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
for Europe

European Commission

Forest Condition in Europe

Results of the 1995 Survey

1996 Executive Report

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CONTENTS

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 26 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), as well as the 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.

Annexes I to VII contain tables concerning the national results. Annex VIII provides a list of tree species with their botanical names and their names in the official UN/ECE and EU languages.

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

2.1.1.1 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.

2.1.1.2 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.

2.1.1.3 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).

2.1.1.4 Assessment parameters and data presentation

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 2.1.1.4.-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.

Table 2.1.1.4-1: 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

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.

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

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.

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". 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 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.

All tree species are referred to in 11 languages as well as by their proper botanical names (Annex VIII).

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. 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. 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

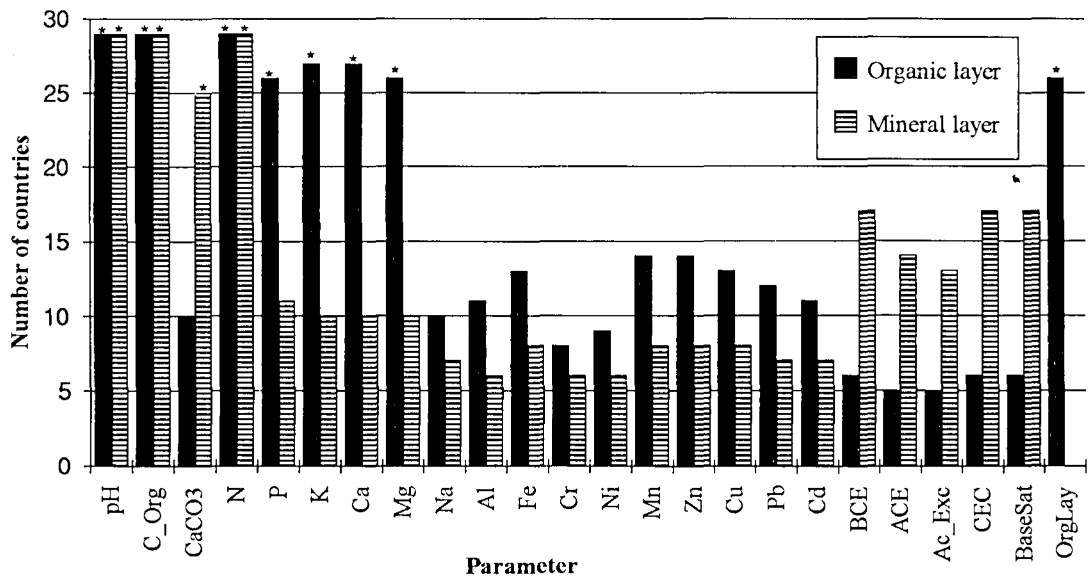
The pedological characterisation is optional for Level I study plots. It includes at least one detailed profile description and is carried out before starting soil measurements. It provides background information on the soil in order to improve the interpretation of other data collected at the plot location. 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 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.

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 necessity 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):

Table 2.1.3-1: 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.

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	

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), 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.

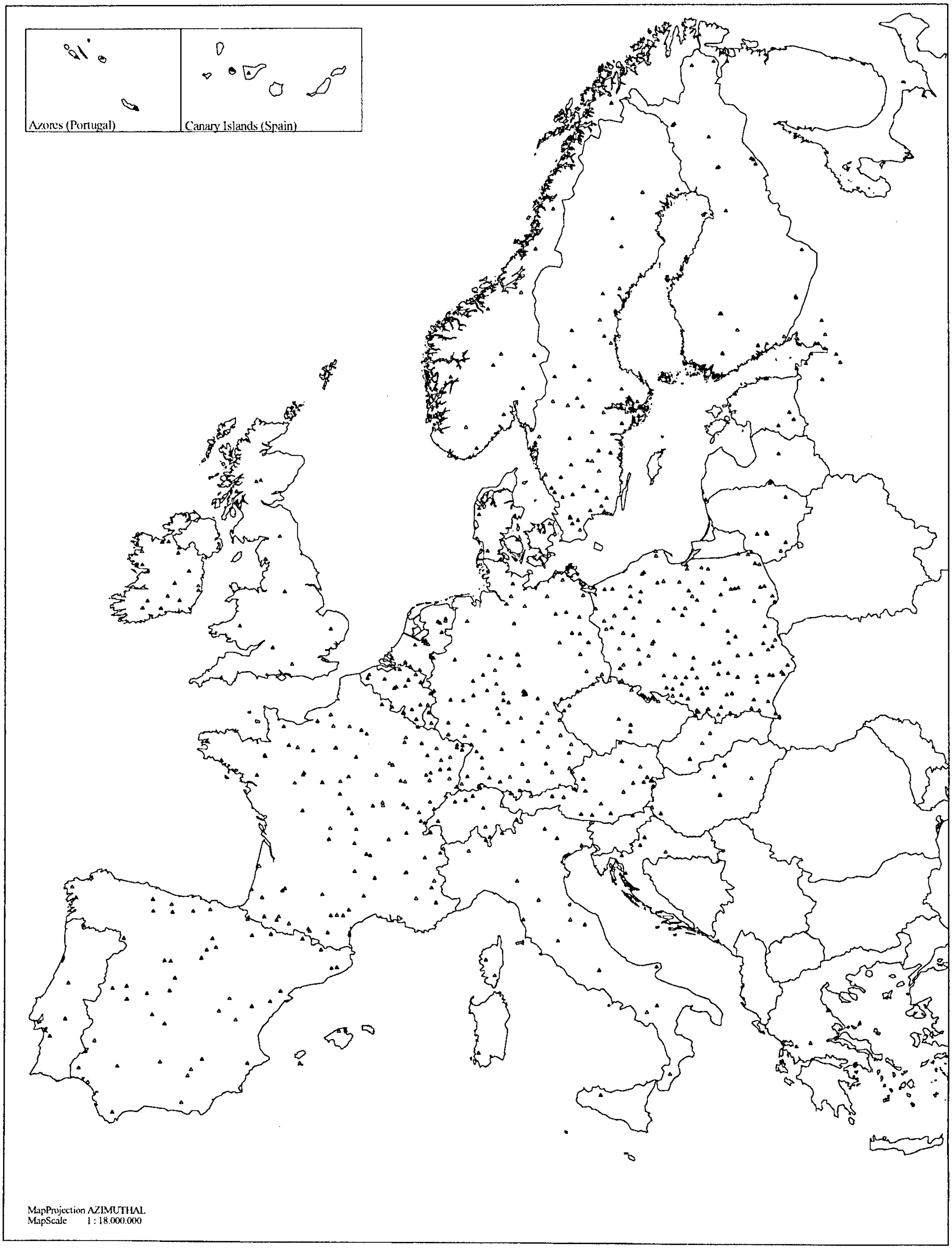


Figure 2.2.1.1-1: The location of the plots of the intensive monitoring

2.2.1.2 Monitoring activities

Level II comprises the following monitoring activities:

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

[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.

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 harmonisation of the assessment of soil solution and ground vegetation. For the assessment of phytopathology, litterfall and phenology the possibilities of harmonisation 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 reported for the various parameters have been evaluated with respect to their distribution among the plots established.

Main tree species

From 651 plots, the main species has been reported. The top five 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)

Altitude

Altitude is known for 651 of the plots. Most of the selected plots are located in the lower altitudes, and the number of plots slowly decreases with higher altitudes.

Mean age

From most of the plots, the mean age of the trees has been reported. In 24 plots, the mean age is not specified yet. 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.

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 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. Participating countries were asked to indicate whether the estimated yield was considered as being low, normal or high for these species under theses plot conditions. This information was received for 85% of the total plot number. Its evaluation showed that the yield is normal in most plots.

Distance to nearby monitoring or meteorological stations

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 monitoring station, but also Integrated Monitoring Plots, and other research plots were mentioned. Based on the coordinates supplied for these stations, the distance between the plot and the nearest stations has been calculated. The distribution of this distance showed that the majority of plots are located within 10 km to a meteorological station.

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, evaluation strategy and 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.

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 3.1.1-1 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 3.1.1-2).

Table 3.1.1-1: Percentages of defoliation for broadleaves, conifers and all species.

	Species	Defoliation							No.
	type	0-10%	>10-25%	0-25%	>25-60%	>60%	dead	>25%	trees
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 3.1.1-2: Percentages of discolouration for broadleaves, conifers and all species

	Species	Discolouration						No.
	type	0-10%	>10-25%	>25-60%	>60%	dead	>10%	trees
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 3.1.1-1. 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 Figures 3.1.1-2 and 3.1.1-3. The mean plot defoliation (Figure 3.1.1-2) 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.

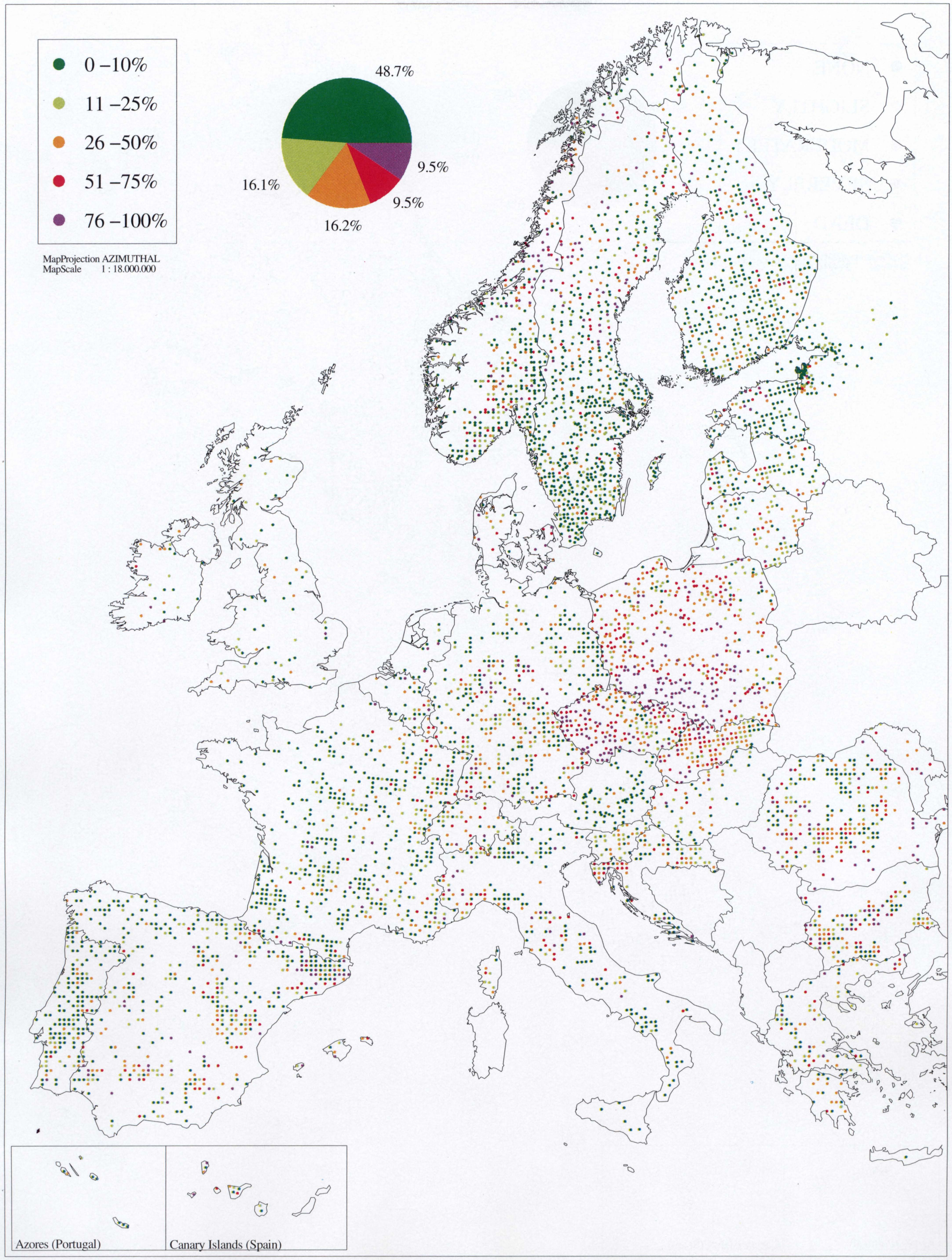


Figure 3.1.1-1: Percentage of trees damaged in 1995. The percentage is the basis for the transnational evaluation and not suitable for comparison between individual countries.

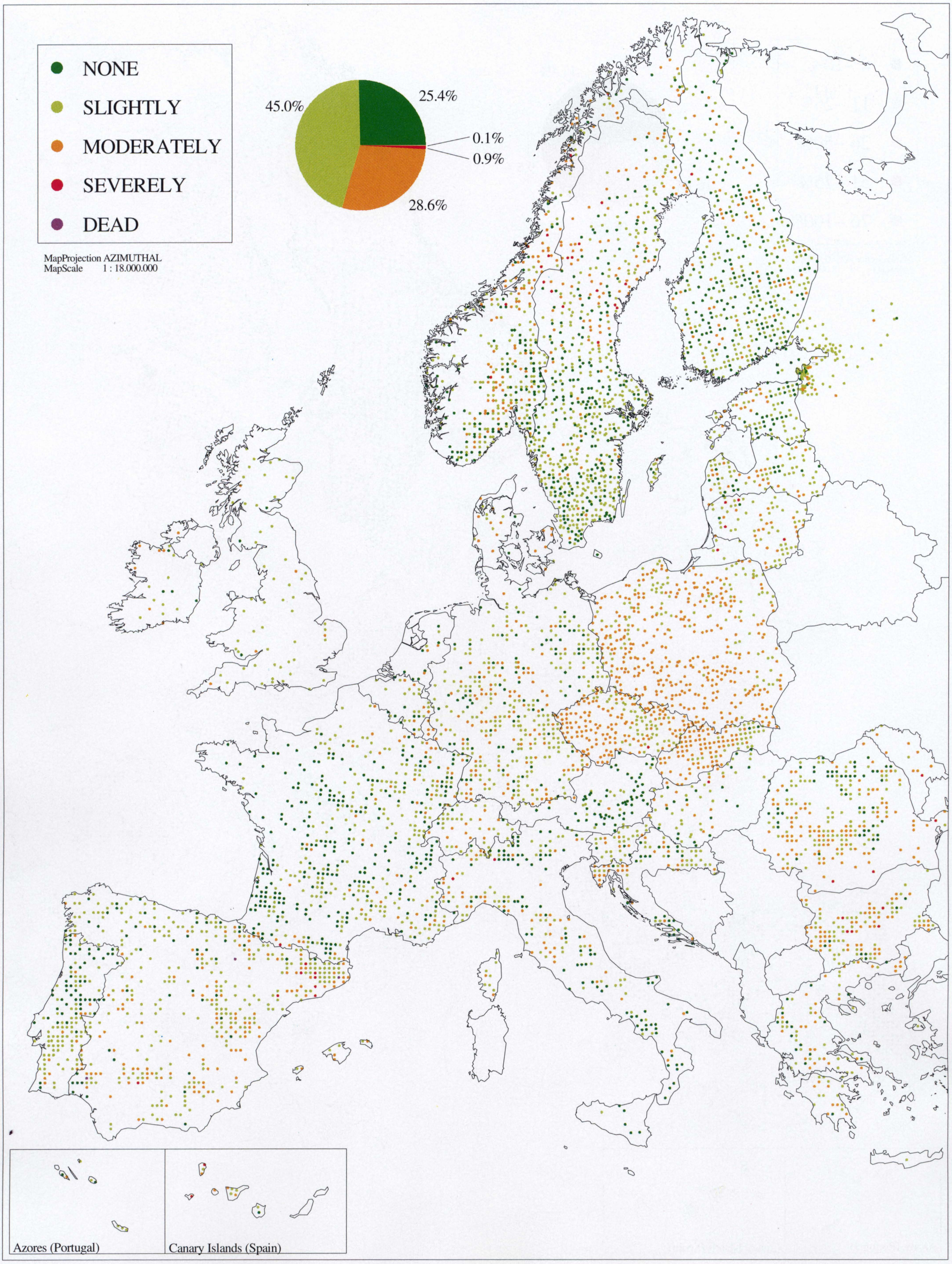


Figure 3.1.1-2: Plot defoliation (1995). The percentage is the basis for the transnational evaluation and not suitable for comparison between individual countries.

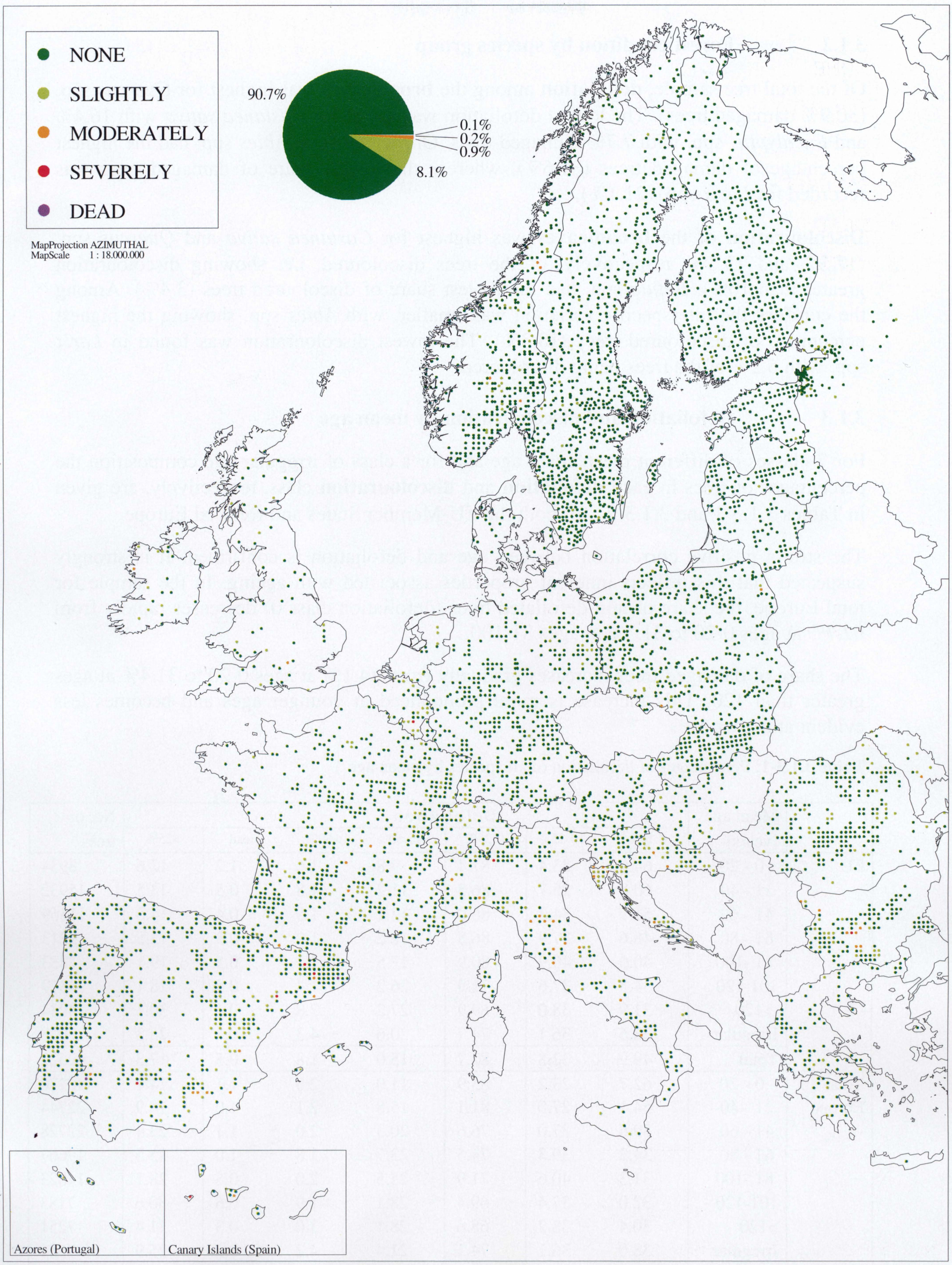


Figure 3.1.1-3: Plot discolouration (1995). The percentage is the basis for the transnational evaluation and not suitable for comparison between individual countries.

3.1.2 Forest condition by species group

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. (21.1%).

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.

3.1.3 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 3.1.3-1 and 3.1.3-2., for both the EU-Member States and for total Europe.

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 non-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.

Table 3.1.3-1: Percentages of defoliation of all species by mean age

	Mean age	Defoliation							No. of
	[years]	0-10%	>10-25%	0-25%	>25-60%	>60%	dead	>25%	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

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 3.1.3-2: Percentages of discolouration of all species by mean age

	Mean age	Discolouration						No. of
	[years]	0-10%	>10-25%	>25-60%	>60%	dead	>10%	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

3.1.4 Changes in defoliation and discolouration from 1994-1995

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 common sample 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 3.1.4-1 shows the percentages of trees in the different defoliation and discolouration classes for the CSTs of 1994 and 1995. 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 3.1.4-1: 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

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.

3.1.4.1 Changes by climatic region

As in previous years, the total tree sample and Common Sample Trees (CSTs) were classified into climatic regions in order to account for various climatic site conditions. The selected climatic regions largely match the most important vegetation types. Figure 3.1.4.1-1 shows the distribution and percentages of all plots over the climatic regions.

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. The changes in the percentage of trees in defoliation classes are visualised in Figure 3.1.4.1-2. 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%. 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 Figure 3.1.4.1-3. 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.

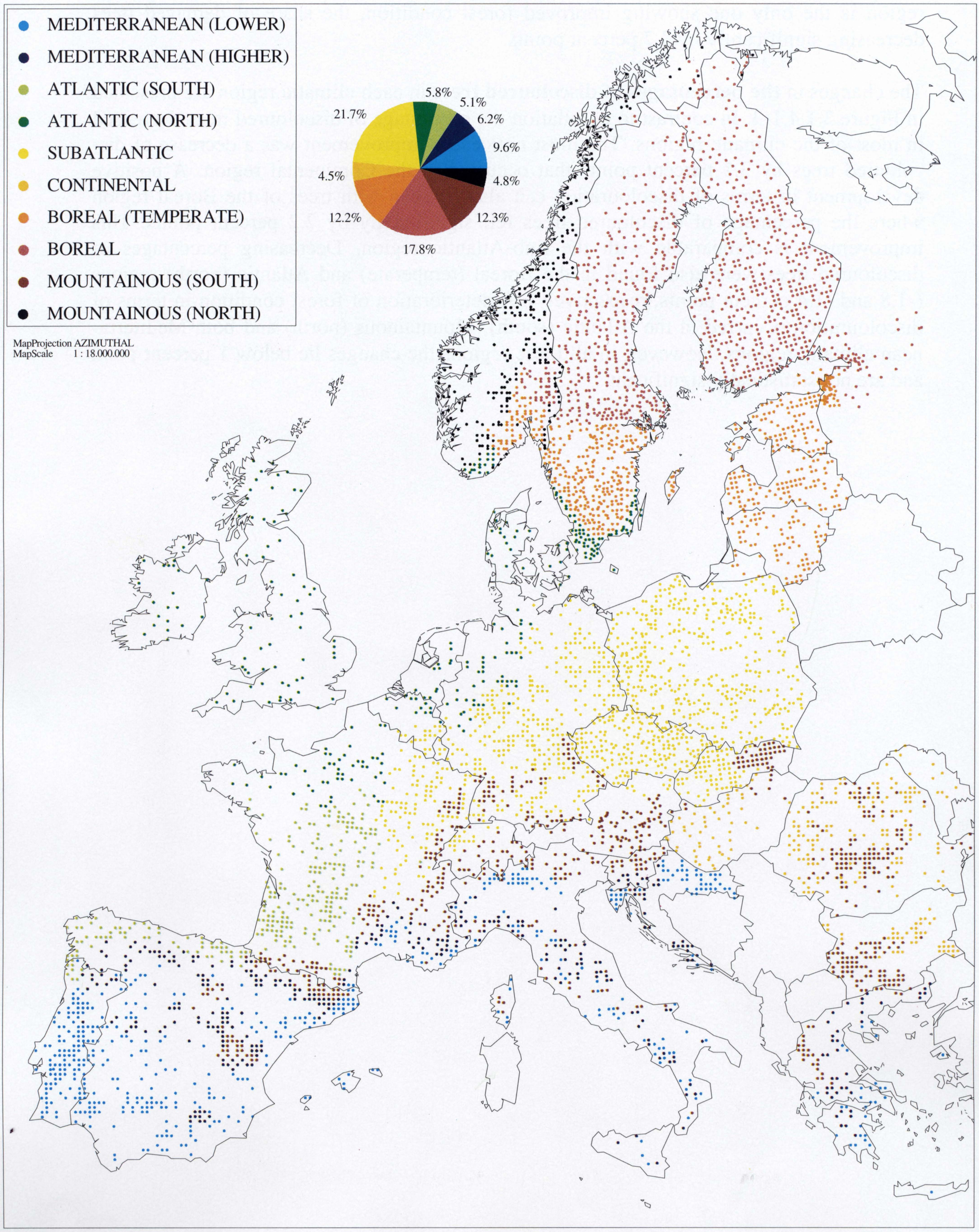


Figure 3.1.4.1-1: Climatic regions

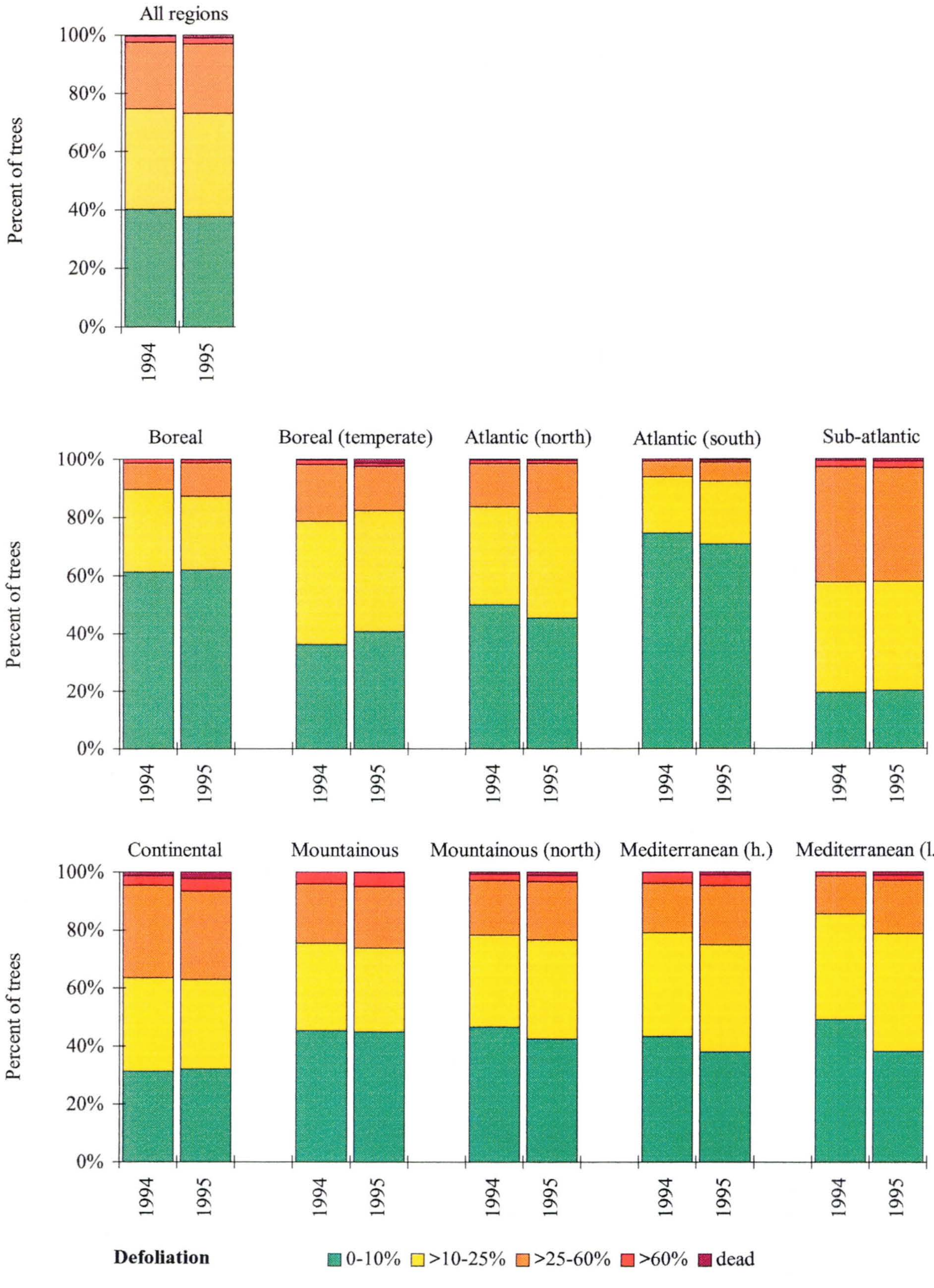


Figure 3.1.4.1-2: Percentages of defoliation of the Common Sample Trees in 1994 and 1995 for each of 10 climatic regions and for the total samples of CSTs.

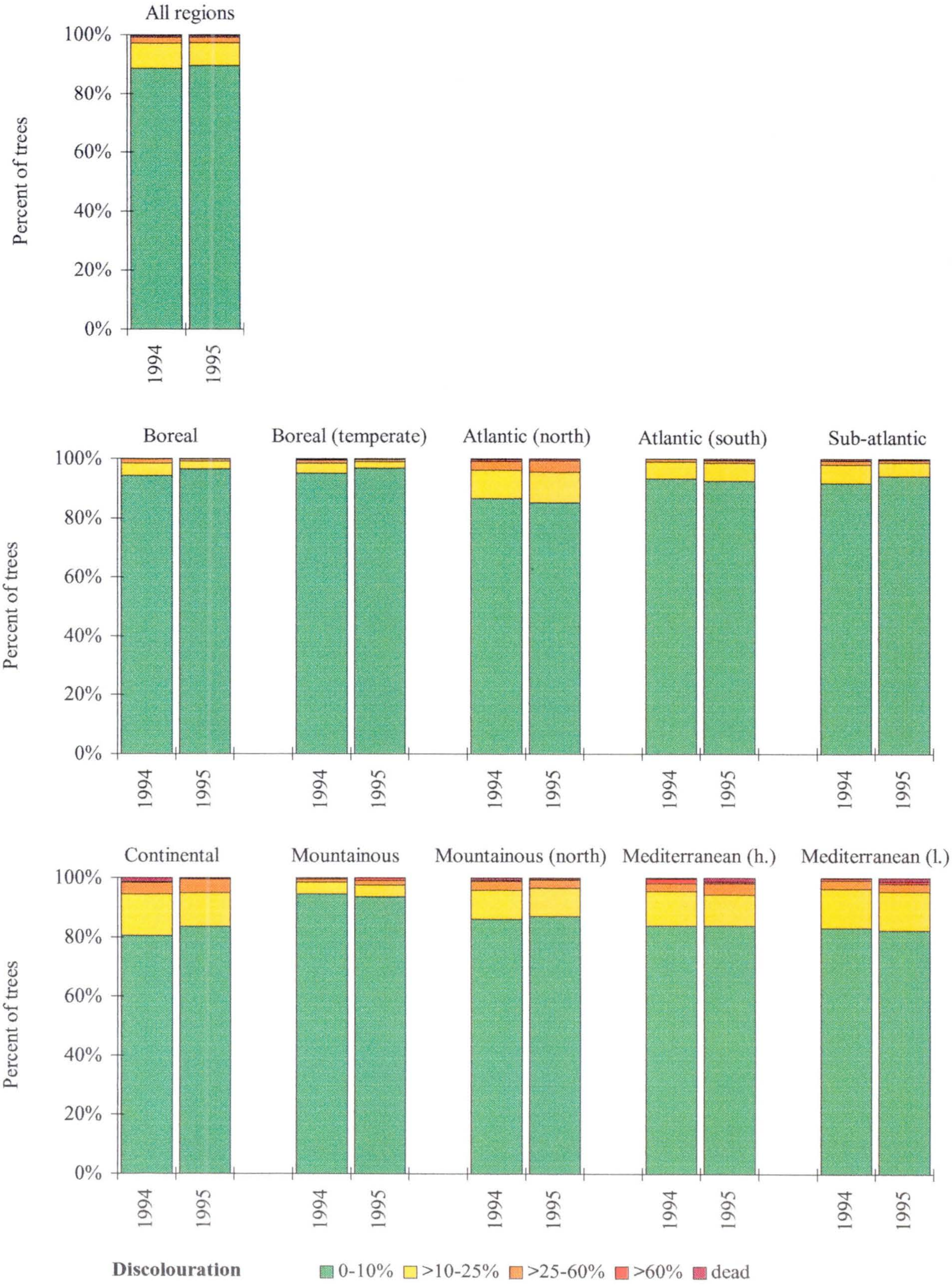


Figure 3.1.4.1-3: Percentages discolouration of the Common Sample Trees in 1994 and 1995 for each of 10 climatic regions and for the total sample of CSTs.

3.1.4.2 Changes by species group

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%.

3.1.5 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. 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 species wise 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 two 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.

Among the conifers (Figure 3.1.5-1) the highest percentage of damaged trees in 1995 had *Abies alba* (25.4%) and *Pinus halepensis* (24.8%) followed by *Picea abies* (22.6%) and *Picea sitchensis* (22.2%). A striking even and stable development of the health status since 1988 shows *Pinus pinaster* with a remarkable low share of damaged trees lying mostly below 10%. Contrasted with this species *Pinus halepensis* seems to have continuously deteriorated its crown conditions as the proportion of the trees damaged rose from 2.7% in 1991 to 24.8% in 1995.

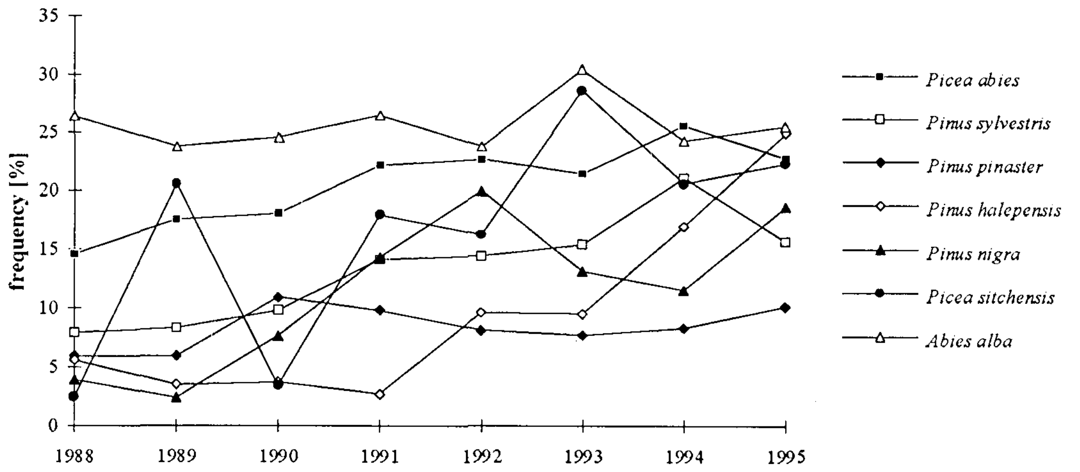


Figure 3.1.5-1: Development of defoliation for coniferous trees (defoliation classes 2-4) common to 1988-1995 (all climatic regions).

As regards broadleaves (Figure 3.1.5-2) a remarkable development shows *Quercus suber*. After a dramatic increase in the share of damaged trees 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. Between 1992 and 1993 the health status of *Quercus suber* improved continuously. In 1994 an increase of damaged trees to 11.7% occurred again and continued in 1995 reaching a share of 23.6%. The developments of the percentage of damaged trees with the other broadleaved species (see Figure 3.1.5-2) are similar indicating a slight deterioration of the health status from 1992 on.

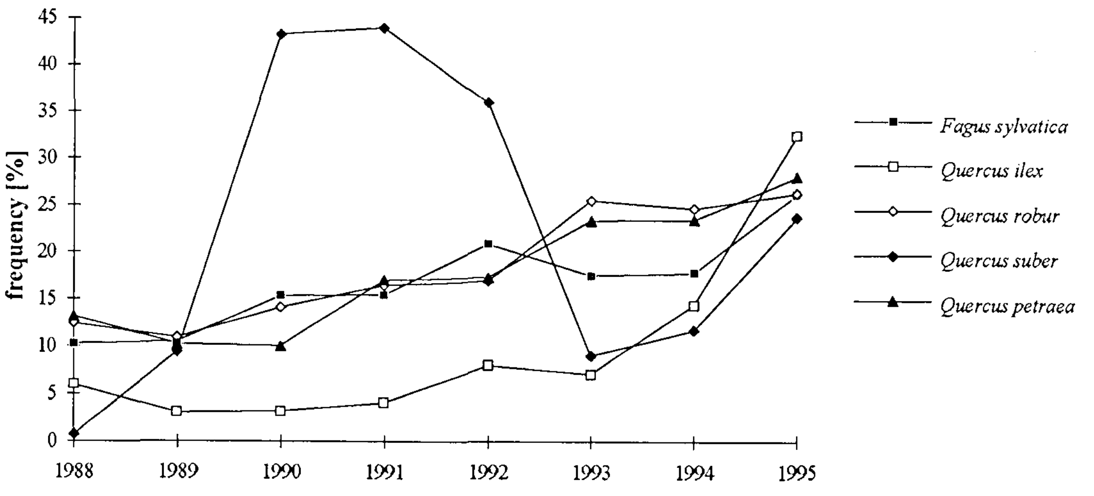


Figure 3.1.5-2: Development of defoliation for broadleaved trees (defoliation classes 2-4) common to 1988-1995 (all climatic regions).

3.2 National surveys

In 1995, 28 European countries submitted national reports in order to present the results of their national surveys. Numerical data were available from 30 countries, which are tabulated in Annexes I-VII. Annex I 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, for the conifers in Annex III and for the broadleaves in Annex IV. The annual changes in the results are presented for all species, for conifers and for broadleaves in Annexes V to VII. 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 in the tables 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 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 V to VII). 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: 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.

3.3 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, the 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 **relationship** between crown condition and stand age is investigated.

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.

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, emphasise that hot, dry summers (or cold winters, respectively) impair forest condition.

Relationship between crown condition and stand age

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 than 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* which 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 of the national reports submitted by individual countries. 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 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 summarise 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.

Annexes

ANNEX I
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
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 III
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 IV
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 V
DEFOLIATION OF ALL SPECIES (1986-1995)

Participating countries	All species Defoliation classes 2-4										change %-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 VI
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 VII
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 VIII
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

For further information please contact:

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

European Commission
DG VI F II.2
Rue de la Loi 130
B-1049 BRUSSELS