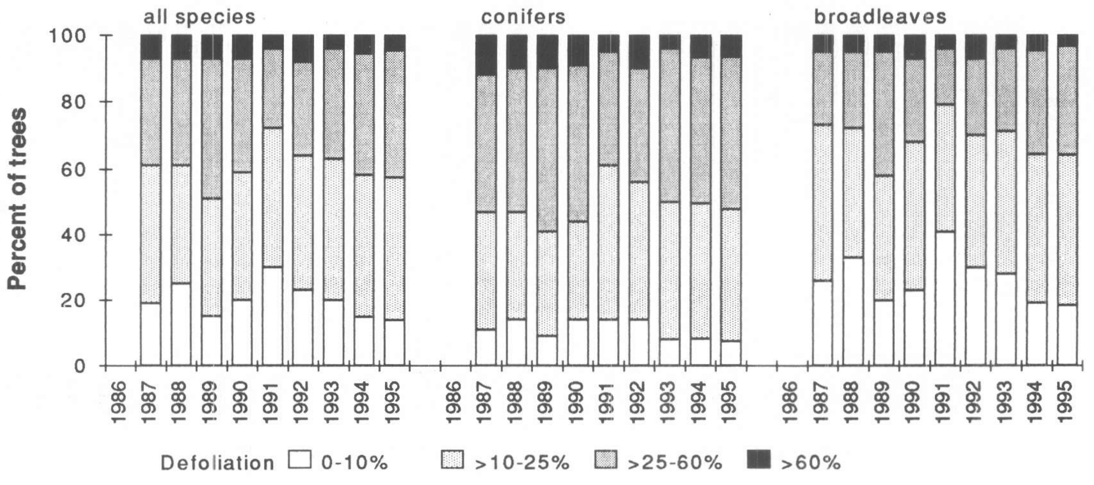

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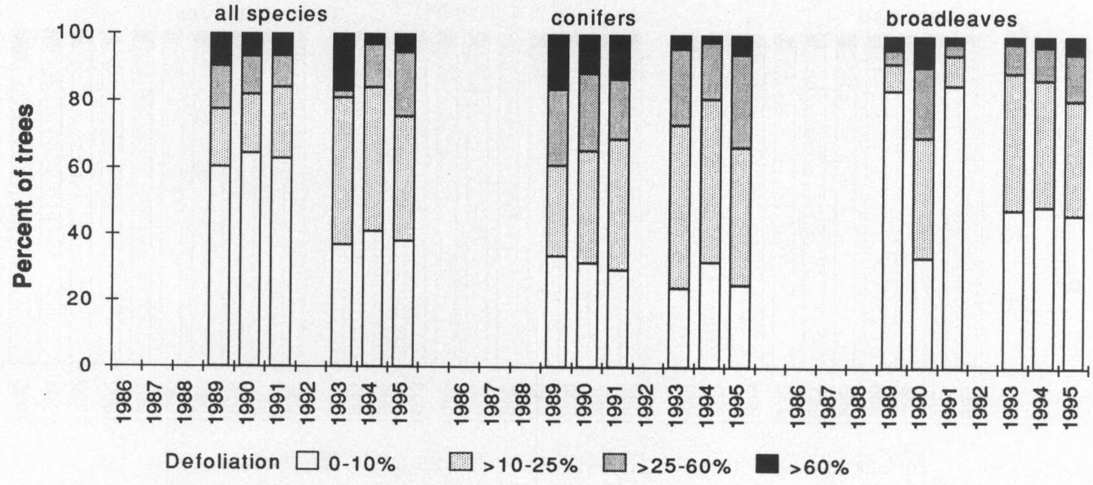

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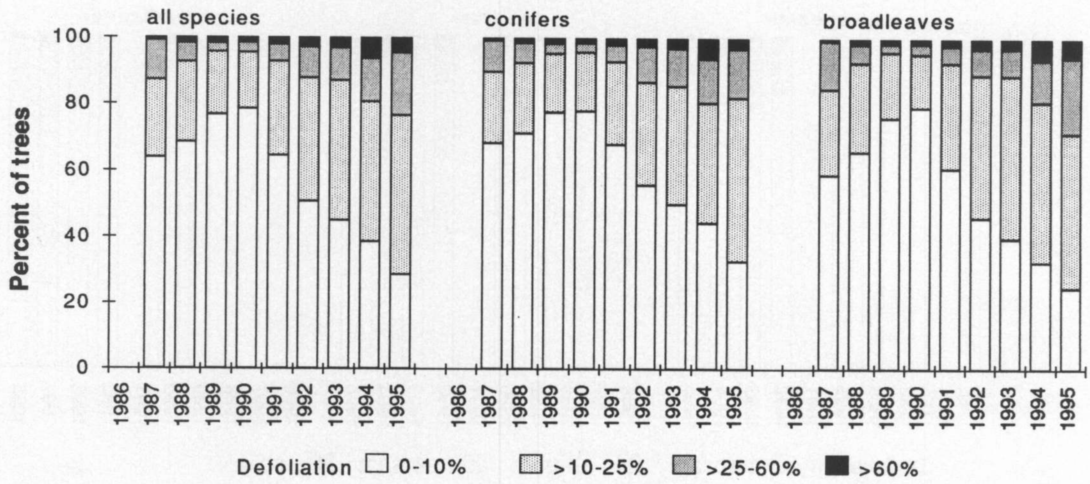

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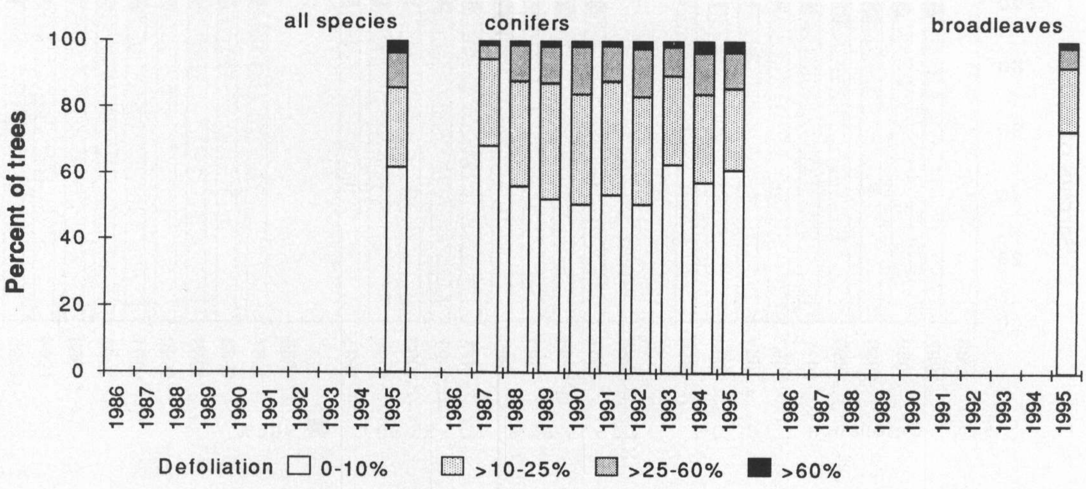

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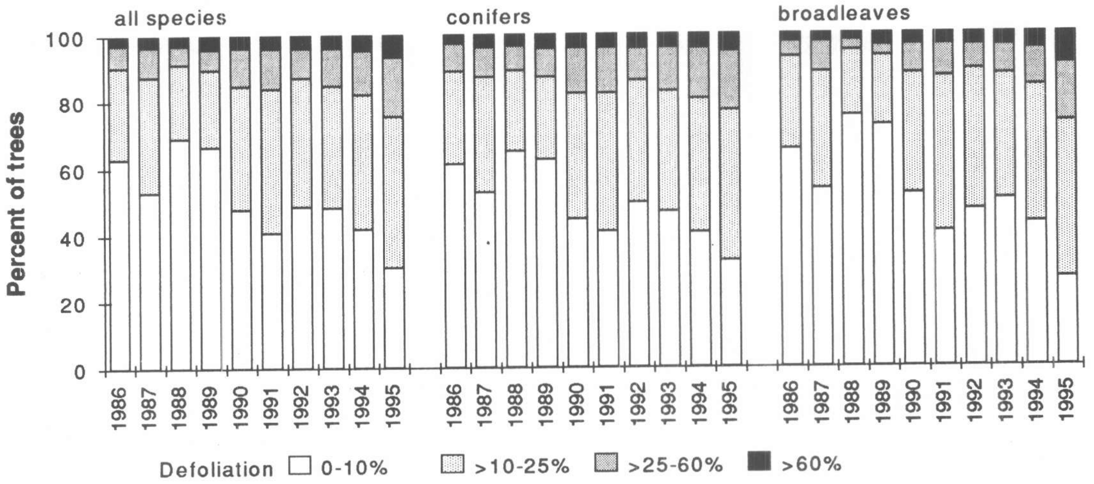
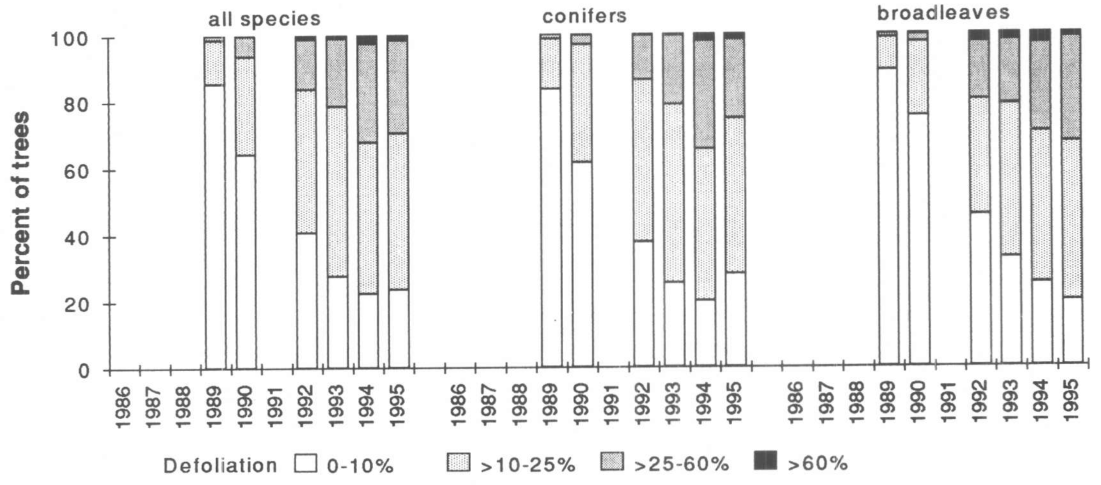
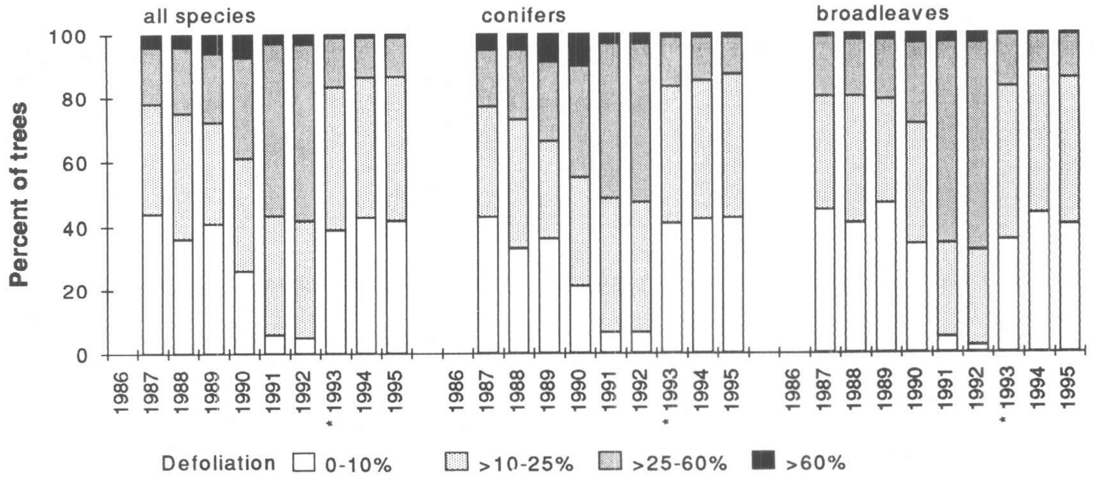


Ukraine



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

Botanical name	Danish	Dutch	English	Finnish
Fagus sylvatica	Bøg	Beuk	Common beech	Pyökki
Quercus petraea	Vintereg	Wintereik	Sessile oak	Talvitammi
Quercus robur	Stilkeg	Zomereik	European oak	Metsätammi
Quercus ilex	Steneg	Steeneik	Holm oak	Rautatammi
Quercus suber	Korkeg	Kurkeik	Cork oak	Korkkitammi
Pinus sylvestris	Skovfyr	Grove den	Scots pine	Metsämänty
Pinus nigra	Østrisk fyr	Oostenrijkse/ Corsicaanse zwarte den	Corsican/Austrian black pine	Euroopanmusta-mänty
Pinus pinaster	Strandfyr	Zeeden	Maritime pine	Rannikkomänty
Pinus halepensis	Aleppofyr	Aleppoden	Aleppo pine	Aleponmänty
Picea abies	Rødgran	Fijnspar	Norway spruce	Metsäkuusi
Picea sitchensis	Sitkagran	Sitkaspar	Sitka spruce	Sitkankuusi
Abies alba	Ædelgran	Zilverden	Silver fir	Saksanpihta
Larix decidua	Lærk	Europese lariks	European larch	Euroopanlehti-kuusi

Botanical name	French	German	Greek	Italian
Fagus sylvatica	Hêtre	Rotbuche	Οξυά δασική	Faggio
Quercus petraea	Chêne rouvre	Traubeneiche	Δρυς απόδισκος	Rovere
Quercus robur	Chêne pédonculé	Stieleiche	Δρυς ποδισκοφόρος	Farnia
Quercus ilex	Chêne vert	Steineiche	Αριά	Leccio
Quercus suber	Chêne liège	Korkeiche	Φελλοδρύς	Sughera
Pinus sylvestris	Pin sylvestre	Gemeine Kiefer	Δασική πεύκη	Pino silvestre
Pinus nigra	Pin noir	Schwarzkiefer	Μαύρη πεύκη	Pino nero
Pinus pinaster	Pin maritime	Seestrandkiefer	Θαλασσία πεύκη	Pino marittimo
Pinus halepensis	Pin d'Alep	Aleppokiefer	Χαλέπιος πεύκη	Pino d'Aleppo
Picea abies	Epicéa commun	Rotfichte	Ερυθρελάτη υψηλή	Abete rosso
Picea sitchensis	Epicéa de Sitka	Sitkafichte	Ερυθρελάτη	Picea di Sitka
Abies alba	Sapin pectiné	Weißtanne	Λευκή ελάτη	Abete bianco
Larix decidua	Mélèze d'Europe	Europäische Lärche	Λάριξ ευρωπαϊκή	Larice

Botanical name	Portuguese	Russian	Spanish	Swedish
Fagus sylvatica	Faia	бук лесной	Haya	Bok
Quercus petraea	Carvalho branco Americano	дуб скальный	Roble albar	Bergek
Quercus robur	Carvalho roble	дуб черещатый	Roble común	Ek
Quercus ilex	Azinheira	дуб каменный	Encina	Stenek
Quercus suber	Sobreiro	дуб пробковый	Alcornoque	Korkek
Pinus sylvestris	Pinheiro silvestre	сосна обыкновенная	Pino silvestre	Tall
Pinus nigra	Pinheiro Austríaco	сосна чёрная	Pino laricio	Svarttall
Pinus pinaster	Pinheiro bravo	сосна приморская	Pino negral	Terpentintall
Pinus halepensis	Pinheiro de alepo	сосна алеппская	Pino carrasco	Aleppotall
Picea abies	Picea	ель европейская	Abeto rojo	Gran
Picea sitchensis	Picea de Sitka	ель ситхинская	Picea de Sitka	Sitkagran
Abies alba	Abeto branco	пихта белая	Abeto común	Sivergran
Larix decidua	Larício Europeu	лиственница европейская	Alerce	Europeisklärk

Annex IV
Addresses

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

UN/ECE	United Nations Economic Commission for Europe Evironment and Human Settlements Division Air Pollution Unit Palais des Nations CH-1211 GENEVA 10 Tel.: +41 22-91 71 234/-91 72 358 Fax: +41 22-73 39 879 Telex: 045-289696 Mr. Lars Nordberg Mr. Radovan Chrast
ICP Forests	International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests, Bundesministerium für Ernährung, Landwirtschaft und Forsten - UAL 61 Postfach 14 02 70 D-53107 BONN Tel.: +49 228-529 4325/Fax: +49 228-529 4262 Mr. Ernst Wermann, Chairman of ICP Forests
PCC East of ICP Forests	Programme Coordinating Centre East, Forestry and Game Management Research Institute (VULHM) Jiloviste-Strnady CZ-15604 PRAHA 516, Zbraslav Tel.: +42 2-59 12 50/Fax: +42 2-59 14 13 e-mail: forinst@earn.cvut.cz Mr. Karel Vancura
PCC West of ICP Forests	Programme Coordinating Centre West, Bundesforschungsanstalt für Forst- und Holzwirtschaft Leuschnerstr. 91 D-21031 Hamburg Tel.: +49 40-739 62 119/Fax: +49 40-739 62 480 e-mail: pccwest@aixh0101.holz.uni-hamburg.de internet: http://www.dainet.de/bfh/icpfor/icpfor.htm Mr. Martin Lorenz
EC	European Commission Forestry Division DG VI F 2.2 (L130-10/177) Rue de la Loi 130 B-1049 BRUSSELS Tel.: +32 2-2951 376 / Fax: +32 2-29 66 255 Tel.: +32 2-2953 075 (Secretariat) e-mail: Hermann.Intemann.@dg6.cec.be Mr. Francois Kremer Mr. Hermann Intemann

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B-1049 BRUSSELS
Mr. Christian Anz
Mr. Guy Legras, General Director

2. Expert Panels, WG and other Coordinating Institutions

Expert Panel on Soil Analysis	Laboratorium Bodemkunde Universiteit Gent Geologisch Instituut Krijgslaan 281 B-9000 GENT Tel.: +32 9-264 46 37/Fax: +32 9-264 49 97 Mr. Frans de Coninck, Chairman
	Laboratorium Bodemkunde Universiteit Gent Geologisch Instituut Krijgslaan 281 B-9000 GENT Tel.: +32 9-264 46 38/Fax: +32 9-264 49 97 Mr. Eric van Ranst, Vice-chairman
Expert Panel on Foliar Analysis	Forstliche Bundesversuchsanstalt Seckendorff-Gudent-Weg 8 A-1131 WIEN Tel.: +43 1-878 38-0/Fax: +43 1-87 75 907 Mr. Klaus Stefan, Chairman
Expert Panel on Increment Analysis	Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft (WSL) Zürcherstr. 111 CH-8903 BIRMENSDORF Tel.: +41 1-739 23 54/Fax: +41 1-739 22 15 e-mail: innes@wsl.ch Mr. John L. Innes, Chairman
Expert Panel on Deposition Measurements	Swedish Environmental Research Institute Institutet för Vatten- och Luftvardsforskning (IVL) P. O. Box 47086 Dagjämningsgatan 1 S-40258 GÖTEBORG Tel.: +46 31-46 00 80/Fax: +46 31-48 21 80 Mrs. Gun Lövblad, Chairperson
Expert Panel on Crown Condition Assessment	Hessische Landesanstalt für Forsteinrichtung, Waldforschung und Waldökologie D-34346 HANN. MÜNDEN Tel.: +49 5541 700416/Fax: + 49 5541 700473 Mr. Johannes Eichhorn, Chairman

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Tel.: +36 1 1314-774/Fax: +36 1 1126-112
Mr. András Szepesi, Vice-chairman

LINNAEA ambiente
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Tel.: +39 55 608073/Fax: +39 55 608311
Mr. Marco Ferretti, Vice-chairman

SAG	Scientific Advisory Group for the European Programme of the Intensive Monitoring, Ministère de l'Agriculture, de la Pêche et de l'Alimentation Direction de l'Espace Rural et de la Forêt Dépt. Santé des Forêts 19 avenue du Maine F-75732 PARIS Cedex 15 Tel.: +33 1-49 55 51 95/Fax: +33 1-49 55 57 67 Mr. Guy Landmann, Chairman
WG on Remote Sensing	Working Group on Remote Sensing Applications on Forest Health Assessment, Albert-Ludwigs-Universität Freiburg Abteilung Fernerkundung und LIS D-79085 FREIBURG Tel.: +49 761-203 3696/Fax: +49 761-203 3701 e-mail: grosscp@combo.forst.uni-freiburg.de Mr. Claus-Peter Gross, Coordinator Centro Interregionale Via del Nazareno 12 I-00187 ROMA Tel.: +39 6-679 3625/Fax: +39 6-679 7648 M. Adriano Cumer, Coordinator
FSCC	Laboratorium Bodemkunde Universiteit Gent Geologisch Instituut Krijgslaan 281 B-9000 GENT Tel.: +32 9-264 46 38/Fax: +32 9-264 49 97 Mr. Eric van Ranst
FFCC	Forstliche Bundesversuchsanstalt Seckendorff-Gudent-Weg 8 A-1131 WIEN Tel.: +43 1-878 38-0/Fax: +43 1-87 75 907 Mr. Klaus Stefan

FIMCI	Forest Intensive Monitoring Coordinating Institute Postbus 24 NL-8440 AA HEERENVEEN Tel.: +31 513 634456/Fax: +31 513 633353 e-mail: fimci@cybercomm.nl Mr. Wim de Vries, Project Manager Mr. Evert Vel, Head Information Section

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

Austria (NFC)	Forstliche Bundesversuchsanstalt Seckendorff-Gudent-Weg 8 A-1131 WIEN Tel.: +43 1-878 38-0/Fax: +43 1-87 75 907 Mr. HR Friedrich Ruhm, Dipl.-Ing., Direktor Mr. Markus Neumann
(Min)	Bundesministerium für Land- und Forstwirtschaft Ferdinandstr. 4 A-1020 WIEN Tel.: +43 1-51 50-0/Fax: +43 1-21323 7216 Mr. R. Themessl
Belarus (Min) (NFC)	Ministry of Forestry Chkalov-Street 6 220039 MINSK Belarus Tel.: +375 0172-24 47 05/Fax: +375 0172-24 41 83 Mr. V. P. Romanovskii Deputy Minister for Forestry
Belgium (Min) (NFC)	Ministère des Affaires Etrangères Direction générale de la Politique Direction d'administration des questions nucléaires, de la politique scientifique et de l'environnement Rue Belliard, 65 B-1040 BRUXELLES Tel.: +32 2-238 25 11/Fax: +32 2-230 02 80 Mr. R. Piscaglia, Directeur général f.f.
Wallonia (Min) (NFC)	Ministère de la Région Wallonne Direction Générale des Ressources Naturelles et de l'Environnement Avenue Prince de Liège, 15 B-5000 NAMUR Tel.: +32 81-24 66 11/24 68 71/Fax: +32 81-32 56 02 Mr. C. Delbeuck, Directeur général Mr. E. Gérard
Flanders (NFC)	Institute for Forestry and Game Management Gaverstraat 4 B-9500 GERAARDSBERGEN Tel. +32 54-43 71 11/Fax: +32 54-41 08 96 Mr. Peter Roskams

(Min)	Ministerie van de Vlaamse Gemeenschap AMINAL Afdeling Bos & Groen Belliardstraat 14-18 B-1040 BRUSSELS Tel.: +32 2-507 30 44/Fax: +32 2-507 30 65 Mr. Carl De Schepper
Bulgaria (NFC)	Higher Forestry Institute Dept. "Ecology and Environmental Protection" Kl. Ochridski 10 BG-1756 SOFIA Tel.: +359 2-62 30 59/Fax: +359 2-62 28 30 Mrs. Ekaterina Pavlova
(Min)	Ministry of Environment National Centre of Environment and Sustainable Develpment 136, Tzar Boris III blvd. BG-1618 SOFIA Mrs. Genoveva Vasileva / Mr. Ivan Peichev
Canada (Min) (NFC)	ARNEWS Canadian Forestry Service 351 St. Joseph Boulevard CDN-OTTAWA, ONT K1A 1G5 Tel.: +1 705-94 99 461/Fax: +1 705-75 95 700 Mr. Peter Hall
Quebec (Min) (NFC)	Ministère des Ressources naturelles Direction de la recherche forestière 2700, Einstein CDN-STE. FOY - QUEBEC G1P 3W8 Mr. Germain Paré
Croatia (NFC)	Sumarski Institut Cvjetno Naselje 41 41420 JASTREBARSKO Tel.: +385 1-83 10 23, 83 10 22/Fax: +385 1-83 14 93 Mr. Nikola Komlenovic
Czech Republic (NFC)	Forestry and Game Management Research Institute (VULHM) Jiloviste-Strnady CZ-15604 PRAHA 516 Tel.: +42 2-59 12 50/Fax: +42 2-59 14 13 Telex: 066-121203 Mr. Karel Vancura
(Min)	Ministerstvo zemedelstvi CR, Odbor lesniho hospodarstvi Tesnov 17 CZ-11705 PRAHA 1 Tel.: +42 2-23 28 912/Fax: +42 2-23 12 836 Mrs. Andrea Pondelickova

Denmark (Min) (NFC)	The National Forest and Nature Agency Division of Silviculture and Forest Law 53 Haraldsgade DK-2100 COPENHAGEN Tel.: +45 39-47 20 00/Fax: +45 39-47 98 99 Mr. Torsten Dybkjaer
(Min)	The Danish Forest and Landscape Research Institute Hörsholm Kongevej 11 DK-2970 HÖRSHOLM Tel.: +45 45-76 32 00/Fax: +45 45-76 32 33 Mr. Karsten Ranlund-Rasmussen, Mrs. Karin Hansen
Estonia (NFC)	Eesti Metsamajanduse ja Looduskaitse Teadusliku Uurimise Instituut Rôômu tee 2 EE-2400 TARTU Tel.:+37274-36375 or 36381/Fax: +37274-36 375 Mr. Kalle Karoles, Director
(Min)	Ministry of Environment State Forest Department of Estonian Republic Toompuiestee 24 EE-200100 TALLINN Tel.: +37274-45 29 82
Finland (NFC)	Finnish Forest Research Institute P.O. Box 18 SF-01301 VANTAA Tel.: +358 0-85705460 / Fax: +358 0-85705569 e-mail: eino.malkonen@metla.fi Mr. Eino Mälkönen
(Min)	Ministry of Agriculture and Forestry Dep. of Forest Policy Hallituskatu 3 A SF-00500 HELSINKI Tel.: +358 0-160 3344 / Fax: +358 0-160 2400 Mrs. Marjukka Mähönen, Mr. Jan Heino
France (NFC)	D.S.F. - antenne spécialisée INRA - Centre de Nancy- B.P. 35 F-54280 CHAMPENOUX Tel.: +33 83-39 40 72/Fax: +33 83-31 71 60
(Min)	Ministère de l'Agriculture, de la Pêche et de l'Alimentation Direction de l'Espace Rural et de la Forêt Dépt. Santé des Forêts 19 avenue du Maine F-75732 PARIS Cedex 15 Tel.: +33 1-49 55 51 95/Fax: +33 1-49 55 57 67 Mr. Guy Landmann

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Greece (NFC)	Institute of Mediterranean Forest Ecosystems Terma Alkmanos GR-11528 ATHENS-ILISSIA Tel.: +30-1-77 84 240/Fax: +30-1-77 84 602 Mr. George Nakos,
(Min)	Ministry of Agriculture Forest Service 3, Hypocratus street GR-10164 ATHENS Fax: +30-1-36 07 138 Mr. V. Frangos
Hungary (NFC)	Forest Management Planning Service Széchenyi u. 14 H-1054 BUDAPEST 5 Tel.: +36 1-13 23 911/Fax: +36 1-11 26 112 Telex: 061-224 492 fgazd h Mr. Peter Csoka
(Min)	Mezögazdasagi es Elelmezesugyi Miniszterium Kossuth Lajos tér 11 H-1055 BUDAPEST Tel.: +36 1-3112 491/Fax: +36 1-3119 604 Mr. Gyula Holdampf
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(NFC)	Forest Inventory State Institute Rigas iela 113 LV-2169 SALASPILS Tel.: +3712-94 2388 or 22 00/Fax: +3712-211176 Mr. M. Sipols
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Luxembourg (Min) (NFC)	Administration des Eaux et Forêts Service de l'Aménagement des Bois et de l'Economie Forestière 49, bd de la Pétrusse B.P. 411 L-2014 LUXEMBOURG Tel.: +352-49 60 71/Fax: +352-407 840 Mr. Marc Wagner
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(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
Portugal (Min) (NFC)	Direcçao Geral das Florestas Divisao de Defesa e Protecçao dos Arvoredos Av. Joao Crisostomo 28-4° P-1000 LISBOA Tel.: +351 1-312 48 96/Fax: +351 1-312 49 87 Telex: 0404-64 238 dgf p Mrs. Maria Barros
Romania (NFC)	Forest Research and Management Institute Soseana Stefanesti nr. 128 sector 2 RO-72904 BUCURESTI Tel.: +40 1-240 6095/Fax: +40 1-240 68 45 Mr. Nicolae Geambasu
(Min)	Ministerul Mediului Bd. Liberatii, Tronson 5 si 6 RO-7000 BUCURESTI Tel.: +40 1-631 04/Fax: +40 1-312 0403 Mr. Constantin Corduneanu
Russian Fed. (Min)	Ministry of Protection of the Environment and Natural Resources B. Grusinskaya str. 4/6 RUS-123812 MOSKVA, GSP Fax: +7-095-254 8283 Mr. M. V. Tolkachev, Deputy Minister

(NFC)	Lesoustroitel'noe Spetsial'noe Predpriyatie VNIITSlesresursa Novocheremushkinskaya 69 RUS-117 877 MOSKVA, GSP 7 Fax: +7-095-332 51 45 Telex: 064-411 667 kedr su Mr. Vasilii Konstantinovich Tuzov
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Slovak Republic (NFC)	Lesnicky vyskumny ustav T.G. Masaryka 22 SK-96092 ZVOLEN Tel.: +42 855-27 311/Fax: +42 855-23 397 e-mail: bucha@classic.fris.sk Mr. Jan Racko
(Min)	Ministerstvo podohospodarstva Dobrovicova 12 SK-81266 BRATISLAVA Tel.: +42-7-324 218 Fax: +42-7-326 509 Mr. Rudolf Sarnek
Slovenia (NFC)	Institut za gozdno in lesno gospodarstvo Vecna pot 2 SLO-61000 LJUBLJANA Tel.: +386 61-26 89 63/Fax: +386 61-273 589 Telex: 062-3112 Mrs. Nevenka Bogataj
Spain (NFC)	Instituto Nacional para la Conservación de la Naturaleza (DGCONA) Servicio de Protección de Agentes Nocivos Gran Via de San Francisco, 4 E-28005 MADRID Tel.: +34 1-347 60 08/Fax: +34 1-347 63 02 Telex: 052-47 591 aeico e Mr. Ramon Montoya
(Min)	Ministerio de Agricultura, Pesca y Alimentación ICONA Subdirección General de Protección de la Naturaleza Gran Via de San Francisco, 4 E-28005 MADRID Tel.: +34 1-347 5896/Fax: +34 1-347 6302 Mr. Pedro Molina

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Switzerland (NFC)	Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft (WSL) Zürcherstr. 111 CH-8903 BIRMENSDORF Tel.: +41 1-73 92 354/Fax: +41 1-739 22 15 e-mail: john.innes@wsl.ch Mr. John L. Innes
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