# Forest Condition in Europe
# 2013 Technical Report of ICP Forests

## Report under the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP)

**Alexa Michel, Walter Seidling, Martin Lorenz, Georg Becher (Eds.)**

Thünen Working Paper 19

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# SUMMARY

Of the 42 countries that have participated in ICP Forests since 1986, 27 countries reported large-scale monitoring data from Level I plots and more detailed forest ecosystem related monitoring data from Level II plots for the year 2012. In total, the participating countries provided information on more than 15,000 plots and more than 220,000 trees. Data analyses for this 2013 Technical Report focused on the impact of air pollution on tree crown condition and on sulphate and nitrogen deposition to forests. In addition, the impact on individual trees of factors other than air pollution, e.g., biotic agents, was assessed.

Crown condition is the most widely applied indicator for forest health and vitality of European forests. One of its primary parameters is the rate of defoliation, which is assessed as the percentage of needle/leaf loss in the crown compared to a reference tree with full foliage. The mean defoliation of 114,361 sample trees on 6,168 transnational Level I plots in 2012 was 19.7%. Of all trees assessed in 2012 every fourth to fifth tree (22.9%) was scored as damaged, i.e., had a defoliation rate of more than 25%.

In general, broadleaved trees showed a higher mean defoliation rate than conifer species (23.6% and 20.2%, respectively). Oak species still seem to be the most vulnerable of all the investigated species. Of the main species groups, deciduous temperate oak species had the highest mean defoliation (26.5%), closely followed by Mediterranean evergreen oak species (25.2%), and deciduous (sub-) temperate oak species (24.6%). A mean defoliation rate of 19.6% was assessed for European beech *(Fagus sylvatica).* Coniferous species expressed lower defoliation rates on average, with European spruce *(Picea abies)* reaching 19.2%, followed by Scots pine *(Pinus sylvestris)* with 19.3%, and Mediterranean lowland pine species with 20.7%,

These figures are, however, not directly comparable to those of previous reports because of fluctuations in the plot sample that are primarily due to changes in the annual participation of countries. Therefore, the temporal development of crown condition was calculated separately from the monitoring results for those countries which have submitted data every year without interruption since 1993, 1998, and 2002, respectively. In addition, maps were drawn that depict temporal species trends in defoliation. The presented results suggest that there was no overall improvement of crown condition for the longest analyzed time period from 1993 to 2012. Over the last 20 years the percentage of plots with clearly increasing mean defoliation (17.2%) even exceeded the share of plots with decreasing defoliation (12.5%) but most of the investigated plots showed no statistically significant change in crown condition (70.3%). Compared to the previous year only, the investigated trees showed on average similar rates of defoliation in 2012. More than three out of four plots (78.7%) showed no statistically significant difference in mean defoliation between those two years. Defoliation increased on 13.8% and decreased on only 7.5% of the plots.

Crown condition assessments also comprised discoloration and damages caused by biotic and abiotic factors. Of the different damage factors that could be identified, insects were the most frequent in 2012 with every third damaged tree (33.4%) displaying symptoms caused by insects.

Deposition of acidifying compounds, inorganic nitrogen as a nutrient, and base cations to forests is a major driver for many processes in forest ecosystems in Europe. Mean annual deposition of sulphur (S) and nitrogen (N) in forest stands (throughfall) and in the open field (bulk) were calculated for 221 ICP Forests Level II plots in 24 countries. Atmospheric deposition of N and S compounds to forests covered a relatively wide range and was still relatively high at certain plots. However, there has been a main tendency of decreasing atmospheric depositions in the last 6 and 10 years especially for S compounds although trend slopes vary from plot to plot. Significant decreasing trends have not been observed for all of the plots and especially for nitrogen compounds there were plots with significant increasing trends as well, especially for the period 2006 to 2011.

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# 1 INTRODUCTION

The International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) was originally set up in 1983 within the framework of the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP) with the aim to solely monitor the effects of air pollution on European forests. Since then ICP Forests has not only evaluated the effects of anthropogenic and natural stress factors on the condition and development of tree crowns. It has also implemented comprehensive transnational surveys which aim at a better understanding of specific cause and effect relationships in forest ecosystems in general, including the assessment of carbon budgets, climate change, and forest biodiversity.

One of the first activities of ICP Forests was to develop a harmonized monitoring scheme for large-scale monitoring studies on a 16 km x 16 km transnational grid of sample plots (Level I) within the participating countries. Additional permanent observation plots were installed in relevant forest stands for detailed studies on interactions between crown condition, increment and chemical composition of foliage and soils (Level II). These monitoring schemes have been collectively agreed on by all participating countries and are described in the ICP Forests Manual.

Every year the participating countries submit their latest monitoring data to the ICP Forests Programme Coordinating Centre (PCC) for validation, storage, and analysis. In October 2013, the PCC, including the Data Management Centre, has moved from the former Thünen Institute for World Forestry to the Thünen Institute of Forest Ecosystems in Eberswalde.

With 42 countries cooperating, including Canada and the U.S.A., ICP Forests is one of the largest biomonitoring networks. Because of the commitment of several hundreds of data collectors, scientific evaluators, and representatives of national focal points and ministries, ICP Forests is indeed a reliable and truly unique cooperative international effort. The annual publication of the Executive and Technical Reports provide policy advisors, scientists, and the interested public with detailed descriptions of the condition of forests in Europe. These reports have proven to be an invaluable source of information for everyone concerned in the well-being of forest ecosystems throughout Europe and beyond.

The present 2013 Technical Report starts with an overview of the Level I and Level II monitoring systems in Chapter 2. Chapter 3 presents results of the 2012 transnational crown condition surveys including assessments of different damage causes. In Chapter 4 the spatial and temporal variation of sulphur and nitrogen deposition is described. Chapter 5 consists of written national reports by the participating countries, focusing on crown condition in 2012 as well as its development and damage causes. For additional maps, figures, and tables concerning the transnational and the national results, respectively, please refer to the Annex.

# 2 THE MONITORING SYSTEM

## 2.1 Background

*Martin Lorenz, Oliver Granke*[1]

Forest monitoring in Europe has been conducted for 28 years according to harmonised methods and standards by the International Cooperative Programme on Assessment and Monitoring of Air Pollution effects on Forests (ICP Forests) of the Convention on Long-range Transboundary Air Pollution (CLRTAP) under the United Nations Economic Commission for Europe (UNECE). The monitoring results meet the scientific information needs of CLRTAP for clean air policies under UNECE. According to its strategy for the years 2007 to 2015, ICP Forests pursues the following two main objectives:

(1) To provide a periodic overview of the spatial and temporal variation of forest condition in relation to anthropogenic and natural stress factors (in particular air pollution) by means of European-wide (transnational) and national large-scale representative monitoring on a systematic network (monitoring intensity Level I).

(2) To gain a better understanding of cause-effect relationships between the condition of forest ecosystems and anthropogenic as well as natural stress factors (in particular air pollution) by means of intensive monitoring on a number of permanent observation plots selected in most important forest ecosystems in Europe (monitoring intensity Level II).

The complete methods of forest monitoring by ICP Forests are described in detail in the "Manual on methods and criteria for harmonised sampling, assessment, monitoring and analysis of the effects of air pollution on forests" (ICP Forests 2010). For many years forest monitoring according to the ICP Forests Manual was conducted jointly by ICP Forests and the European Commission (EC) based on EU–co-financing under relevant Council and Commission Regulations. The monitoring results are also delivered to processes and bodies of international forest and environmental policies other than CLRTAP, such as Forest Europe (FE), the Convention on Biological Diversity (CBD), the UN-FAO Forest Resources Assessment (FRA), and EUROSTAT of EC. In order to better meet the new information needs with respect to carbon budgets, climate change, and biodiversity, the forest monitoring system was further developed in the years 2009 to 2011 within the project "Further Development and Implementation of an EU-level Forest Monitoring System" (FutMon) under EU-co-financing. The following chapters describe briefly the selection of sample plots and the surveys on the revised Level I and Level II monitoring networks.

[1] For contact information, please refer to Annex III-4.

## 2.2 Large-scale forest monitoring (Level I)

The large-scale forest monitoring grid consists of more than 7500 plots. The selection of Level I plots is within the responsibility of the participating countries, but the density of the plots should resemble that of the previous 16 x 16 km grid. For this reason, the number of plots in each country should be equal to the forest area of the country (in $km^2$) divided by 256.

By the end of FutMon in June 2012, 58% of the Level I plots in the EU-Member States were coincident with National Forest Inventory (NFI) plots. No coincidence with NFI plots was given for 29% of the plots. It is expected, however, that a number of countries will merge these plots with NFI plots at a later date. For the remaining plots no information was made available (Fig. 2.2-1).

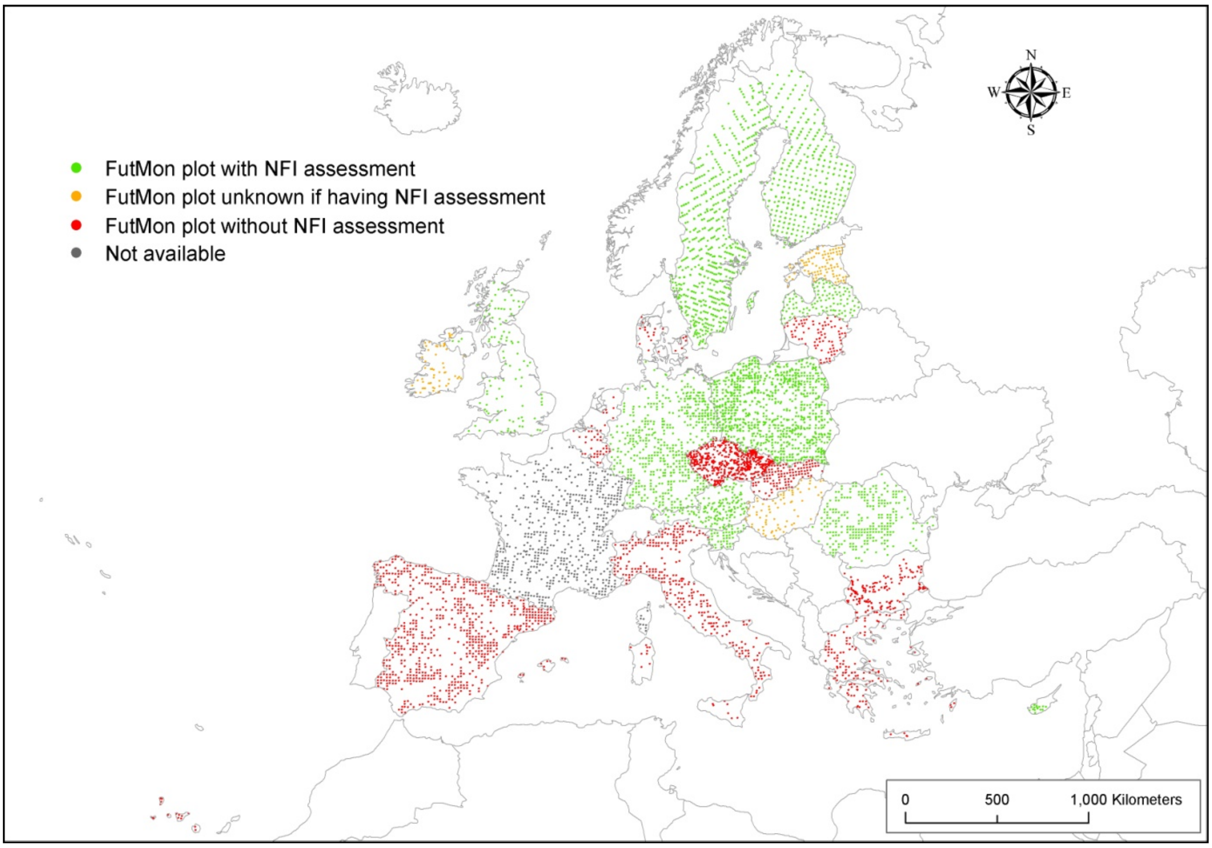


**Figure 2.2-1**: Spatial distribution of the large-scale plots under FutMon. Green colour implies a coincidence with NFI plots.

On most of the Level I plots tree crown condition is assessed every year. In 1995, element contents in needles and leaves were assessed on about 1500 plots and a forest soil condition survey was carried out on about 3500 plots. The Level I soil condition survey was repeated on about 5300 plots in 2005 and 2006 and the species diversity of forest ground vegetation was assessed on about 3400 plots in 2006 under the Forest Focus Regulation of EC within the BioSoil project (Fig. 2.2-2).

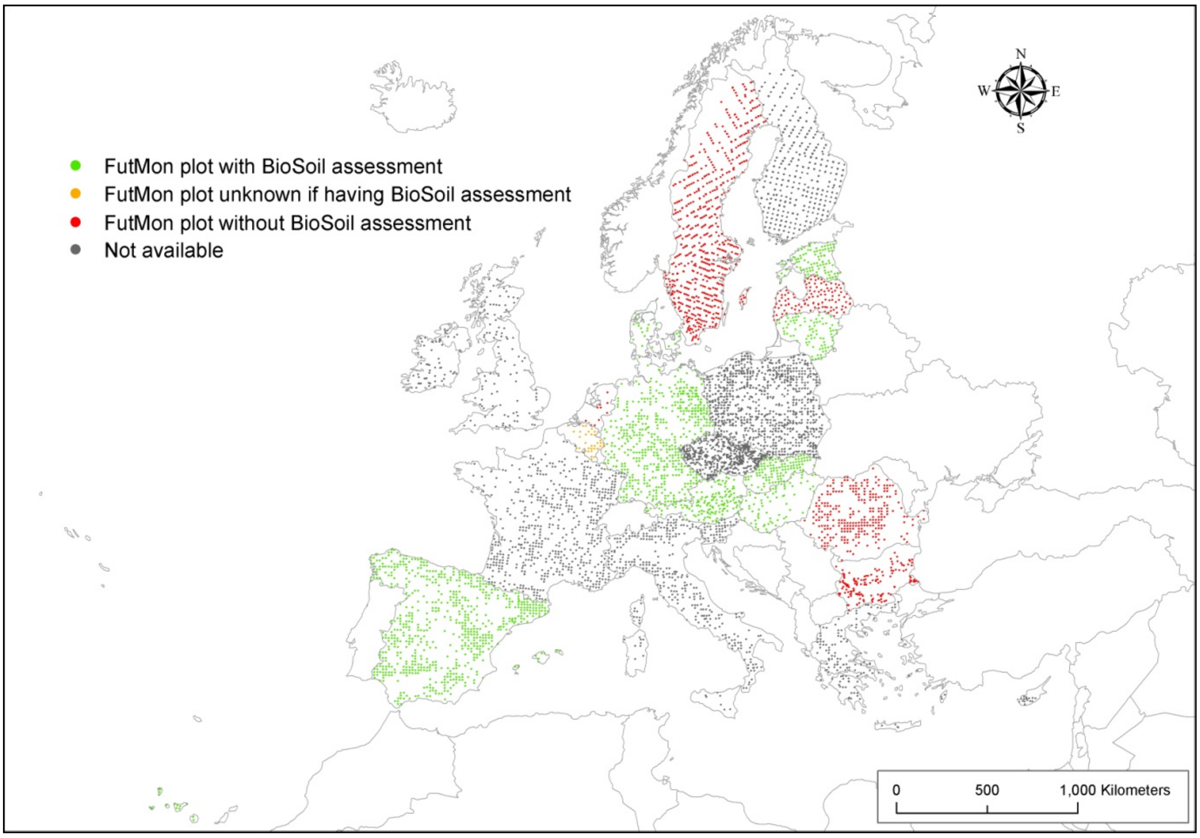


**Figure 2.2-2**: Spatial distribution of the large-scale plots under FutMon. Green colour implies inclusion in the BioSoil project under the Forest Focus Regulation of EC.

## 2.3 Forest ecosystem monitoring (Level II)

The number of forest ecosystem monitoring (Level II) plots in the data base is 938 including plots with different assessment intensities and a number of abandoned plots as well. On the plots up to 17 surveys are conducted. Of these surveys many are not conducted continuously or annually, but are due only every few years. The complete set of surveys, however, is carried out on only about 100 Level II "core plots". The map in Fig. 2.3-1 shows those plots on which crown condition was assessed in 2009, coming close to the total of all Level II plots assessed in 2009. Moreover, the map indicates the locations of Level II plots of previous years.

## 2.4 References

ICP Forests (2010) Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests. UNECE, ICP Forests, Hamburg. ISBN: 978-3-926301-03-1, [http://www.icp-forests.org/Manual.htm]


**Figure 2.3-1:** Level II plots with crown condition assessments in 2009. Also shown are plots with other surveys and of previous years.

# 3 TREE CROWN CONDITION AND DAMAGE CAUSES

*Georg Becher, Martin Lorenz, Henny Haelbich, Volker Mues*[2]

## 3.1 Large scale tree crown condition

### 3.1.1 Methods of the 2012 survey

The annual transnational tree condition survey was conducted on 6189 Level I plots in 27 countries including 20 EU-Member States (Tab. 3.1.1-1). The assessment was carried out under national responsibilities according to harmonized methods laid down by ICP Forests. Prior to the evaluation all data were checked for consistency by the participating countries and submitted online to the Programme Coordinating Centre (PCC) that was located at the Thünen Institute of International Forestry and Forest Economics (formerly the Institute for World Forestry) in Hamburg, Germany, until September 2013. The PCC has moved to the Thünen Institute of Forest Ecosystems in Eberswalde in October 2013.

**Table 3.1.1-1:** Number of sample plots assessed for crown condition from 2000 to 2012

| Country | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 130 | 130 | 133 | 131 | 136 | 136 | 135 | | | | 135 | | |
| Belgium | 29 | 29 | 29 | 29 | 29 | 29 | 27 | 27 | 26 | 26 | 9 | 9 | 8 |
| Bulgaria | 108 | 108 | 98 | 105 | 103 | 102 | 97 | 104 | 98 | 159 | 159 | 159 | 159 |
| Cyprus | | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Czech Republic | 139 | 139 | 140 | 140 | 140 | 138 | 136 | 132 | 136 | 133 | 132 | 136 | 135 |
| Denmark | 21 | 21 | 20 | 20 | 20 | 22 | 22 | 19 | 19 | 16 | 17 | 18 | 18 |
| Estonia | 90 | 89 | 92 | 93 | 92 | 92 | 92 | 93 | 92 | 92 | 97 | 98 | 97 |
| Finland | 453 | 454 | 457 | 453 | 594 | 605 | 606 | 593 | 475 | 886 | 932 | 717 | 785 |
| France | 516 | 519 | 518 | 515 | 511 | 509 | 498 | 504 | 508 | 500 | 532 | 544 | 553 |
| Germany | 444 | 446 | 447 | 447 | 451 | 451 | 423 | 420 | 423 | 412 | 411 | 404 | 415 |
| Greece | 93 | 92 | 91 | | | 87 | | | | 97 | 98 | | |
| Hungary | 63 | 63 | 62 | 62 | 73 | 73 | 73 | 72 | 72 | 73 | 71 | 72 | 74 |
| Ireland | 20 | 20 | 20 | 19 | 19 | 18 | 21 | 30 | 31 | 32 | 29 | | 20 |
| Italy | 255 | 265 | 258 | 247 | 255 | 238 | 251 | 238 | 236 | 252 | 253 | 253 | 245 |
| Latvia | 94 | 97 | 97 | 95 | 95 | 92 | 93 | 93 | 92 | 207 | 207 | 203 | 203 |
| Lithuania | 67 | 66 | 66 | 64 | 63 | 62 | 62 | 62 | 70 | 72 | 75 | 77 | 77 |
| Luxembourg | 4 | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | | | | |
| Netherlands | 11 | 11 | 11 | 11 | 11 | 11 | 11 | | | 11 | 11 | | |
| Poland | 431 | 431 | 433 | 433 | 433 | 432 | 376 | 458 | 453 | 376 | 374 | 367 | 369 |

[2] For contact information, please refer to Annex III-4.

| **Country** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Portugal | 149 | 150 | 151 | 142 | 139 | 125 | 124 | | | | | | |
| Romania | 235 | 232 | 231 | 231 | 226 | 229 | 228 | 218 | | 227 | 239 | 242 | 241 |
| Slovak Rep. | 111 | 110 | 110 | 108 | 108 | 108 | 107 | 107 | 108 | 108 | 108 | 109 | 108 |
| Slovenia | 41 | 41 | 39 | 41 | 42 | 44 | 45 | 44 | 44 | 44 | 44 | 44 | 44 |
| Spain | 620 | 620 | 620 | 620 | 620 | 620 | 620 | 620 | 620 | 620 | 620 | 620 | 620 |
| Sweden | 769 | 770 | 769 | 776 | 775 | 784 | 790 | | | 857 | 830 | 640 | 609 |
| United Kingdom | 89 | 86 | 86 | 86 | 85 | 84 | 82 | 32 | | | 76 | | |
| **EU** | **4982** | **5004** | **4997** | **4887** | **5039** | **5110** | **4938** | **3885** | **3522** | **5215** | **5474** | **4727** | **4795** |
| Andorra | | | | | 3 | | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Belarus | 408 | 408 | 407 | 406 | 406 | 403 | 398 | 400 | 400 | 409 | 410 | 416 | |
| Croatia | 83 | 81 | 80 | 78 | 84 | 85 | 88 | 83 | 84 | 83 | 83 | 92 | 100 |
| Rep. of Moldova | 10 | 10 | | | | | | | | | | | |
| Montenegro | | | | | | | | | | | 49 | 49 | 49 |
| Norway | 382 | 408 | 414 | 411 | 442 | 460 | 463 | 476 | 481 | 487 | 491 | 496 | 496 |
| Russia | | | | | | | | | | 365 | 288 | 295 | |
| Serbia | | | | 103 | 130 | 129 | 127 | 125 | 123 | 122 | 121 | 119 | 121 |
| Switzerland | 49 | 49 | 49 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 47 | 47 |
| Turkey | | | | | | | | 43 | 396 | 560 | 554 | 563 | 578 |
| **Total** | **5914** | **5960** | **5947** | **5933** | **6152** | **6235** | **6065** | **5063** | **5057** | **7292** | **7521** | **6807** | **6189** |

Similar to the previous Forest Condition Report, data on forest damage causes collected in 2012 are analysed and detailed results presented in Chapter 3.2.

The spatial distribution of the plots assessed in 2012 is shown in Fig. 3.1.1-1. For certain analyses of defoliation, the Level I plots are stratified according to the European Forest Types (EFT). The system of EFT was developed in 2006 by the European Environment Agency (EEA) of the European Union in cooperation with experts from some European countries coordinated by the Italian Academy of Forest Sciences. After improvements and refinements based on experts' knowledge and information gained from NFIs plots, forest maps and forest management plans, the classification of European forests into forest types became operational. The system of the European Forest Types consists of 14 categories, representing groups of ecologically distinct forest communities dominated by specific assemblages of trees. The classification is conceived to categorize stocked forest land, with the help of classification keys mainly based on forest dominant tree species (Tab. 3.1.1-2).

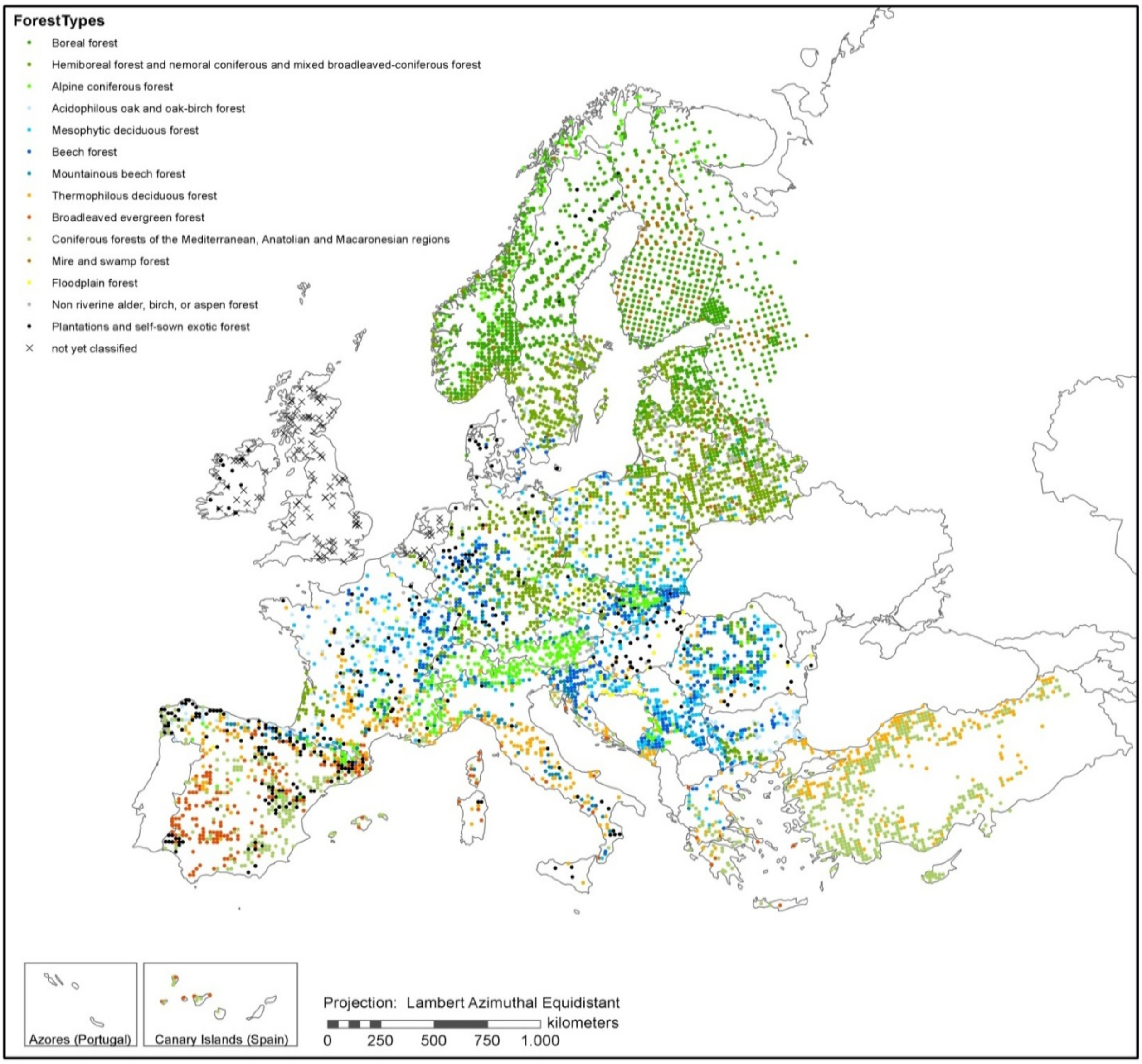


**Figure 3.1.1-1:** Plots according to European Forests Types (2012)

**Table 3.1.1-2:** Description of the European Forest Types (EFT)

| Forest type category | Main characteristics |
|---|---|
| **1. Boreal forest** | Extensive boreal, species-poor forests, dominated by *Picea abies* and *Pinus sylvestris*. Deciduous trees including birch *(Betula* spp.*)*, *aspen (Populus tremula)*, rowan *(Sorbus aucuparia)* and willow *(Salix* spp.*)* tend to occur as early colonisers. |
| **2. Hemiboreal forest and nemoral coniferous and mixed broadleaved-coniferous forest** | Latitudinal mixed forests located in between the boreal and nemoral (or temperate) forest zones with similar characteristics to EFT 1, but a slightly higher tree species diversity, including also temperate deciduous trees like *Tilia cordata, Fraxinus excelsior, Ulmus glabra* and *Quercus robur*. Includes also: pure and mixed forests in the nemoral forest zone dominated by coniferous species native within the borders of individual FOREST EUROPE member states like *Pinus sylvestris*, pines of the *Pinus nigra* group, *Pinus pinaster, Picea abies, Abies alba.* |
| **3. Alpine coniferous forest** | High-altitude forest belts of central and southern European mountain ranges, covered by *Picea abies, Abies alba, Pinus sylvestris, Pinus nigra, Larix decidua, Pinus cembra* and *Pinus mugo*. Includes also the mountain forest dominated by birch of the boreal region. |
| **4. Acidophilous oak and oak-birch forest** | Scattered occurrence associated with less fertile soils of the nemoral forest zone; the tree species composition is poor and dominated by acidophilous oaks *(Q. robur, Q. petraea)* and birch *(Betula pendula)*. |
| **5. Mesophytic deciduous forest** | Related to medium rich soils of the nemoral forest zone; forest composition is mixed and made up of a relatively large number of broadleaved deciduous trees: *Carpinus betulus*, *Quercus petraea*, *Quercus robur*, *Fraxinus* spp.*, Acer* spp. and *Tilia cordata*. |
| **6. Beech forest** | Widely distributed lowland to submountainous beech forest. Beech (*Fagus sylvatica* and *F. orientalis* (Balkan)) dominate, locally important is *Betula pendula*. |
| **7. Mountainous beech forest** | Mixed broadleaved deciduous and coniferous vegetation belt in the main European mountain ranges. Species composition differs from EFT 6, including *Picea abies, Abies alba, Betula pendula* and mesophytic deciduous tree species. |
| **8. Thermophilous deciduous forest** | Deciduous and semi-deciduous forests mainly of the Mediterranean region dominated by thermophilous species, mainly of the genus *Quercus*; *Acer, Ostrya, Fraxinus, Carpinus* species are frequent as associated secondary trees. Includes also *Castanea sativa* dominated forest. |
| **9. Broadleaved evergreen forest** | Broadleaved evergreen forests of the Mediterranean and Macaronesian regions dominated by sclerophyllous or lauriphyllous trees, mainly *Quercus* species. |
| **10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions** | Varied group of coniferous forests in Mediterranean, Anatolian and Macaronesian regions, from the coast to high mountains. Dry and often poorly-developed soils limit tree growth. Several tree species, including a number of endemics, of the genera *Pinus, Abies* and *Juniperus*. |
| **11. Mire and swamp forest** | Wetland forests on peaty soils widely distributed in the boreal region. Water and nutrient regimes determine the dominant tree species: *Pinus sylvestris, Picea abies* or *Alnus glutinosa*. |
| **12. Floodplain forest** | Riparian and riverine species-rich forests characterised by different assemblages of species of *Alnus, Betula, Populus, Salix, Fraxinus, Ulmus*. |
| **13. Non riverine alder, birch, or aspen forest** | Pioneer forests dominated by *Alnus, Betula or Populus*. |
| **14. Plantations and self-sown exotic forest** | Reforestation/plantations and forests dominated by introduced species. Introduced tree species can be identified at regional (recommended) or national level. |

## Defoliation: Scientific background for its assessment and analysis

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

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

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

## Classification of defoliation data

The results of the evaluations of the crown condition data are presented in terms of mean plot defoliation or the percentages of the trees falling into 5%-defoliation steps. In previous presentations of survey results, partly the traditional classification of both defoliation and discoloration had been applied, although it is considered arbitrary by some countries. This classification (Tab. 3.1.1-3) is a practical convention, as real physiological thresholds cannot be defined.

**Table 3.1.1-3**: Defoliation and discoloration classes according to UNECE and EU classification

| Defoliation class | Needle/leaf loss | Degree of defoliation |
|---|---|---|
| 0 | up to 10% | none |
| 1 | > 10 - 25% | slight (warning stage) |
| 2 | > 25 - 60% | moderate |
| 3 | > 60 - < 100% | severe |
| 4 | 100% | dead |
| **Discoloration class** | **Foliage discolored** | **Degree of discoloration** |
| 0 | up to 10% | none |
| 1 | > 10 - 25% | slight |
| 2 | > 25 - 60% | moderate |
| 3 | > 60% | severe |
| 4 | | dead |

In order to discount background perturbations which might be considered minor, a defoliation of >10-25% is considered a warning stage, and a defoliation >25% is taken as a threshold for damage.

Therefore, in the present report a distinction has sometimes only been made between defoliation classes 0 and 1 (0-25% defoliation) on the one hand, and classes 2, 3 and 4 (defoliation >25%) on the other hand.

Classically, trees in classes 2, 3 and 4 are referred to as "damaged", as they represent trees with considerable defoliation. In the same way, the sample points are referred to as "damaged" if the mean defoliation of their trees (expressed as percentages) falls into class 2 or higher. Otherwise the sample point is considered as "undamaged". The most important results have been tabulated separately for all participating countries (called "all plots") and for the participating EU-Member States.

## 3.1.2 Results of the transnational crown condition survey in 2012

On each sampling point sample trees were selected according to national procedures and assessed for defoliation. According to Tab. 3.1.2-1 the defoliation assessment was carried out in 27 countries including 115,537 trees. The figures in Tab. 3.1.2-1 are not necessarily identical with those published in the reports of the past years since in case of a restructure of the national observation networks a resubmission of older data is possible.

**Table 3.1.2-1:** Number of sample trees from 2000 to 2012 according to the current data base

| Country | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 3,506 | 3,451 | 3,503 | 3,470 | 3,586 | 3,528 | 3,425 | | | | 3,087 | | |
| Belgium | 686 | 682 | 684 | 684 | 681 | 676 | 618 | 616 | 599 | 599 | 216 | 230 | 207 |
| Bulgaria | 4,197 | 4,174 | 3,720 | 3,836 | 3,629 | 3,592 | 3,510 | 3,569 | 3,304 | 5,560 | 5,569 | 5,583 | 5,608 |
| Cyprus | | 360 | 360 | 360 | 360 | 361 | 360 | 360 | 360 | 362 | 360 | 360 | 360 |
| Czech Republic | 3,475 | 3,475 | 3,500 | 3,500 | 3,500 | 3,450 | 3,425 | 3,300 | 3,400 | 3,325 | 3,300 | 3,400 | 3,375 |
| Denmark | 504 | 504 | 480 | 480 | 480 | 528 | 527 | 442 | 452 | 384 | 408 | 432 | 411 |
| Estonia | 2,160 | 2,136 | 2,169 | 2,228 | 2,201 | 2,167 | 2,191 | 2,209 | 2,196 | 2,202 | 2,348 | 2,372 | 2,348 |
| Finland | 8,576 | 8,579 | 8,593 | 8,482 | 11,210 | 11,535 | 11,489 | 11,199 | 8,812 | 7,182 | 7,946 | 4,217 | 4,676 |
| France | 10,317 | 10,373 | 10,355 | 10,298 | 10,219 | 10,129 | 9,950 | 10,079 | 10,138 | 9,949 | 10,584 | 11,111 | 11,268 |
| Germany | 13,722 | 13,478 | 13,534 | 13,572 | 13,741 | 13,630 | 10,327 | 10,241 | 10,347 | 10,088 | 10,063 | 9,635 | 9,917 |
| Greece | 2,192 | 2,168 | 2,144 | | | 2,054 | | | | 2,289 | 2,311 | | |
| Hungary | 1,488 | 1,469 | 1,446 | 1,446 | 1,710 | 1,662 | 1,674 | 1,650 | 1,661 | 1,668 | 1,626 | 1,702 | 1,655 |
| Ireland | 420 | 420 | 424 | 403 | 400 | 382 | 445 | 646 | 694 | 717 | 641 | | 489 |
| Italy | 7,128 | 7,350 | 7,165 | 6,866 | 7,109 | 6,548 | 6,936 | 6,636 | 6,579 | 6,794 | 8,338 | 8,454 | 5,507 |
| Latvia | 2,256 | 2,325 | 2,340 | 2,293 | 2,290 | 2,263 | 2,242 | 2,228 | 2,184 | 3,911 | 3,888 | 3,797 | 4,172 |
| Lithuania | 1,609 | 1,597 | 1,583 | 1,560 | 1,487 | 1,512 | 1,505 | 1,507 | 1,688 | 1,734 | 1,814 | 1,846 | 1,847 |
| Luxembourg | 96 | | 96 | 96 | 96 | 97 | 96 | 96 | 96 | | | | |
| Netherlands | 218 | 231 | 232 | 231 | 232 | 232 | 230 | | | 247 | 227 | | |
| Poland | 8,620 | 8,620 | 8,660 | 8,660 | 8,660 | 8,640 | 7,520 | 9,160 | 9,036 | 7,520 | 7,482 | 7,342 | 7,404 |
| Portugal | 4,470 | 4,500 | 4,530 | 4,260 | 4,170 | 3,749 | 3,719 | | | | | | |
| Romania | 5,640 | 5,568 | 5,544 | 5,544 | 5,424 | 5,496 | 5,472 | 5,232 | | 5,448 | 5,736 | 5,808 | 5,784 |
| Slovak Rep. | 5,157 | 5,054 | 5,076 | 5,116 | 5,058 | 5,033 | 4,808 | 4,910 | 4,956 | 4,944 | 4,831 | 5,218 | 4,888 |
| Slovenia | 984 | 984 | 936 | 983 | 1,006 | 1,056 | 1,069 | 1,056 | 1,056 | 1,056 | 1,052 | 1,057 | 1,053 |

| Country | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spain | 14,880 | 14,880 | 14,880 | 14,880 | 14,880 | 14,880 | 14,880 | 14,880 | 14,880 | 14,880 | 14,880 | 14,880 | 14,880 |
| Sweden | 11,361 | 11,283 | 11,278 | 11,321 | 11,255 | 11,422 | 11,186 | | | 2,591 | 2,742 | 2,057 | 1,991 |
| United Kingdom | 2,136 | 2,064 | 2,064 | 2,064 | 2,040 | 2,016 | 1,968 | 768 | | | 1,803 | | |
| **EU** | **115,798** | **115,725** | **115,296** | **112,633** | **115,424** | **116,638** | **109,572** | **90,784** | **82,438** | **93,450** | **101,252** | **89,501** | **87,840** |
| Andorra | | | | | 72 | | 74 | 72 | 72 | 73 | 72 | 72 | 72 |
| Belarus | 9,763 | 9,761 | 9,723 | 9,716 | 9,682 | 9,484 | 9,373 | 9,424 | 9,438 | 9,615 | 9,617 | 9,583 | |
| Croatia | 1,991 | 1,941 | 1,910 | 1,869 | 2,009 | 2,046 | 2,109 | 2,013 | 2,015 | 1,991 | 1,992 | 2,208 | 2,400 |
| Rep. of Moldova | 234 | 234 | | | | | | | | | | | |
| Montenegro | | | | | | | | | | | 1,176 | 1,176 | 1,176 |
| Norway | 4,051 | 4,304 | 4,444 | 4,547 | 5,014 | 5,319 | 5,525 | 5,824 | 6,085 | 6,014 | 6,330 | 6,463 | 6,542 |
| Russia | | | | | | | | | | 11,016 | 8,958 | 9,275 | |
| Serbia | | | | 2,274 | 2,915 | 2,995 | 2,902 | 2,860 | 2,788 | 2,752 | 2,786 | 2,742 | 2,782 |
| Switzerland | 855 | 834 | 827 | 806 | 748 | 807 | 812 | 790 | 773 | 801 | 795 | 1,105 | 1,122 |
| Turkey | | | | | | | | 941 | 9,291 | 13,156 | 12,974 | 13,282 | 13,603 |
| **Total** | **132,692** | **132,799** | **132,200** | **131,845** | **135,864** | **137,289** | **130,367** | **112,708** | **112,900** | **138,868** | **145,952** | **135,407** | **115,537** |

The main results summarized in Tab. 3.1.2-2 show that the mean defoliation of all trees assessed in Europe and used in the analysis was 19.7%. Broadleaved trees showed a higher mean defoliation (22.4%) than conifers (19.3%). The spatial distribution of the two species groups depicted in Annex I-1 shows that in 2012 60.1% of the plots were dominated by coniferous and 39.9% by broadleaved trees.

**Table 3.1.2-2:** Percentages of trees in defoliation classes and mean defoliation for broadleaves, conifers and all species

| | | Percentages of tres in defoliation classes | | | | | | | Defoliation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Species | 0-10 | >10-25 | **0-25** | >25-60 | >60 | dead | **>25** | **mean** | **median** | **no of trees** |
| EU | **broadleaves** | 25.5 | 45.0 | **70.5** | 25.4 | 2.9 | 1.2 | **29.5** | 23.6 | 20 | **41 465** |
| | **conifers** | 29.9 | 48.5 | **78.4** | 19.4 | 1.5 | 0.7 | **21.6** | 20.2 | 15 | **45 011** |
| | **all species** | 27.8 | 46.9 | **74.6** | 22.3 | 2.2 | 0.9 | **25.4** | **21.8** | **20** | **86 476** |
| Total Europe | Fagus sylv. | 36.3 | 41.6 | **77.9** | 20.1 | 1.4 | 0.7 | **22.1** | 19.6 | 15 | **11 346** |
| | Decid. Temp. Oak | 17.6 | 43.6 | **61.2** | 34.9 | 3.0 | 0.8 | **38.8** | 26.5 | 25 | **8 683** |
| | Med. Decid. Oak | 25.0 | 44.7 | **69.7** | 25.1 | 3.2 | 2.0 | **30.3** | 24.6 | 20 | **7 562** |
| | Med. Evergr. Oak | 10.6 | 59.9 | **70.5** | 25.6 | 3.6 | 0.3 | **29.5** | 25.2 | 20 | **4 604** |
| | **broadleaves** | 29.4 | 43.9 | **73.3** | 22.9 | 2.6 | 1.2 | **26.7** | **22.4** | **20** | **54 456** |
| | Pinus sylvestris | 30.2 | 52.0 | **82.2** | 16.1 | 1.2 | 0.5 | **17.8** | 19.3 | 15 | **15 774** |
| | Picea abies | 41.3 | 34.0 | **75.2** | 22.0 | 1.9 | 0.8 | **24.8** | 19.2 | 15 | **21 869** |
| | Med. lowland pines | 20.9 | 64.2 | **85.2** | 12.0 | 1.1 | 1.7 | **14.8** | 20.7 | 15 | **15 774** |
| | **conifers** | 33.8 | 46.8 | **80.6** | 17.1 | 1.5 | 0.8 | **19.4** | **19.3** | **15** | **59 857** |
| | **all species** | 31.7 | 45.4 | **77.1** | 19.8 | 2.0 | 1.0 | **22.9** | **19.7** | **15** | **114 313** |

The maps in Annex I-2 and Annex I-3 indicate that defoliation is highest on plots located in central and southern Europe. The largest shares (55.3%) are plots with mean defoliation ranging from 11 to 25%. The percentage of trees damaged, i.e. trees defoliated by 25% and more, is relatively low in northern Europe, whereas clusters of severely damaged trees are found in some parts of the Czech Republic, France and Bulgaria (Annex I-2).

For the 5% defoliation classes including dead trees a frequency distribution was calculated. Fig. 3.1.2-1 indicates that about 20% of all species were defoliated by 15%. More conifers than broadleaves in 2012 fell in defoliation classes of up to 20%, whereas deciduous trees are more frequently represented in defoliation classes above 20%.

In addition to the evaluation by tree species crown condition data were also evaluated according to the European Forest Types (EFT) described in Tab. 3.1.1-2 of this report. As indicated in Tab. 3.1.2-3 the highest mean defoliation was found in the broadleaved evergreen forests (25.7%), corresponding with the high share of trees defoliated by 25% and more. Also high mean defoliation was calculated for mesophytic deciduous forests (25.2%). The values of mean defoliation of the most forest types vary between 19 and 21%. Apart from the rarely occurring mire and swamp forest, the healthiest trees in terms of mean defoliation are found in boreal forests with mean defoliation of 16.3% and a percentage of healthy trees of 47%.

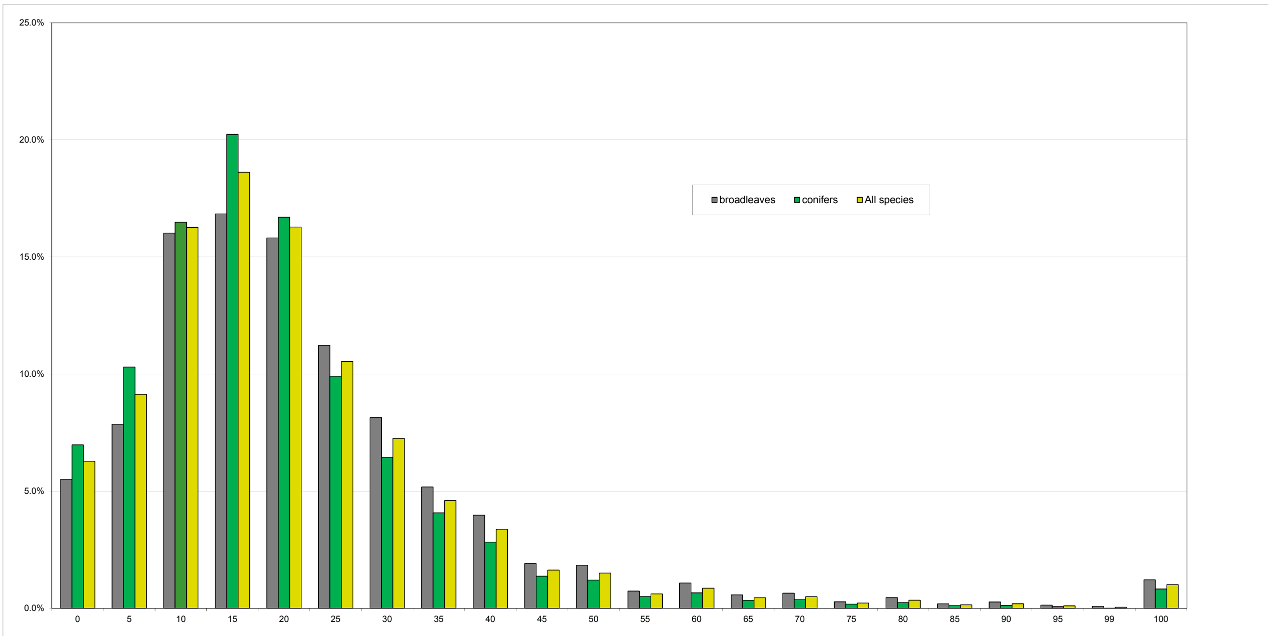


**Figure 3.1.2-1:** Relative frequency distribution of all trees assessed in 2012 in 5% defoliation steps

In view of the species richness (about 130) recorded within the transnational forest monitoring only the most abundant species could be evaluated. For other, also important but less abundant species the following groups were created and evaluated in this report:

- **Deciduous temperate oak:** (*Quercus robur* and *Q. petraea*) accounting together for 6.7% of the assessed trees,
- **Mediterranean lowland pines:** (*Pinus brutia, P. pinaster, P. halepensis* and *P. pinea*) accounting together for 6.1% of the assessed trees,
- **Deciduous (sub-) temperate oak:** (*Quercus frainetto, Q. pubescens, Q. pyrenaica* and *Q. cerris*) accounting together for 5.5% of the assessed trees,
- **Evergreen oak:** (*Quercus coccifera, Q. ilex, Q. rotundifolia* and *Q. suber*) accounting together for 3.9% of the assessed trees.

For all evaluations related to a particular tree species a criterion had to be set up to decide if a given plot represents this species or not. This criterion was that the number of trees of the particular species had to be three or more per plot. The mean plot defoliation for the particular species was then calculated as the mean defoliation of the trees of the species on that plot based on sample size N ≥ 3.

**Table 3.1.2-3:** Percentages of trees in defoliation classes and mean defoliation according to European Forest Types (EFT)

| Forest type | Percentage of trees in defoliation class | | | | | | | mean defoliation |
|---|---|---|---|---|---|---|---|---|
| | 0-10 | >10-25 | 0-25 | >25-60 | >60 | dead | >25 | |
| Boreal forest | 47.0 | 37.8 | **84.7** | 12.6 | 2.3 | 0.4 | **15.3** | 16.3 |
| Hemiboreal forest and nemoral coniferous and mixed broadleaved-coniferous forest | 25.7 | 51.0 | **76.7** | 21.8 | 1.0 | 0.6 | **23.3** | 20.9 |
| Alpine coniferous forest | 26.4 | 41.6 | **68.0** | 28.7 | 2.2 | 1.1 | **32.0** | 23.4 |
| Acidophilous aok and oak-birch forest | 19.0 | 52.5 | **71.5** | 25.2 | 2.5 | 0.7 | **28.5** | 23.8 |
| Mesophytic deciduous forest | 20.7 | 44.0 | **64.7** | 31.6 | 3.1 | 0.6 | **35.3** | 25.2 |
| Beech forest | 40.2 | 37.3 | **77.5** | 20.8 | 1.4 | 0.3 | **22.5** | 18.6 |
| Mountainous beech forest | 34.7 | 42.8 | **77.5** | 20.3 | 1.9 | 0.3 | **22.5** | 20.0 |
| Thermophilous deciduous forest | 26.0 | 42.2 | **68.2** | 26.5 | 3.6 | 1.6 | **31.8** | 24.6 |
| Broadleaved evergreen forest | 9.7 | 59.8 | **69.5** | 26.1 | 4.1 | 0.3 | **30.5** | 25.7 |
| Coniferous forests of the Mediterranean Anatolian and Macaronesian regions | 21.2 | 59.9 | **81.1** | 15.2 | 2.3 | 1.3 | **18.9** | 21.7 |
| Mire and swamp forest | 52.8 | 42.7 | **95.5** | 2.1 | 0.0 | 2.4 | **4.5** | 14.1 |
| Floodplain forest | 40.4 | 37.7 | **78.1** | 18.2 | 1.3 | 2.5 | **21.9** | 19.9 |
| Non riverine alder, birch, or aspen forests | 38.7 | 42.5 | **81.2** | 15.9 | 1.9 | 1.0 | **18.8** | 19.0 |
| Plantations and selv-self-sown exotic forest | 40.2 | 35.5 | **75.7** | 19.6 | 2.9 | 1.8 | **24.3** | 20.5 |

In Fig. 3.1.2-2 to 3.1.2-8 mean plot defoliation for *Pinus sylvestris*, *Picea abies*, *Fagus sylvatica* and the four species groups **Deciduous temperate oak, Mediterranean lowland pines, Deciduous (sub-) temperate oak and Evergreen oak** (see above) is mapped. The spatial distribution of these species and species groups will be described in relation to Tab. 3.1.2-2. According to this table the highest level of mean defoliation had deciduous temperate oaks (26.5%) with 10.9% of moderate damaged plots evenly scattered over the area of their occurrence (Fig. 3.1.2-6). Relatively slight damaged among broadleaves is *Fagus sylvatica* showing a mean defoliation of 19.6%. Clustered occurrence of severely damaged *Fagus sylvatica* plots is in Germany (Fig. 3.1.2-5).

For the evergreen oaks a mean defoliation of 25.2% (Tab. 3.1.2-2) was calculated but the majority of the plots namely 59.8% have a mean defoliation lying between 11 and 25% (Fig. 3.1.2-8).

The mean defoliation value of *Pinus sylvestris* is rather low (19.3%). The spatial distribution of the plots defoliated by 26 to 40% displays clusters in central Europe, whereas healthy plots (0-10% defoliation) can mostly be found in Scandinavia (Fig. 3.1.2-2).

The mean defoliation of *Picea abies* (19.2%) is comparable with that of *Pinus sylvestris.* Also the distribution of the plots show similar spatial pattern with relatively healthy *Picea abies* plots concentrated in Northern Europe (Fig. 3.1.2-3).

The mean defoliation of the Mediterranean lowland pines was 20.7% with several plots in southern France defoliated between 40 and 60% (Fig. 3.1.2-4).

In the group of deciduous (sub-) Mediterranean oaks the most affected plots are in southern Europe. The share of plots in this species group showing negligible signs of crown transparency is 10.5% (Fig. 3.1.2-7).

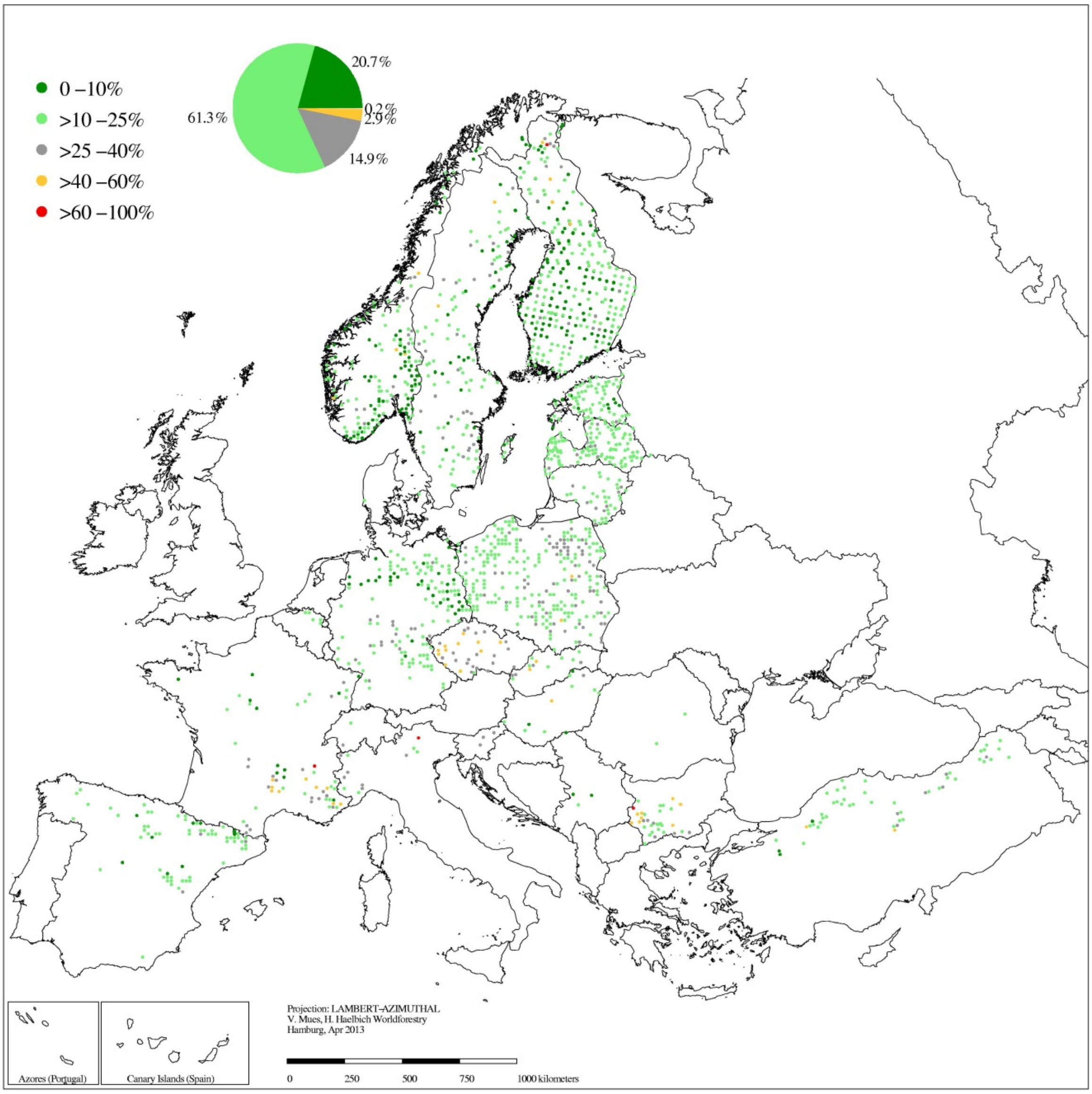


**Figure 3.1.2-2**: Mean plot defoliation for *Pinus sylvestris* (2012)

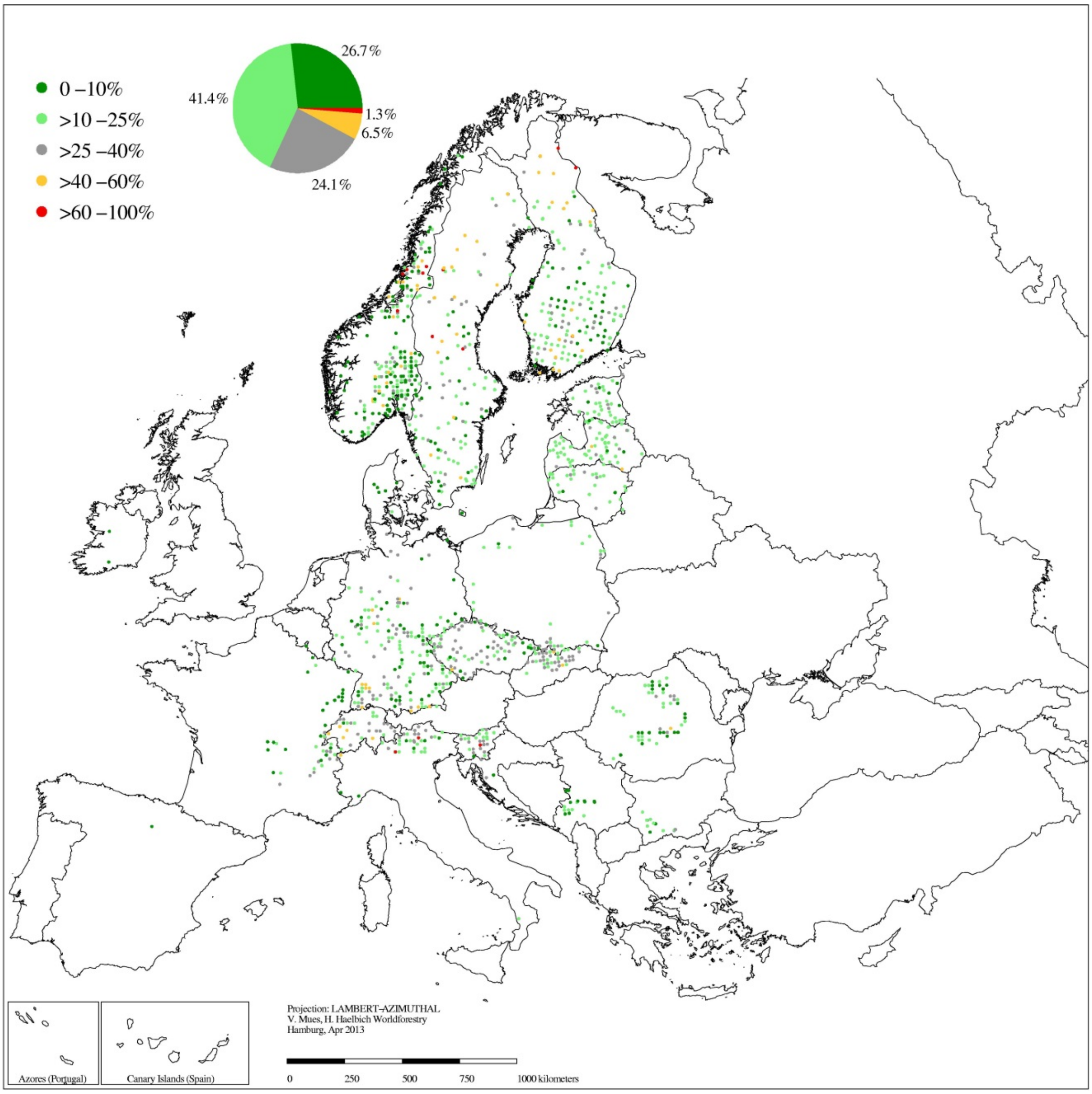


**Figure 3.1.2-3**: Mean plot defoliation for *Picea abies* (2012)

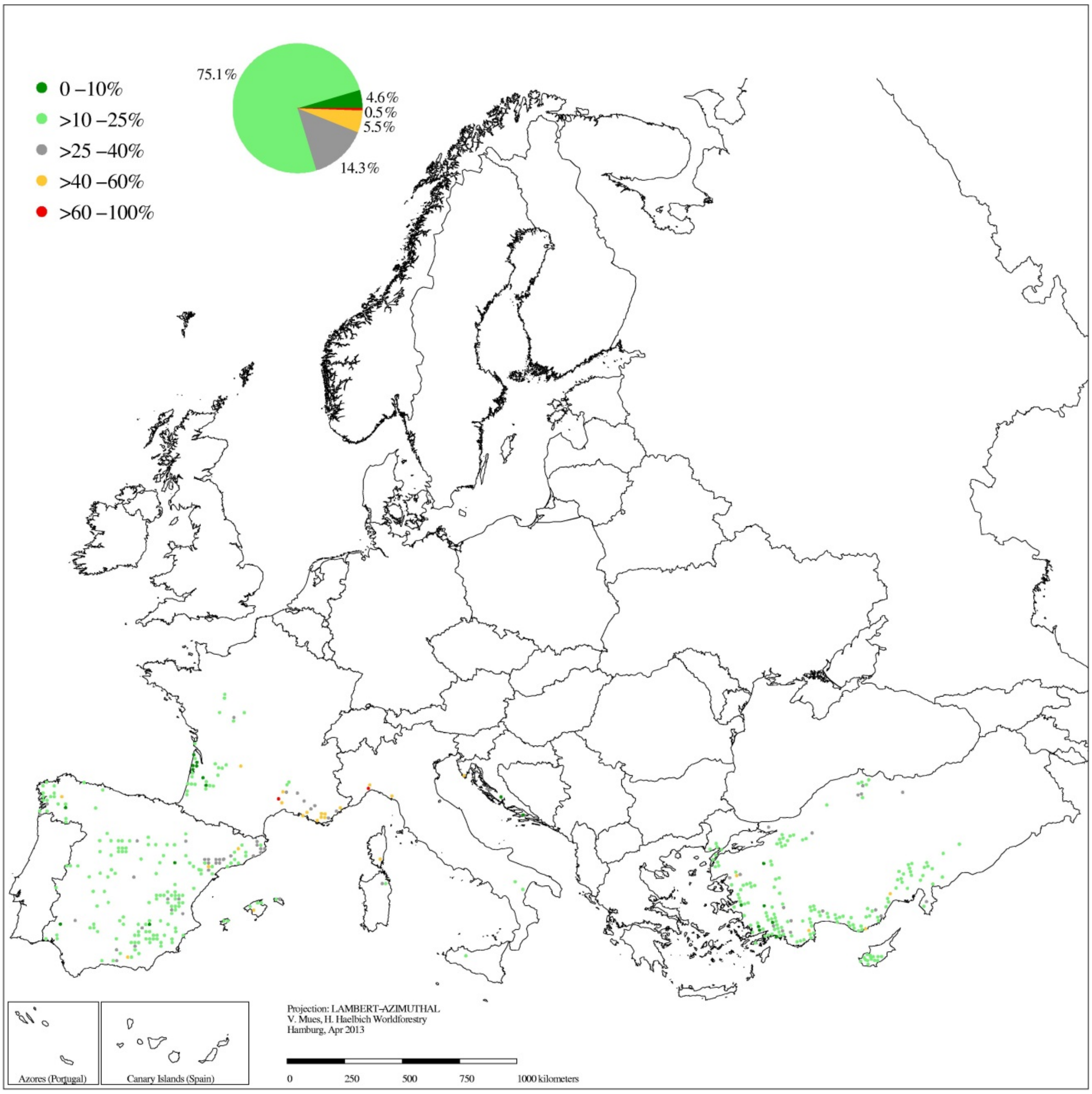


**Figure 3.1.2-4**: Mean plot defoliation for Mediterranean lowland pine *(Pinus brutia, Pinus halepensis, Pinus pinaster, Pinus pinea),* 2012

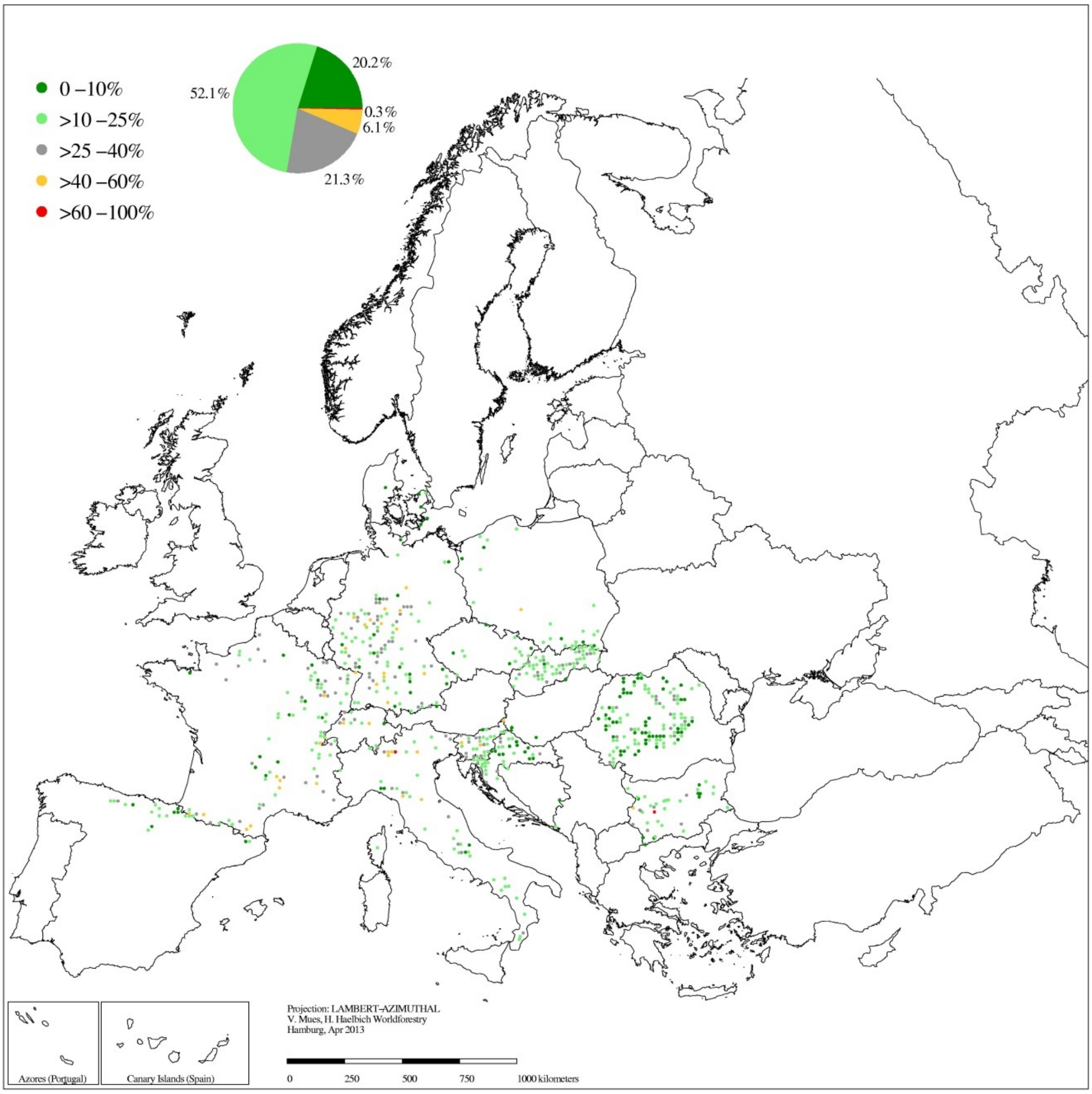


**Figure: 3.1.2-5**: Mean plot defoliation for *Fagus sylvatica* (2012)

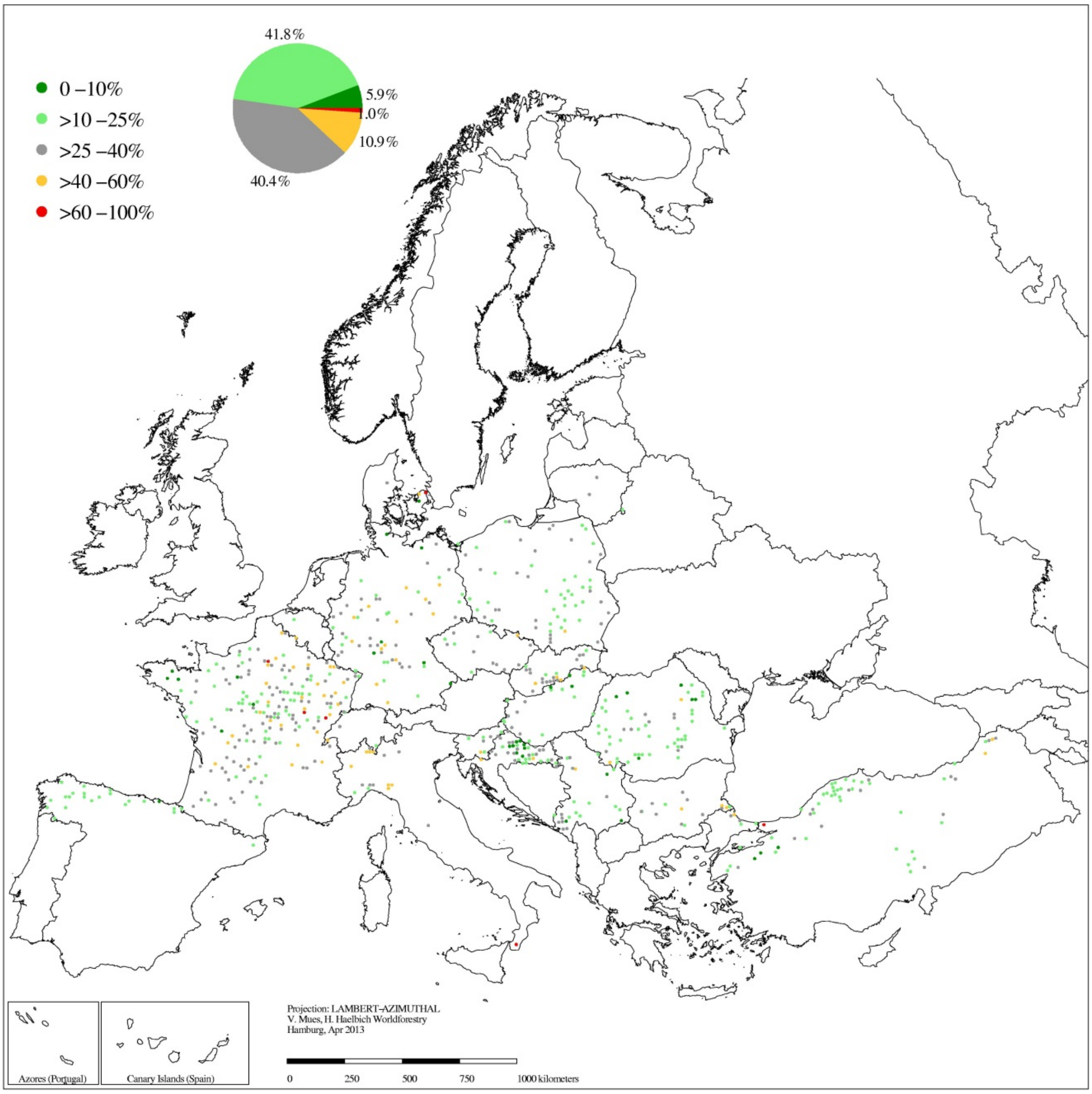


**Figure 3.1.2-6**: Mean plot defoliation for deciduous temperate oak *(Quercus petraea and Quercus robur),* 2012

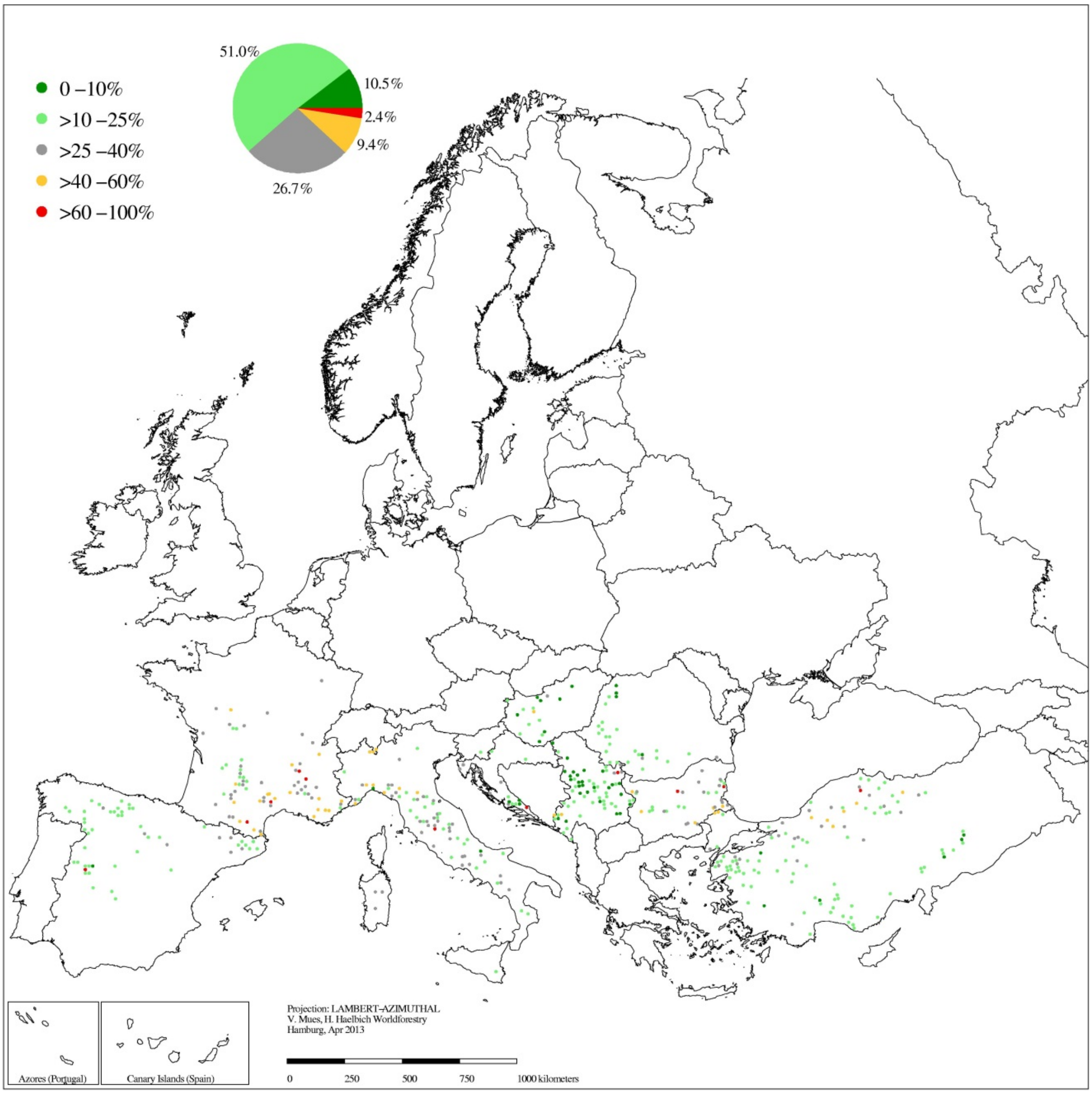


**Figure 3.1.2-7**: Mean plot defoliation for deciduous (sub-) Mediterranean oak (*Quercus cerris, Quercus frainetto, Quercus pubescens, Quercus pyrenaica*), 2012

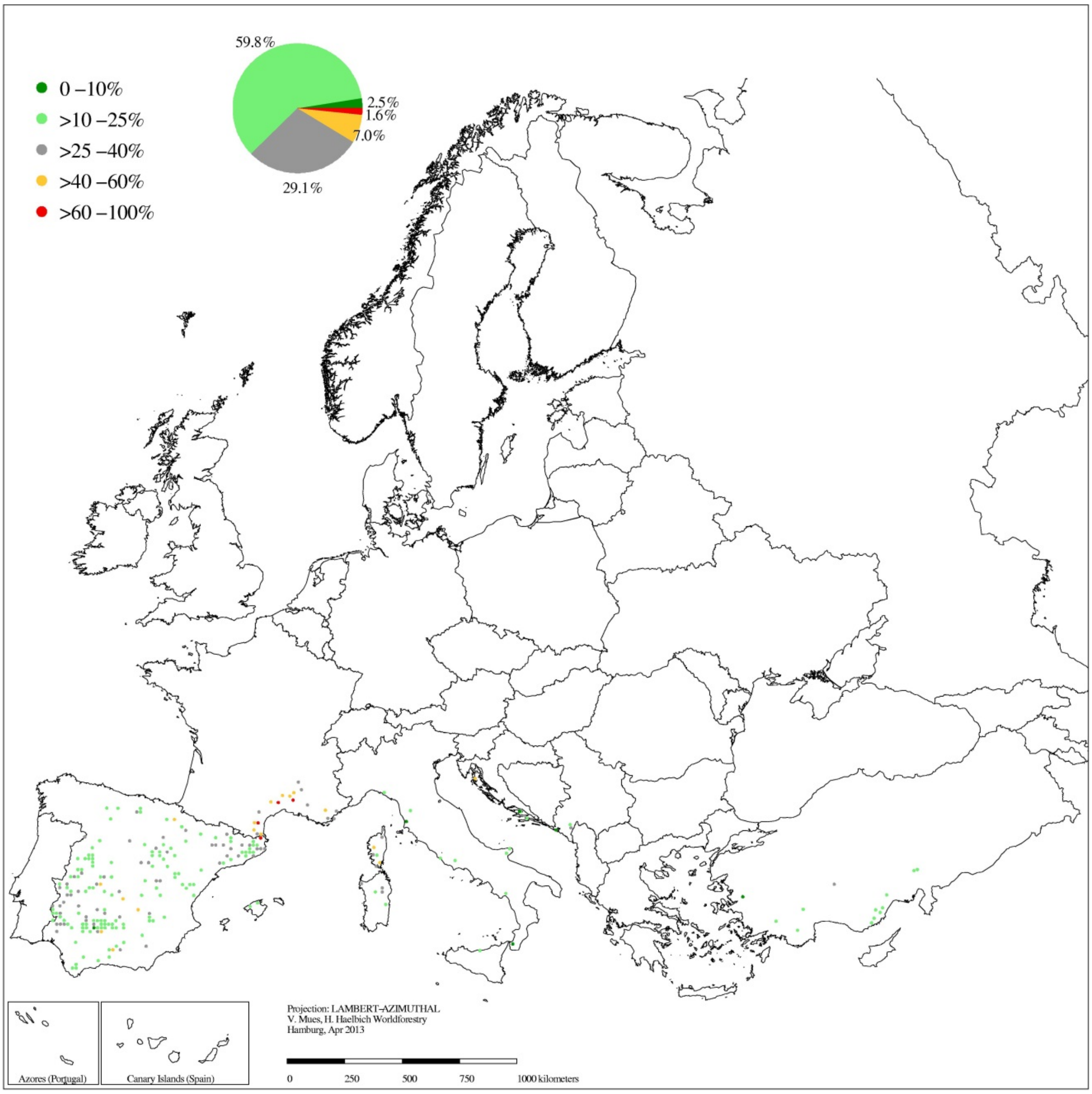


**Figure 3.1.2-8**: Mean plot defoliation for evergreen oak (Quercus coccifera, Quercus ilex, Quercus rotundifolia, Quercus suber, 2012

## 3.1.3 Defoliation trends: time series

The development of defoliation is calculated assuming that the sample trees of each survey year reflect the influence of forest conditions. Studies carried out in the past years show that the fluctuation of trees in this sample (due to the exclusion of dead and felled trees as well as inclusion of replacement trees) does not cause bias or other distortions of the results over the years. However, fluctuations due to the inclusion of newly participating countries must be excluded, because forest condition among countries can deviate greatly. For this reason, the development of defoliation can only be calculated for defined sets of countries. Different lengths of time series require different sets of countries, because at the beginning of the surveys the number of participating countries was much smaller than it is today.

For the present evaluation the following three time periods and the following countries were selected for tracing the development of defoliation:

- **Period 1993-2012 ("long term period")**: Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Latvia, Lithuania, Norway, Poland, Slovak Republic, Slovenia, Spain, Switzerland
- **Period 1998-2012 ("many countries"):** Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Latvia, Lithuania, Norway, Poland, Slovak Republic, Slovenia, Spain and Switzerland.
- **Period 2002-2012 ("short term period used to calculate the trend of the mean plot defoliation"):** Belgium, Bulgaria, Croatia, Czech Republic, Cyprus, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Latvia, Lithuania, Norway, Poland, Slovak Republic, Slovenia, Spain, and Switzerland.

Several countries could not be included in one of the three time periods because of changes in their tree sample sizes, their assessment methods or missing assessments in certain years. Development of defoliation is presented for the periods 1993-2012 and 1998-2012 in graphs and in tables. Graphs show the fluctuations of mean defoliation and shares of trees in defoliation classes over time.

The maps depict trends in mean defoliation from 2002-2012. Whereas all plots of the countries mentioned above are included for the two respective time periods in graphs, the maps of the trend analysis only represent plots within these countries that were included in all of the surveys. In the last years plots were shifted within Finland and parts of northern Germany (Brandenburg). These plots are not depicted in the maps but the countries are included in the time series calculation.

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

Besides the temporal development, also the change in the results from 2011 to 2012 was calculated. In this case, changes in mean defoliation per plot are called 'significant' only if the significance at the 95% probability level was proven in a statistical test.

The spatial pattern of the changes in mean defoliation from 2011 to 2012 across Europe is shown in Annex I-4. On 78.7% of the plots between 2011 and 2012 no statistical significant differences in mean plot defoliation were detected. The share of plots with increasing defoliation was 13.8%, the share of plots with a decrease 7.5%.

### 3.1.3.1 All species

For all species, the two time series show very similar trends for mean defoliation due to the fact that the countries included in the short time series were also included in the evaluation of the long time series (Fig. 3.1.3.1-1 and Fig. 3.1.3.1-2). For *evergreen oak* and *Mediterranean lowland pines* there was hardly any difference in sample sizes on which evaluations of the different time series were based. The largest differences occurred for *Fagus sylvatica* with sample sizes for the long time series being 11% smaller than that of the shorter time series.

Since 1993 mean defoliation of the evaluated tree species developed very differently. With the exception of *Picea abies* and *Pinus sylvestris*, all tree species showed a sharp increase in mean defoliation in the first years of the study. Mean defoliation of *Picea abies*, *Fagus sylvatica* and the deciduous temperate oaks reached largest values after the extremely dry and warm summer in 2003. In all samples studied, deciduous temperate oaks exhibited the highest mean defoliation over the last decade. In contrast, *Pinus sylvestris* clearly showed the lowest mean defoliation from all evaluated species.

Trends in mean plot defoliation for all tree species for the period 2002-2012 are mapped in Fig. 3.1.3.1-3. The percentage of plots with clearly increasing defoliation (17.2%) exceeds the share of plots with decreasing defoliation (12.5%). Plots showing deterioration are scattered across Europe, but their share is particularly high in southern France, at the eastern edge of the Pyrenean Mountains, in the Czech Republic, and in north eastern Italy.

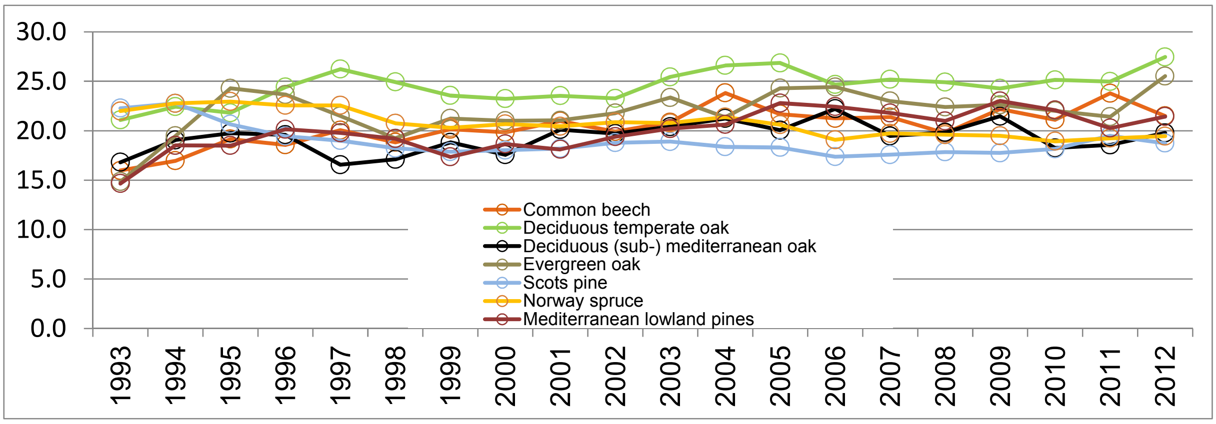


**Figure 3.1.3.1-1:** Mean defoliation (%) of main species 1993-2012

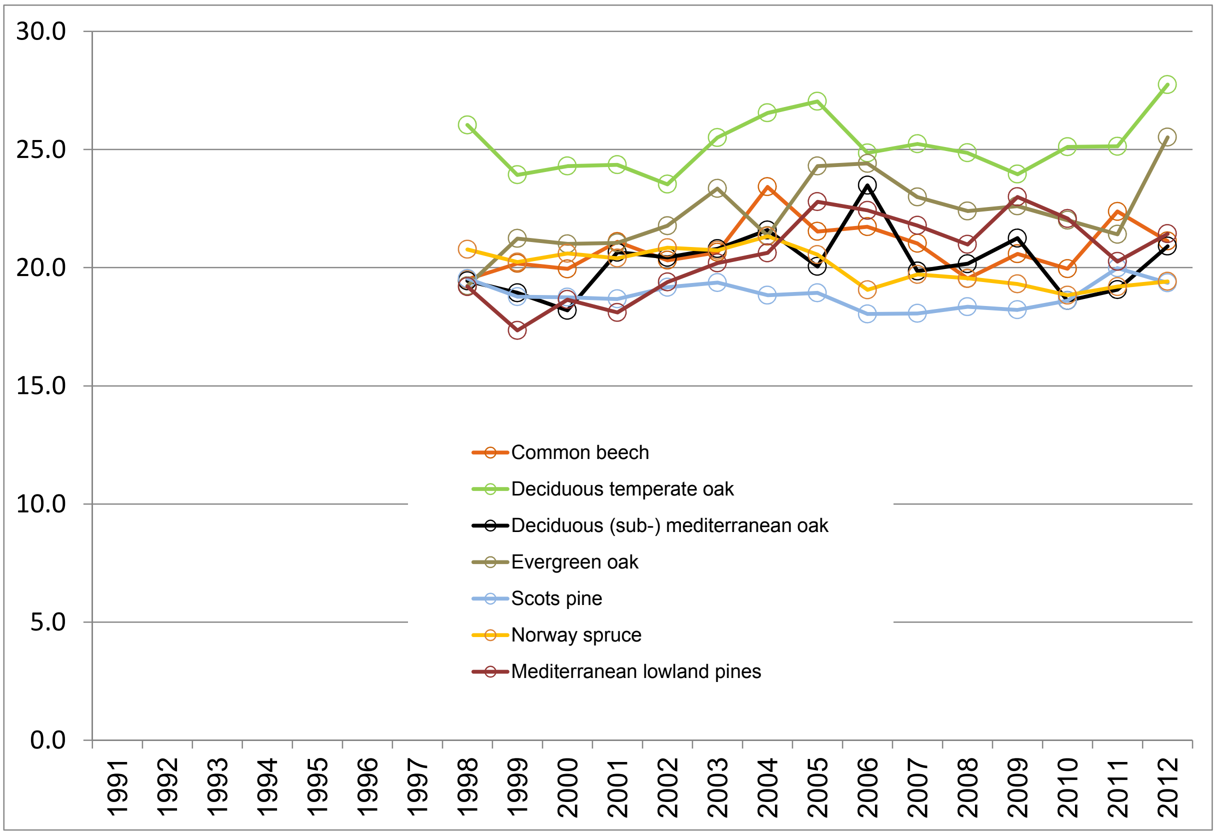


**Figure 3.1.3.1-2:** Mean defoliation (%) of main species 1998-2012

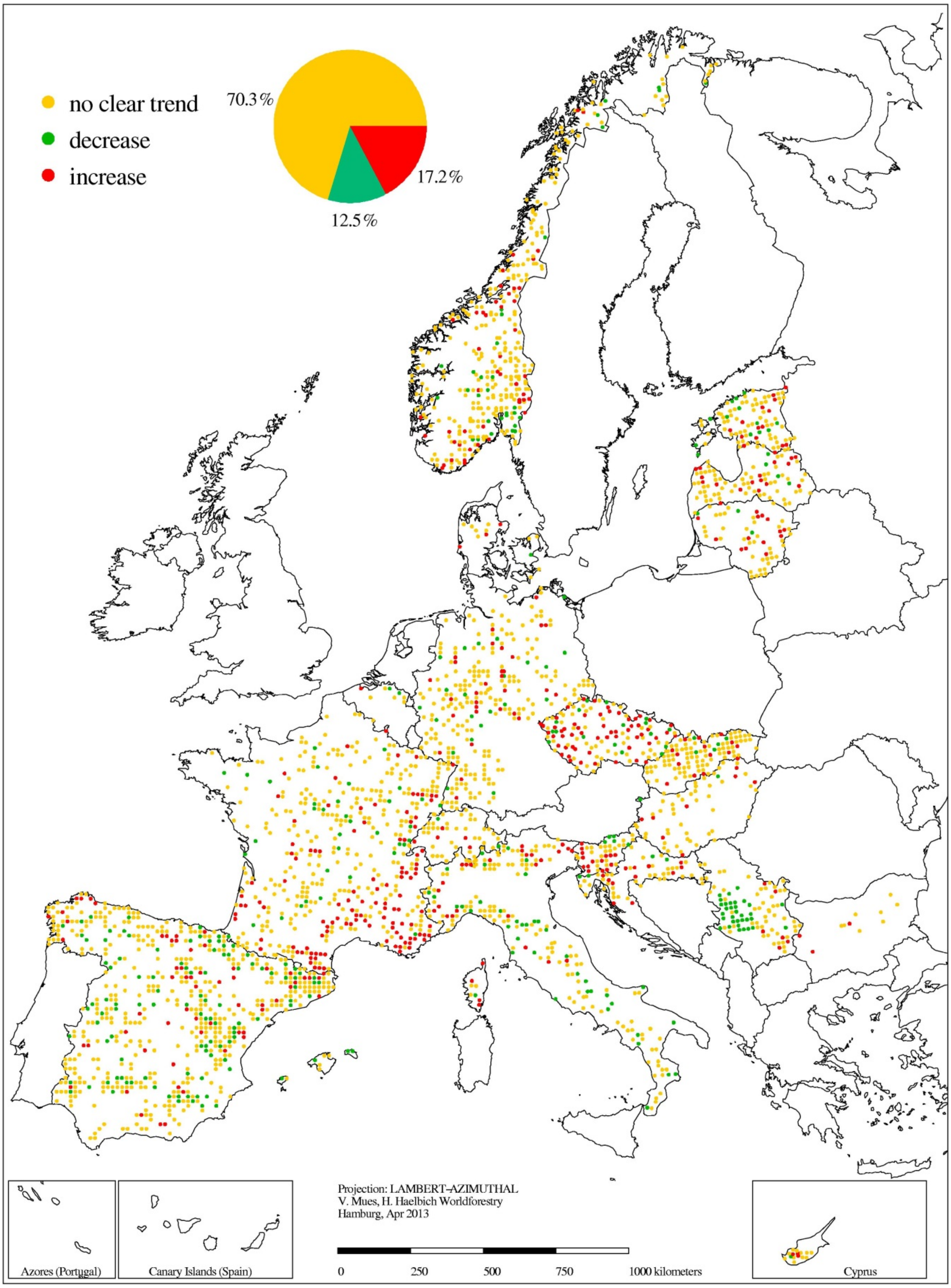


**Figure 3.1.3.1-3:** Development of mean plot defoliation (slope of linear regression) of all species over the years 2002 – 2012

## 3.1.3.2 Pinus sylvestris

*Pinus sylvestris* is the most common tree species in Europe. The area of its occurrence spreads from Scandinavia to the Mediterranean region. When considering the time series from 1993 on, the mean defoliation has decreased until 2006. Afterwards the mean defoliation rose at moderate level reaching a maximum in 2011. It fell off in 2012 below 20%. In both time periods the percentage of healthy pines (0-10%) increased and the share of damaged trees (>25%) decreased (Tab. 3.1.3.2-1, Fig. 3.1.3.2-1, Fig. 3.1.3.2-2). Between 2011 and 2012 the share of trees damaged decreased in both time series.

Considered spatially (Fig. 3.1.3.2-3), the only region showing a high share of deteriorated plots lies in the western part of the Czech Republic. For most plots no signs of positive or negative trends in the development of crown condition can be seen. The share of pines exhibiting deteriorated crown development since 2002 (16.8%) exceeds the positive trend (12.2%).

**Table 3.1.3.2-1:** Shares of trees in different defoliation classes

| | N Trees | 0-10% | >10-25% | >25% |
|---|---|---|---|---|
| **1993** | 20572 | 29.0 | 39.2 | 31.8 |
| **1994** | 19919 | 28.2 | 38.5 | 33.3 |
| **1995** | 22128 | 33.9 | 38.6 | 27.5 |
| **1996** | 22195 | 35.7 | 41.7 | 22.5 |
| **1997** | 22229 | 35.0 | 44.0 | 21.0 |
| **1998** | 22597 | 36.1 | 45.7 | 18.1 |
| **1999** | 22858 | 36.3 | 47.0 | 16.7 |
| **2000** | 22819 | 35.9 | 47.5 | 16.5 |
| **2001** | 22947 | 34.5 | 49.3 | 16.2 |
| **2002** | 22871 | 32.2 | 50.6 | 17.2 |
| **2003** | 22901 | 31.1 | 51.8 | 17.1 |
| **2004** | 24587 | 34.8 | 48.1 | 17.0 |
| **2005** | 24846 | 36.2 | 46.3 | 17.5 |
| **2006** | 22258 | 38.6 | 46.4 | 15.0 |
| **2007** | 22866 | 36.7 | 48.6 | 14.6 |
| **2008** | 21344 | 35.4 | 49.2 | 15.5 |
| **2009** | 19704 | 36.9 | 47.2 | 15.9 |
| **2010** | 20907 | 35.9 | 48.0 | 16.1 |
| **2011** | 18643 | 30.3 | 50.6 | 19.1 |
| **2012** | 18956 | 30.7 | 52.7 | 16.6 |

| | N Trees | 0-10% | >10-25% | >25% |
|---|---|---|---|---|
| **1998** | 24074 | 34.5 | 44.1 | 21.4 |
| **1999** | 24117 | 35.1 | 45.9 | 18.9 |
| **2000** | 23800 | 35.0 | 47.0 | 18.1 |
| **2001** | 23915 | 34.2 | 48.6 | 17.3 |
| **2002** | 23775 | 31.7 | 50.1 | 18.2 |
| **2003** | 24062 | 30.1 | 51.6 | 18.3 |
| **2004** | 25589 | 33.9 | 47.6 | 18.5 |
| **2005** | 25768 | 35.1 | 45.9 | 19.0 |
| **2006** | 23062 | 37.5 | 46.1 | 16.4 |
| **2007** | 23662 | 35.7 | 48.5 | 15.8 |
| **2008** | 22141 | 34.3 | 48.9 | 16.7 |
| **2009** | 20705 | 35.7 | 47.2 | 17.1 |
| **2010** | 22025 | 34.7 | 48.1 | 17.2 |
| **2011** | 19761 | 29.3 | 50.4 | 20.3 |
| **2012** | 20074 | 29.7 | 52.3 | 18.1 |

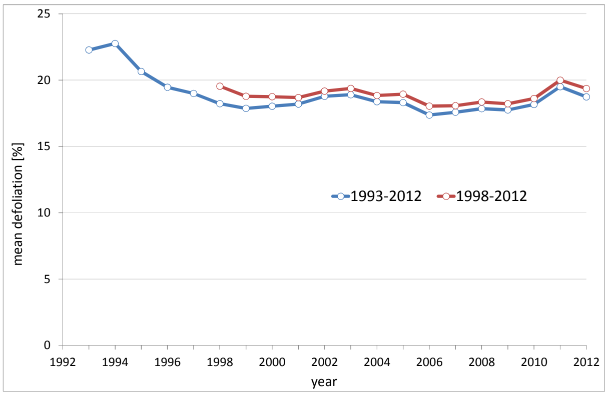


**Figure 3.1.3.2-1:** Mean defoliation in two periods (1993-2012 and 1998-2012)

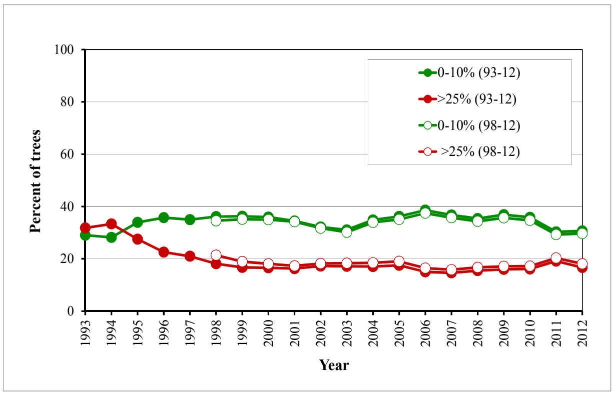


**Figure 3.1.3.2-2:** Shares of trees of defoliation 0-10% and >25% in two periods (1993-2012 and 1998-2012)

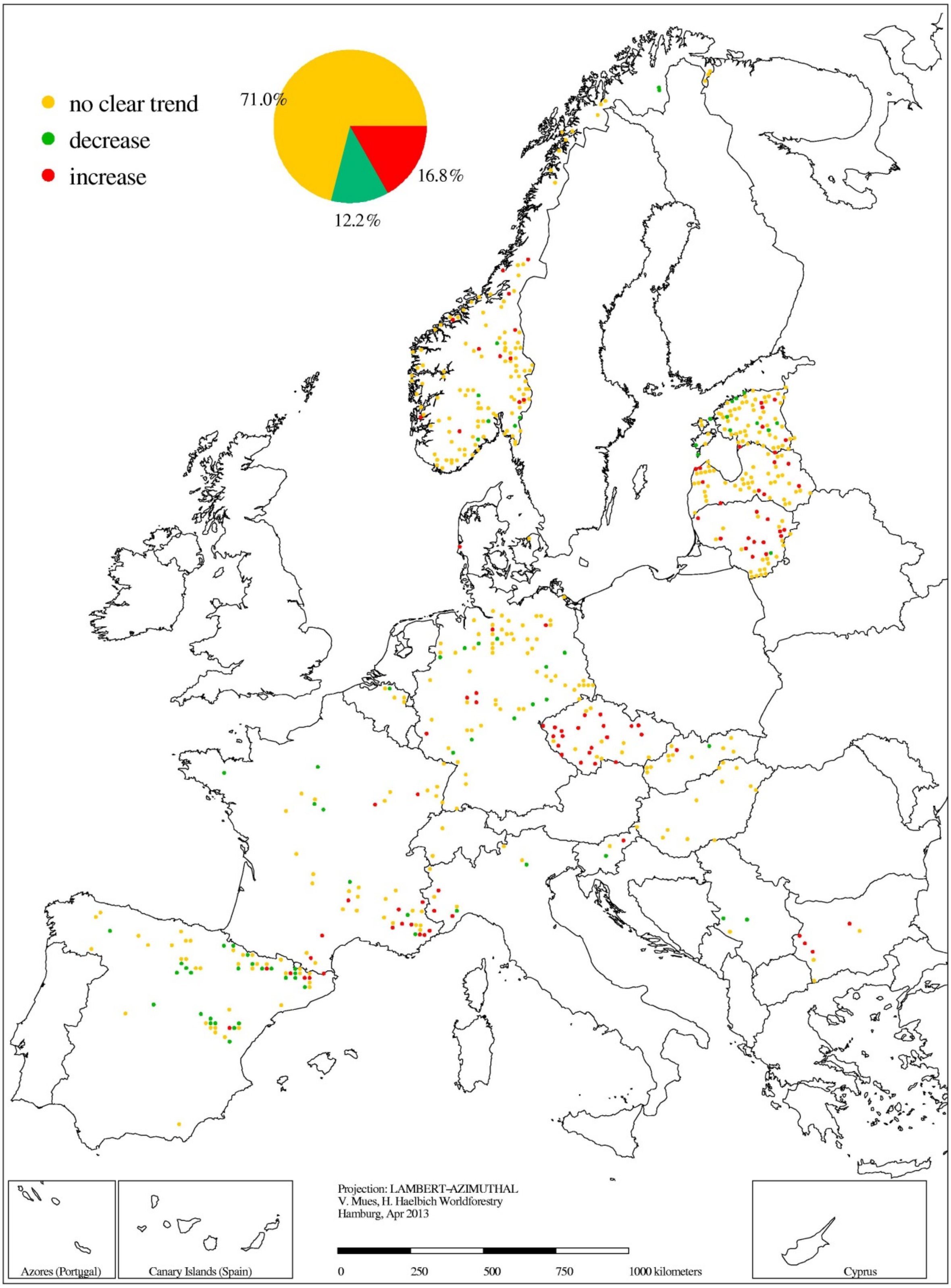


**Figure 3.1.3.2-3:** Development of mean plot defoliation (slope of linear regression) of *Pinus sylvestris* over the years 2002-2012

## 3.1.3.3 Picea abies

*Picea abies* is the second most frequently occurring species in the large scale tree sample. Its area extends from Scandinavia to northern Italy.

The crown condition of *Picea abies* slight-ly improved over both observation peri-ods. Due to extreme weather conditions the mean defoliation went up in 2004. Until 2006 a recuperation phase was ob-served. Since then the level of the crown condition remained more or less stable (Tab. 3.1.3.3-1, Fig. 3.1.3.3-1, Fig. 3.1.3.3-2).

Since 2006 the proportion of healthy trees (0-10%) increased permanently. Significant improvements in the crown condition of spruce were observed in 2001 and 2010.

Between 2002 and 2012 no clear trend was observed for 64.8% plots. In this time period a deterioration of crown condition occurred on 24.2% of the plots. The share of the plots showing positive trend in crown condition between 2002 and 2012 is 11% (Fig. 3.1.3.3-3).

**Table 3.1.3.3-1:** Shares of trees in different defoliation classes

| | N Trees | 0-10% | >10-25% | >25% |
|---|---|---|---|---|
| **1993** | 15366 | 32.7 | 35.9 | 31.3 |
| **1994** | 15617 | 31.1 | 34.7 | 34.2 |
| **1995** | 17285 | 32.3 | 32.9 | 34.7 |
| **1996** | 17148 | 33.0 | 31.3 | 35.7 |
| **1997** | 16945 | 30.6 | 33.4 | 36.0 |
| **1998** | 16435 | 34.9 | 35.5 | 29.5 |
| **1999** | 16834 | 36.0 | 35.9 | 28.1 |
| **2000** | 16821 | 34.4 | 37.1 | 28.5 |
| **2001** | 16612 | 33.8 | 38.1 | 28.1 |
| **2002** | 16683 | 33.1 | 37.9 | 29.0 |
| **2003** | 16743 | 32.8 | 38.9 | 28.3 |
| **2004** | 17277 | 32.4 | 36.4 | 31.2 |
| **2005** | 16959 | 33.5 | 37.7 | 28.8 |
| **2006** | 15055 | 39.4 | 34.9 | 25.8 |
| **2007** | 14746 | 37.2 | 36.1 | 26.7 |
| **2008** | 14524 | 37.9 | 35.5 | 26.7 |
| **2009** | 13823 | 38.5 | 35.1 | 26.4 |
| **2010** | 14686 | 40.1 | 35.0 | 24.9 |
| **2011** | 13581 | 40.2 | 34.0 | 25.7 |
| **2012** | 13446 | 39.6 | 34.6 | 25.8 |

| | N Trees | 0-10% | >10-25% | >25% |
|---|---|---|---|---|
| **1998** | 16573 | 35.1 | 35.5 | 29.4 |
| **1999** | 17006 | 36.3 | 35.8 | 27.9 |
| **2000** | 16984 | 34.6 | 37.1 | 28.3 |
| **2001** | 16735 | 34.0 | 38.1 | 27.9 |
| **2002** | 16776 | 33.1 | 38.0 | 28.9 |
| **2003** | 16900 | 32.9 | 39.0 | 28.1 |
| **2004** | 17459 | 32.5 | 36.5 | 31.0 |
| **2005** | 17072 | 33.7 | 37.7 | 28.6 |
| **2006** | 15207 | 39.3 | 35.1 | 25.6 |
| **2007** | 14874 | 37.2 | 36.2 | 26.5 |
| **2008** | 14638 | 38.0 | 35.5 | 26.5 |
| **2009** | 14208 | 39.1 | 35.1 | 25.9 |
| **2010** | 15071 | 40.5 | 34.9 | 24.6 |
| **2011** | 13966 | 40.5 | 34.2 | 25.3 |
| **2012** | 13831 | 39.8 | 34.9 | 25.4 |

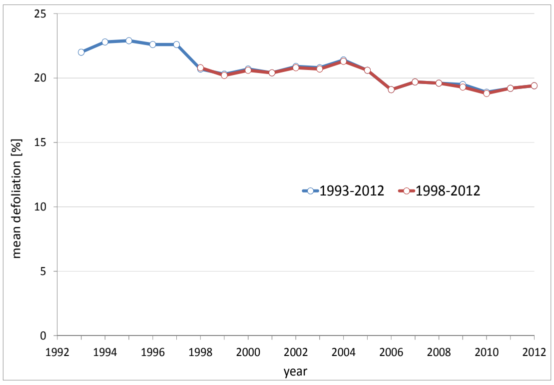


**Figure 3.1.3.3-1:** Mean defoliation in two periods (1993-2012 and 1998-2012)

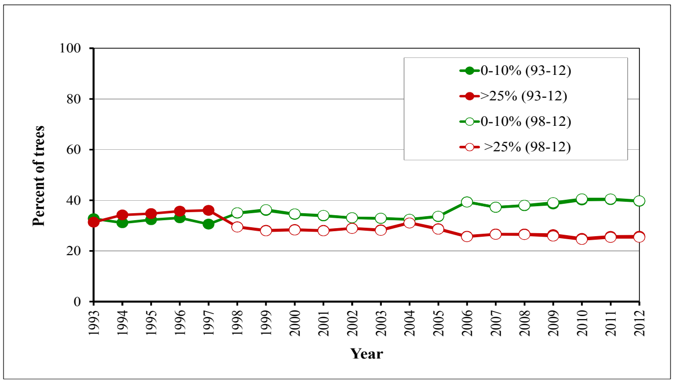


**Figure 3.1.3.3-2:** Shares of trees of defoliation 0-10% and >25% in two periods (1993-2012 and 1998-2012)

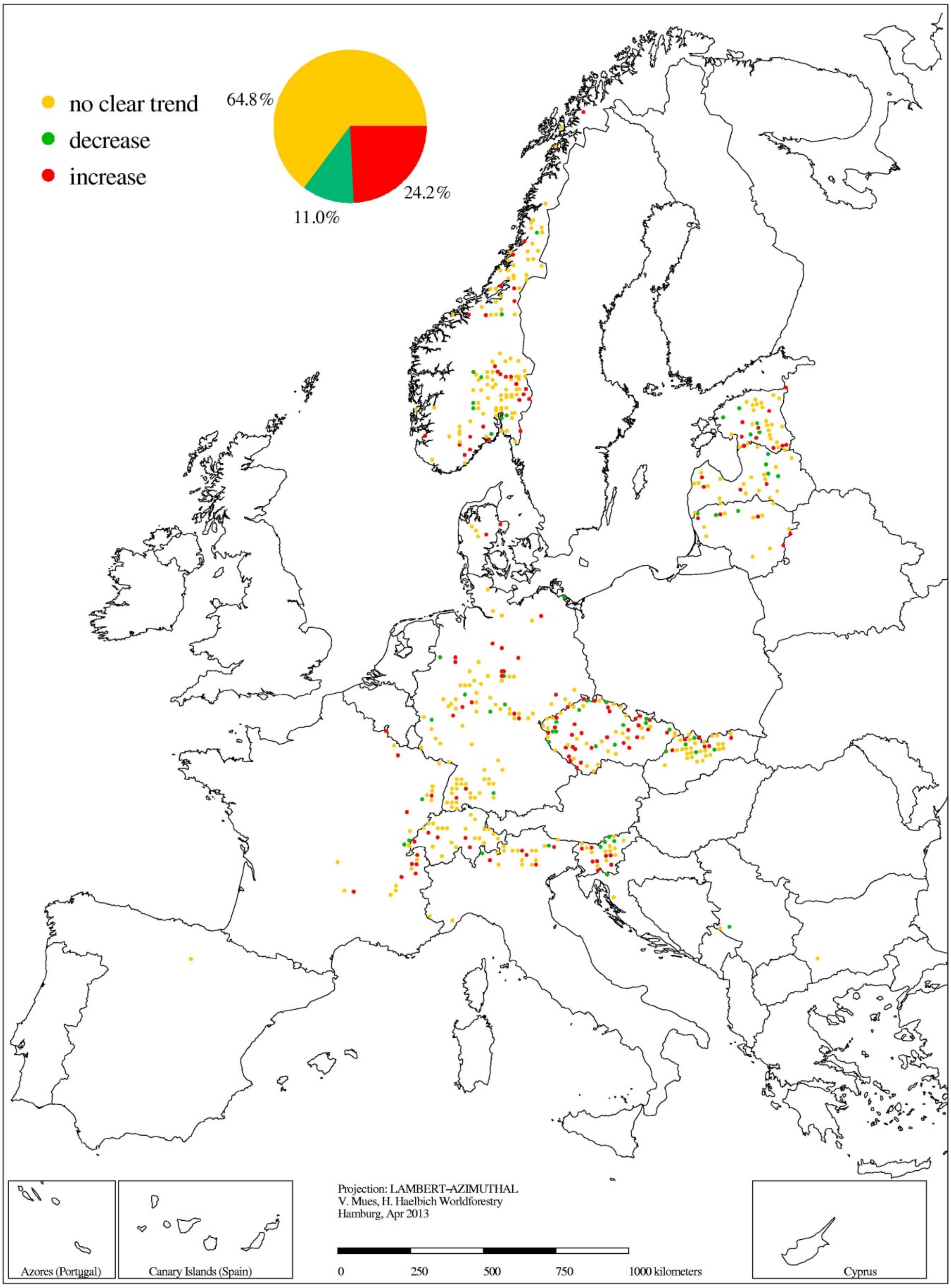


**Figure 3.1.3.3-3:** Development of mean plot defoliation (slope of linear regression) of *Picea abies* over the years 2002-2012

## 3.1.3.4 Mediterranean lowland pines

To the group of Mediterranean lowland belong three pine species: *P. pinaster, P.halepensis and P.pinea.* Crown condition of these tree species is characterized by a pronounced increase in mean defoliation since 1993. This is evident from the development of healthy trees. Their share dropped from about 50% in 1993 to 19.5% in 2012. The lowest share of undamaged trees (18.9%) was recorded in 2009. In contrast to the healthy trees the percentage of damaged pines peaked in 2005, decreased thereafter and fluctuated since then reaching about 18% in 2012 (Tab. 3.1.3.4-1, Fig. 3.1.3.4-1 and Fig. 3.1.3.4-2).

As regards the spatial trend, the share of plots showing deterioration (16.1%) exceeds the share of plots, on which the mean defoliation decreased between 2002 and 2012 (12.5%). The plots with worsened tree condition are mainly located along the Mediterranean coast in France and in northern Spain (Fig. 3.1.3.4-3).

**Table 3.1.3.4-1:** Shares of trees in different defoliation classes

| | N Trees | 0-10% | >10-25% | >25% |
|---|---|---|---|---|
| **1993** | 3747 | 62.1 | 25.9 | 12.0 |
| **1994** | 3719 | 50.3 | 32.0 | 17.7 |
| **1995** | 3743 | 39.9 | 42.5 | 17.6 |
| **1996** | 3686 | 36.9 | 43.7 | 19.4 |
| **1997** | 3680 | 38.5 | 45.7 | 15.7 |
| **1998** | 3672 | 37.5 | 46.9 | 15.6 |
| **1999** | 4887 | 39.9 | 47.4 | 12.7 |
| **2000** | 4934 | 39.4 | 48.4 | 12.2 |
| **2001** | 4936 | 34.1 | 53.8 | 12.1 |
| **2002** | 4893 | 30.7 | 55.0 | 14.3 |
| **2003** | 4861 | 27.8 | 55.2 | 17.1 |
| **2004** | 4877 | 28.9 | 54.0 | 17.2 |
| **2005** | 4860 | 21.6 | 53.6 | 24.9 |
| **2006** | 4860 | 21.6 | 54.9 | 23.5 |
| **2007** | 4874 | 23.5 | 55.4 | 21.1 |
| **2008** | 4825 | 22.2 | 59.4 | 18.4 |
| **2009** | 4681 | 18.9 | 59.9 | 21.2 |
| **2010** | 4656 | 23.7 | 58.6 | 17.6 |
| **2011** | 4751 | 28.0 | 55.7 | 16.3 |
| **2012** | 4661 | 19.5 | 62.6 | 17.9 |

| | N Trees | 0-10% | >10-25% | >25% |
|---|---|---|---|---|
| **1998** | 3672 | 37.5 | 46.9 | 15.6 |
| **1999** | 4887 | 39.9 | 47.4 | 12.7 |
| **2000** | 4934 | 39.4 | 48.4 | 12.2 |
| **2001** | 4936 | 34.1 | 53.8 | 12.1 |
| **2002** | 4893 | 30.7 | 55.0 | 14.3 |
| **2003** | 4861 | 27.8 | 55.2 | 17.1 |
| **2004** | 4877 | 28.9 | 54.0 | 17.2 |
| **2005** | 4860 | 21.6 | 53.6 | 24.9 |
| **2006** | 4860 | 21.6 | 54.9 | 23.5 |
| **2007** | 4874 | 23.5 | 55.4 | 21.1 |
| **2008** | 4825 | 22.2 | 59.4 | 18.4 |
| **2009** | 4681 | 18.9 | 59.9 | 21.2 |
| **2010** | 4656 | 23.7 | 58.6 | 17.6 |
| **2011** | 4751 | 28.0 | 55.7 | 16.3 |
| **2012** | 4661 | 19.5 | 62.6 | 17.9 |

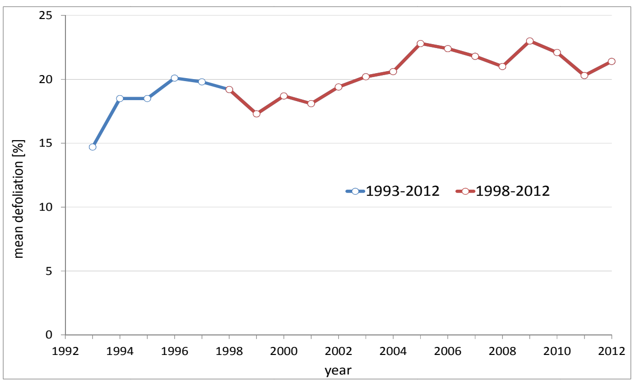


**Figure 3.1.3.4-1:** Mean defoliation in two periods (1993-2012 and 1998-2012)

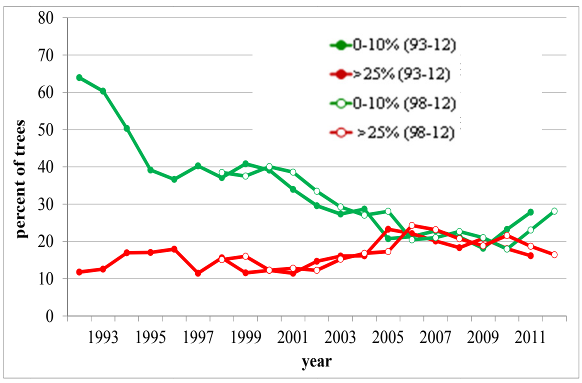


**Figure 3.1.3.4-2:** Shares of trees of defoliation 0-10% and >25% in two periods (1993-2012 and 1998-2012)

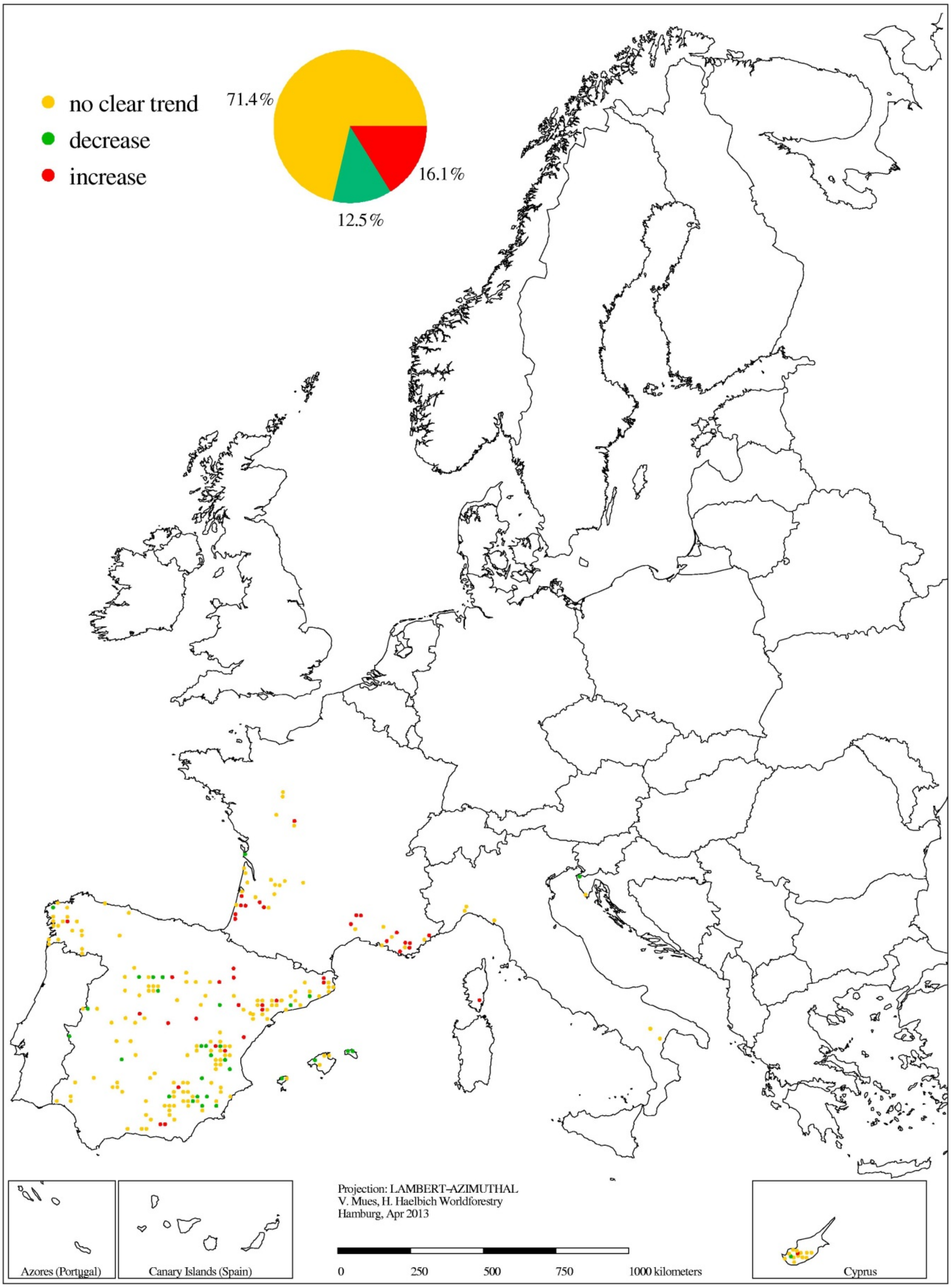


**Figure 3.1.3.4-3:** Development of mean plot defoliation (slope of linear regression) of Mediterranean lowland pines over the years 2002-2012

## 3.1.3.5 Fagus sylvatica

*Fagus sylvatica* is the most frequent deciduous tree species on the large- scale plots. The area of its occurrence spreads from southern Scandinavia to Sicily and from the northern coast of Spain to Bulgaria.

Since the beginning of the study crown condition of this tree species expressed by mean defoliation worsened slightly. The highest defoliation was recorded in the year after the hot and dry summer in central Europe in 2003. Since then a recovery has been observed (Tab. 3.1.3.5-1, Fig. 3.1.3.5-1, Fig. 3.1.3.5-2)

Between 1993 and 2004 the percentage of healthy trees (0-10%) diminished from 47.6 to 28.3%. In 2011 the share of damaged trees (>25%) rose rapidly reaching 33% in the long and about 29% in the short time. A marked improvement of the health status occurred in 2012 when the proportion of damage trees dropped to 26.7% and 25.1% for long and short time series. But this is not reflected in the shares of plots with decreasing (8.4%) and increasing defoliation (16.5%).

**Table 3.1.3.5-1:** Shares of trees in different defoliation classes

| | N Trees | 0-10% | >10-25% | >25% |
|---|---|---|---|---|
| **1993** | 7198 | 47.6 | 33.4 | 19.0 |
| **1994** | 7188 | 43.9 | 36.0 | 20.1 |
| **1995** | 7175 | 37.3 | 37.8 | 24.9 |
| **1996** | 7345 | 37.0 | 42.7 | 20.3 |
| **1997** | 7228 | 33.2 | 44.3 | 22.5 |
| **1998** | 7531 | 36.2 | 43.3 | 20.5 |
| **1999** | 8231 | 30.0 | 47.5 | 22.6 |
| **2000** | 8262 | 32.9 | 45.2 | 21.9 |
| **2001** | 8321 | 28.2 | 46.5 | 25.3 |
| **2002** | 8300 | 29.7 | 48.6 | 21.7 |
| **2003** | 8278 | 27.2 | 48.8 | 24.0 |
| **2004** | 8348 | 21.8 | 46.6 | 31.6 |
| **2005** | 8436 | 26.8 | 46.9 | 26.2 |
| **2006** | 7953 | 28.9 | 44.6 | 26.6 |
| **2007** | 8093 | 25.2 | 49.7 | 25.1 |
| **2008** | 8166 | 30.5 | 48.0 | 21.5 |
| **2009** | 7978 | 26.6 | 44.0 | 29.3 |
| **2010** | 8344 | 27.3 | 48.0 | 24.7 |
| **2011** | 8330 | 24.1 | 42.9 | 33.0 |
| **2012** | 7905 | 28.3 | 45.1 | 26.7 |
| | **N Trees** | **0-10%** | **>10-25%** | **>25%** |
| **1998** | 8597 | 36.1 | 43.0 | 20.9 |
| **1999** | 8866 | 31.2 | 46.6 | 22.2 |
| **2000** | 9078 | 34.5 | 43.7 | 21.7 |
| **2001** | 9067 | 29.9 | 45.0 | 25.1 |
| **2002** | 9151 | 31.0 | 47.1 | 21.9 |
| **2003** | 9081 | 29.0 | 47.9 | 23.0 |
| **2004** | 9033 | 22.9 | 47.0 | 30.1 |
| **2005** | 9190 | 29.3 | 45.6 | 25.1 |
| **2006** | 8745 | 30.7 | 43.4 | 25.9 |
| **2007** | 9013 | 28.5 | 47.8 | 23.8 |
| **2008** | 8971 | 32.4 | 47.2 | 20.4 |
| **2009** | 9456 | 32.1 | 42.4 | 25.5 |
| **2010** | 9770 | 31.8 | 45.8 | 22.4 |
| **2011** | 9756 | 29.7 | 41.1 | 29.2 |
| **2012** | 9332 | 31.2 | 43.7 | 25.1 |

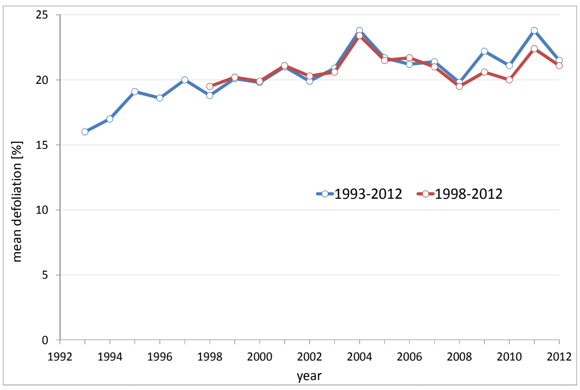


**Figure 3.1.3.5-1:** Mean defoliation in two periods (1993-2012 and 1998-2012)

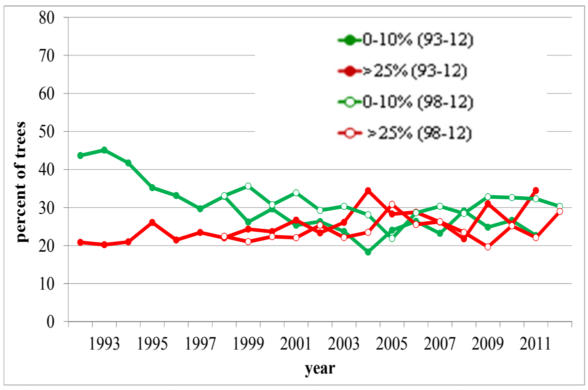


**Figure 3.1.3.5-2:** Shares of trees of defoliation 0-10% and >25% in two periods (1993-2012 and 1998-2012)

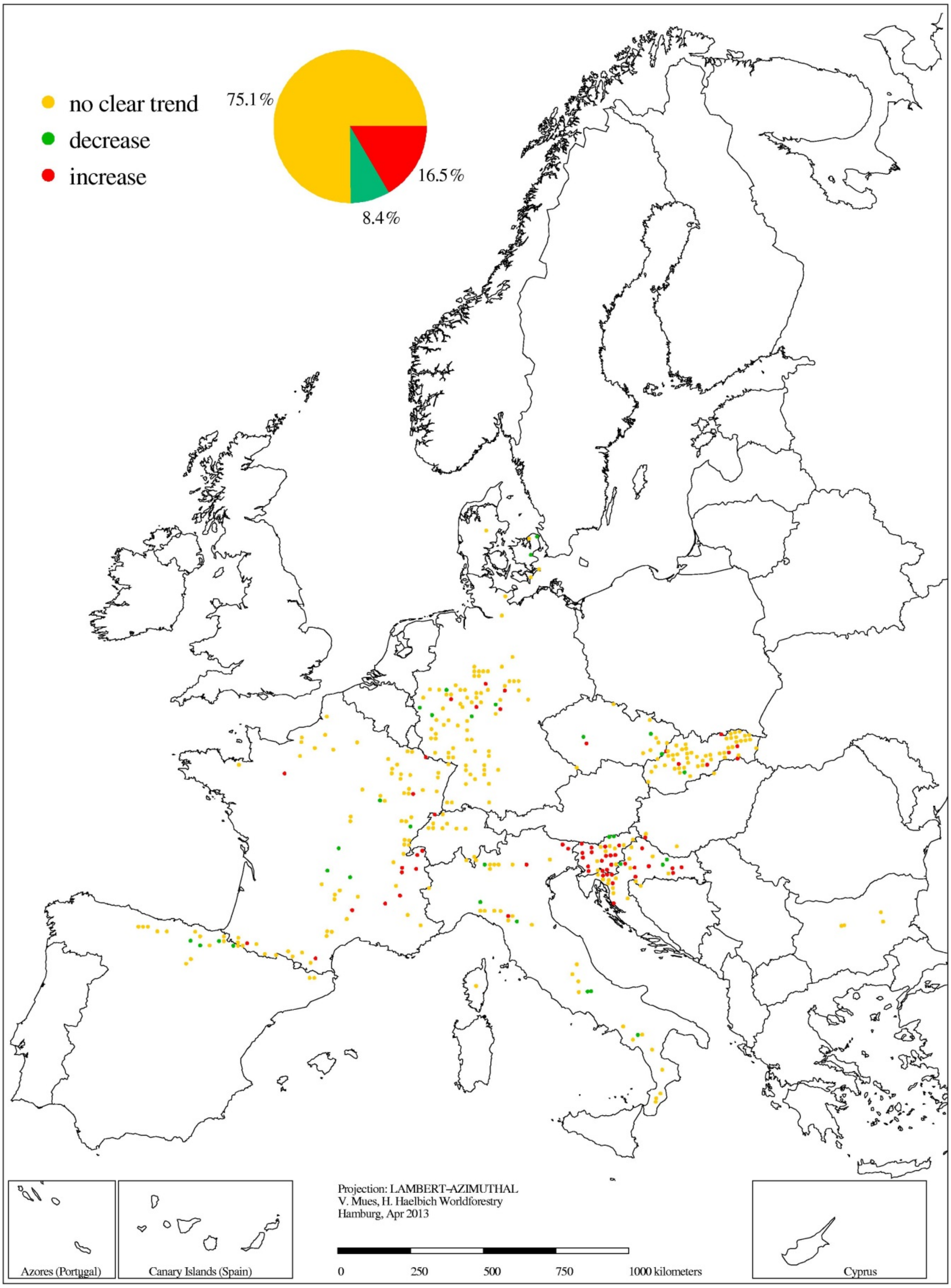


**Figure 3.1.3.5-3:** Development of mean plot defoliation (slope of linear regression) of *Fagus sylvatica* over the years 2002-2012

## 3.1.3.6 Deciduous temperate oak

The group of deciduous temperate oaks includes *Quercus robur and Q. petraea* occurring throughout central Europe.

Temporal development of these tree species is characterized by peaks in 1997 and 2005. In the subsequent years including 2011 some trees may have recovered as the percentage of trees defoliated by 25% and more decreased and varied since then between 33.4% and 35.7% in both time series (Tab. 3.1.3.6-1, Fig. 3.1.3.6-1, Fig. 3.1.3.6-2).

The linear trend based on time period 2002-2012 shows that on 14% of all plots the mean defoliation increased. For 75.7% of the plots the calculation does not support the existence of any trends.

A cluster of plots showing decreasing trend of mean defoliation can be seen in central France (Fig. 3.1.3.6-3).

**Table 3.1.3.6-1:** Shares of trees in different defoliation classes

| | N Trees | 0-10% | >10-25% | >25% |
|---|---|---|---|---|
| **1993** | 5886 | 36.9 | 32.8 | 30.3 |
| **1994** | 6195 | 32.9 | 32.6 | 34.5 |
| **1995** | 6063 | 33.0 | 36.2 | 30.8 |
| **1996** | 5903 | 24.9 | 39.2 | 35.9 |
| **1997** | 5970 | 16.8 | 42.6 | 40.6 |
| **1998** | 6183 | 20.5 | 42.3 | 37.1 |
| **1999** | 6349 | 20.9 | 47.5 | 31.6 |
| **2000** | 6345 | 21.3 | 48.0 | 30.7 |
| **2001** | 6365 | 19.8 | 49.3 | 30.9 |
| **2002** | 6380 | 19.1 | 50.8 | 30.1 |
| **2003** | 6379 | 15.7 | 47.6 | 36.7 |
| **2004** | 6498 | 16.1 | 44.9 | 39.0 |
| **2005** | 6547 | 14.9 | 43.4 | 41.7 |
| **2006** | 6053 | 19.5 | 45.3 | 35.3 |
| **2007** | 6157 | 18.1 | 46.2 | 35.7 |
| **2008** | 6339 | 17.5 | 47.4 | 35.1 |
| **2009** | 6260 | 19.5 | 45.9 | 34.6 |
| **2010** | 6286 | 17.9 | 46.5 | 35.5 |
| **2011** | 6463 | 18.9 | 46.1 | 35.0 |
| **2012** | 6441 | 15.1 | 41.7 | 43.2 |

| | N Trees | 0-10% | >10-25% | >25% |
|---|---|---|---|---|
| **1998** | 6611 | 20.1 | 41.7 | 38.1 |
| **1999** | 6657 | 21.0 | 47.4 | 31.6 |
| **2000** | 6749 | 20.3 | 46.5 | 33.1 |
| **2001** | 6694 | 19.2 | 48.1 | 32.7 |
| **2002** | 6541 | 18.8 | 50.3 | 30.9 |
| **2003** | 6542 | 15.5 | 47.6 | 37.0 |
| **2004** | 6670 | 16.3 | 44.5 | 39.3 |
| **2005** | 6738 | 14.6 | 43.2 | 42.2 |
| **2006** | 6253 | 19.2 | 45.4 | 35.5 |
| **2007** | 6380 | 17.6 | 47.1 | 35.3 |
| **2008** | 6523 | 17.2 | 48.2 | 34.7 |
| **2009** | 6796 | 19.3 | 47.4 | 33.4 |
| **2010** | 6770 | 17.5 | 47.0 | 35.5 |
| **2011** | 6947 | 17.8 | 47.6 | 34.5 |
| **2012** | 6925 | 14.3 | 42.5 | 43.2 |

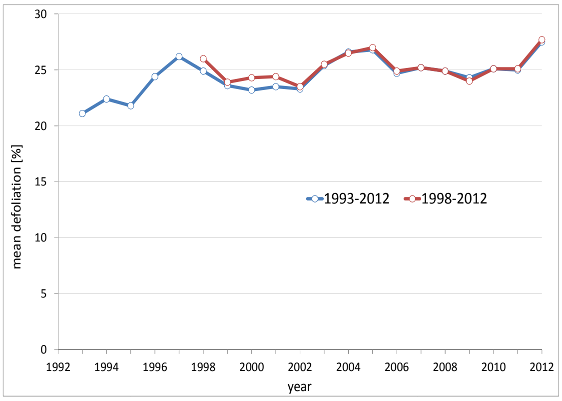


**Figure 3.1.3.6-1:** Mean defoliation in two periods (1993-2012 and 1998-2012)

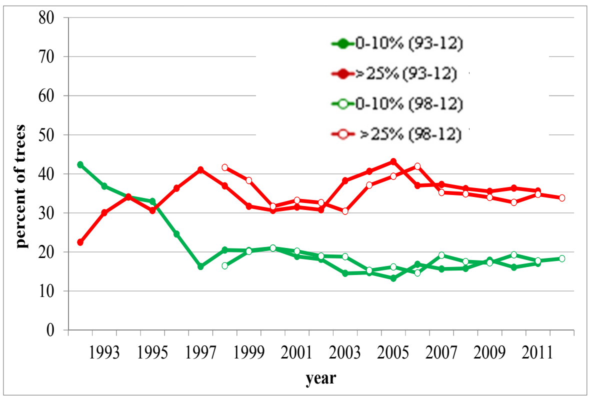


**Figure 3.1.3.6-2:** Shares of trees of defoliation 0-10% and >25% in two periods (1993-2012 and 1998-2012)

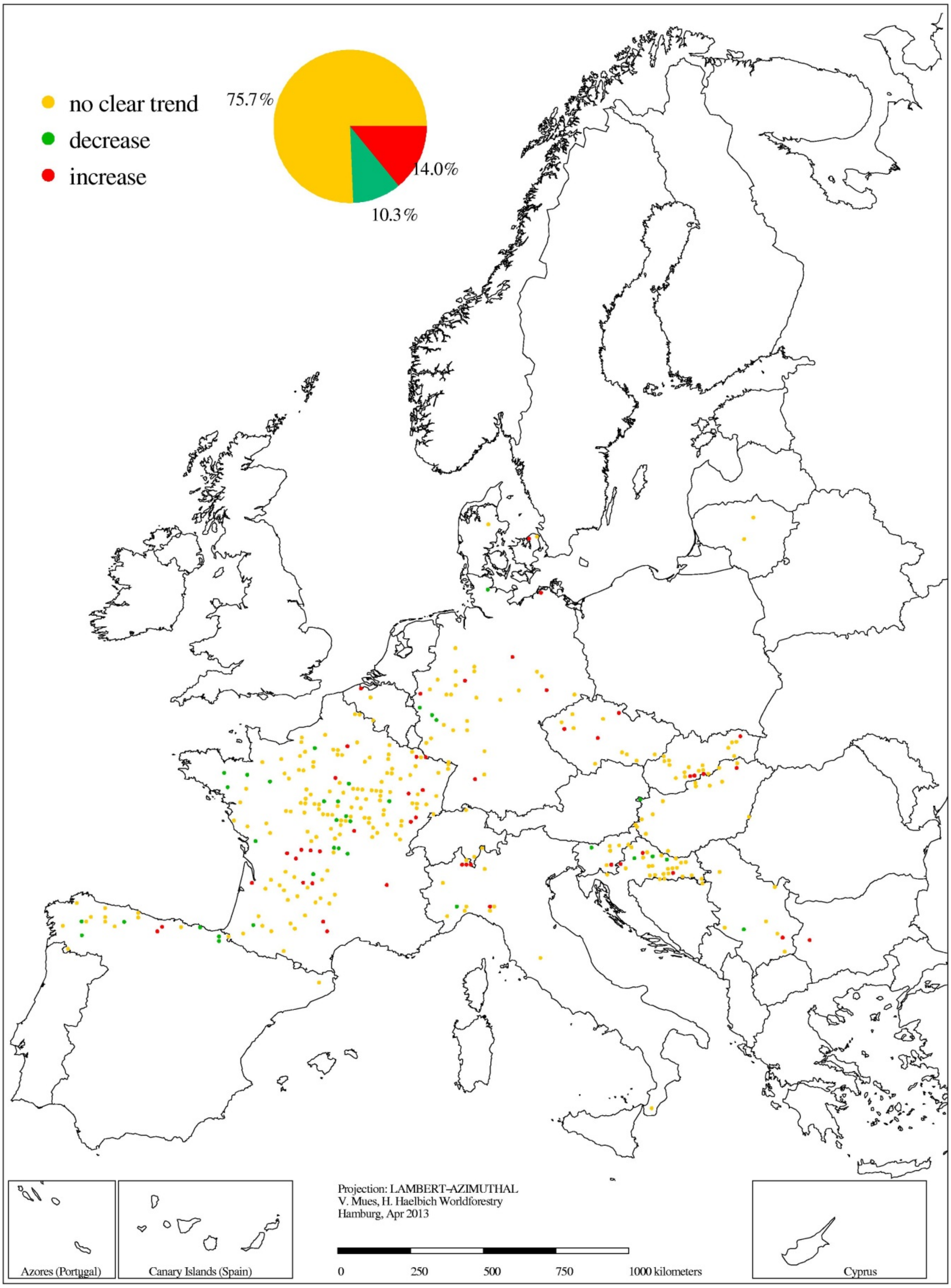


**Figure 3.1.3.6-3:** Development of mean plot defoliation (slope of linear regression) of deciduous temperate oak species over the years 2002-2012

## 3.1.3.7 Deciduous (sub-) Mediterranean oak

The group of deciduous (sub-) Mediterranean oak is composed of Quercus cerris, Q. pubescens, Q. frainetto and Q. pyrenaica. The occurrence of these oaks is confined to southern Europe.

Crown condition of these oaks deteriorated dramatically until the end of the 1990s. In the following years the share of damaged trees increased at slower rate reaching a maximum of 37.1% in 2006. In the subsequent years a slow decrease in defoliation can be observed (Tab. 3.1.3.7-1, Fig. 3.1.3.7-1 and Fig. 3.1.3.7-2). The share of damaged trees in the last four years levelled off between 2008 and 2011 at about 34% (long time series) or 32% (short time series). In 2012 the defoliation increased rapidly reaching 38.2% and 36.9% of tress damaged in long and short time series respectively.

The spatial distribution shows a negative trend in crown condition on 17.9% of all plots mainly in southern France. Positive develop-ment of the four oak species was identified on 18.4% plots. These plots are more or less scattered over the southern Europe. A small cluster of plots with positive trend of crown condition since 2002 can be identified in Serbia (Fig. 3.1.3.7-3).

**Table 3.1.3.7-1:** Shares of trees in different defoliation classes

| | N Trees | 0-10% | >10-25% | >25% |
|---|---|---|---|---|
| **1993** | 3433 | 54.9 | 30.5 | 14.6 |
| **1994** | 3408 | 47.9 | 32.2 | 19.8 |
| **1995** | 3451 | 46.4 | 34.4 | 19.2 |
| **1996** | 3492 | 31.1 | 42.4 | 26.5 |
| **1997** | 3309 | 25.6 | 41.3 | 33.2 |
| **1998** | 3344 | 26.1 | 41.6 | 32.3 |
| **1999** | 3868 | 25.0 | 46.1 | 28.9 |
| **2000** | 3843 | 22.6 | 47.2 | 30.3 |
| **2001** | 3877 | 20.1 | 45.1 | 34.8 |
| **2002** | 3763 | 17.9 | 46.6 | 35.5 |
| **2003** | 3681 | 16.2 | 46.8 | 36.9 |
| **2004** | 3812 | 16.4 | 48.8 | 34.8 |
| **2005** | 3767 | 18.5 | 48.4 | 33.1 |
| **2006** | 3789 | 17.6 | 45.3 | 37.1 |
| **2007** | 3797 | 15.1 | 48.3 | 36.5 |
| **2008** | 3780 | 16.3 | 49.2 | 34.5 |
| **2009** | 3805 | 16.1 | 49.5 | 34.4 |
| **2010** | 4146 | 19.8 | 48.5 | 31.8 |
| **2011** | 4199 | 19.1 | 46.5 | 34.4 |
| **2012** | 3427 | 16.1 | 45.8 | 38.2 |

| | N Trees | 0-10% | >10-25% | >25% |
|---|---|---|---|---|
| **1998** | 3731 | 24.1 | 41.8 | 34.1 |
| **1999** | 4072 | 25.7 | 46.0 | 28.3 |
| **2000** | 4034 | 22.3 | 47.1 | 30.6 |
| **2001** | 4197 | 20.1 | 45.2 | 34.7 |
| **2002** | 4119 | 17.0 | 48.0 | 35.0 |
| **2003** | 3964 | 15.5 | 47.9 | 36.6 |
| **2004** | 4043 | 15.7 | 49.6 | 34.7 |
| **2005** | 3965 | 18.7 | 49.3 | 32.0 |
| **2006** | 4121 | 16.8 | 46.5 | 36.8 |
| **2007** | 4031 | 14.5 | 49.8 | 35.6 |
| **2008** | 3971 | 15.7 | 50.1 | 34.2 |
| **2009** | 4262 | 15.7 | 52.2 | 32.1 |
| **2010** | 4603 | 19.6 | 49.8 | 30.5 |
| **2011** | 4669 | 18.5 | 49.2 | 32.3 |
| **2012** | 3897 | 15.4 | 47.7 | 36.9 |

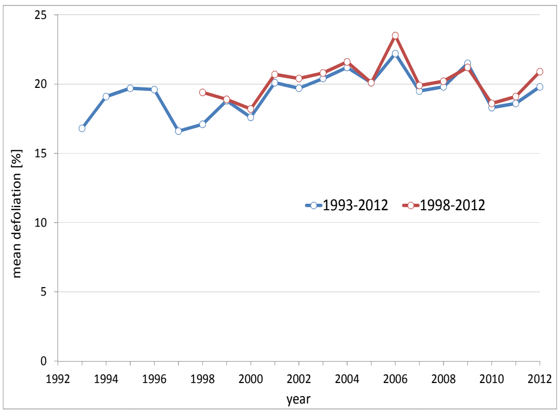


**Figure 3.1.3.7-1:** Mean defoliation in two periods (1993-2012 and 1998-2012)

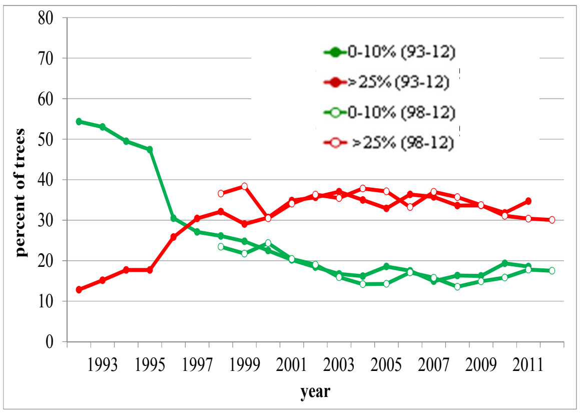


**Figure 3.1.3.7-2:** Shares of trees of defoliation 0-10% and >25% in two periods (1993-2012 and 1998-2012)

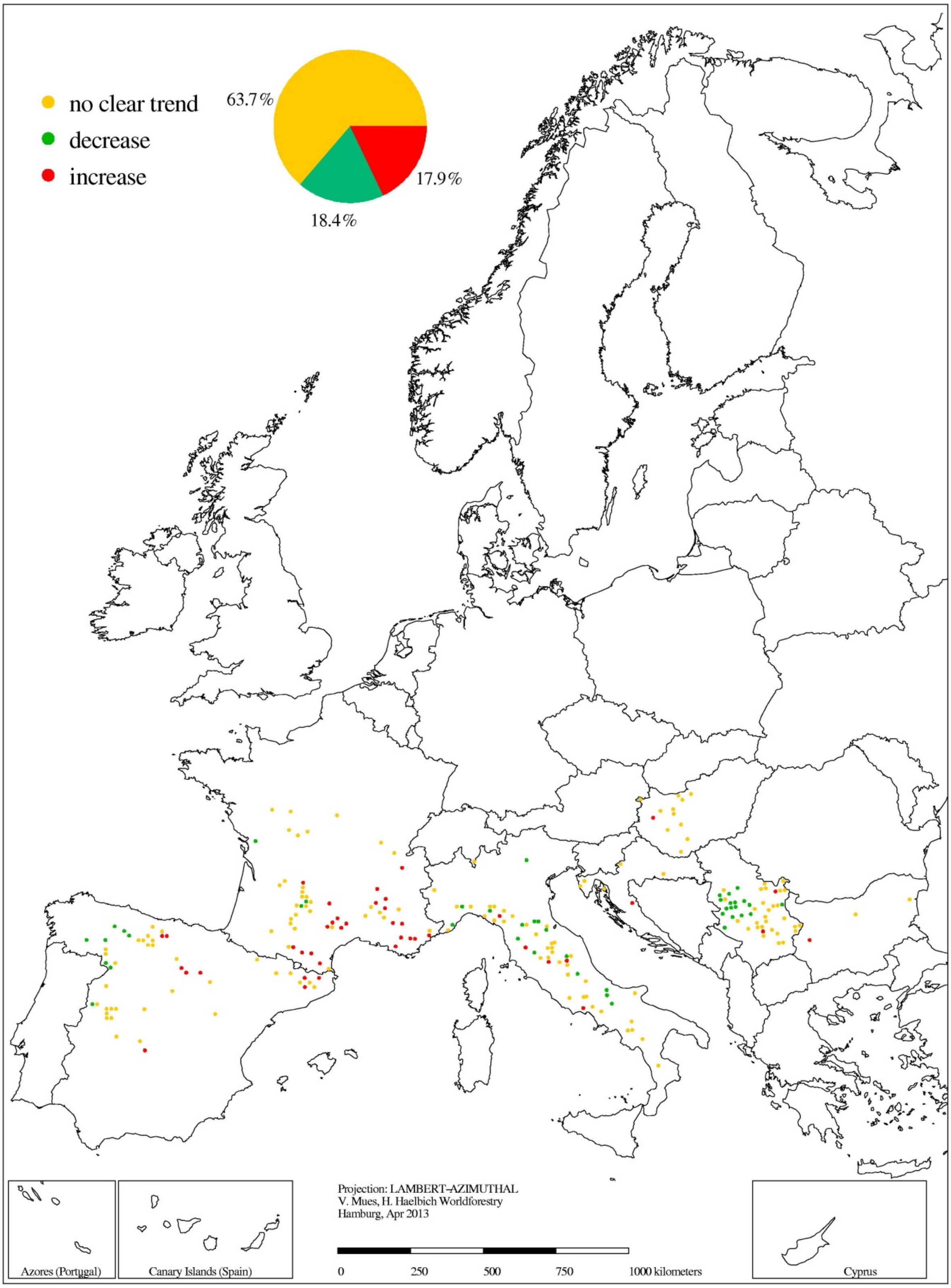


**Figure 3.1.3.7-3:** Development of mean plot defoliation (slope of linear regression) of deciduous (sub-) Mediterranean oak species over the years 2002-2012

## 3.1.3.8 Evergreen oak

The group of evergreen oaks includes *Quercus coccifera, Q. ilex, Q. rotundifolia and Q. suber.* The results presented in Table 3.1.3.8-1 do not differ since the compositions of countries on which both time series are based are the same.

In the early 1990s, at the beginning of the study, the mean defoliation of evergreen oaks was less than 15%, which corresponds with a high percentage of healthy trees. The share of damaged trees (> 25%) shows three peaks: in 1995 (31.9%), in 2005 (27.9%) and in 2012 (30.2%) (Tab. 3.1.3.8-1).

The majority of plots with evergreen oaks are located in Spain. Few of the plots are in southern France and along the western coast of Italy. The share of evergreen oaks with deteriorating trends between 2002 and 2012 is with 12.6% rather small. The percentage of these plots is exceeded by the share of plots which have been recovering since 2002 (20.3%) (Fig. 3.1.3.8-3).

**Table 3.1.3.8-1:** Shares of trees in different defoliation classes

| | N Trees | 0-10% | >10-25% | >25% |
|---|---|---|---|---|
| **1993** | 3363 | 41.8 | 50.8 | 7.4 |
| **1994** | 3362 | 32.7 | 51.5 | 15.9 |
| **1995** | 3384 | 19.3 | 48.8 | 31.9 |
| **1996** | 3355 | 18.6 | 53.4 | 28.0 |
| **1997** | 3354 | 22.1 | 57.7 | 20.2 |
| **1998** | 3288 | 28.4 | 56.1 | 15.5 |
| **1999** | 4255 | 21.6 | 57.1 | 21.2 |
| **2000** | 4330 | 19.2 | 60.2 | 20.6 |
| **2001** | 4346 | 19.8 | 62.7 | 17.4 |
| **2002** | 4333 | 16.2 | 63.0 | 20.9 |
| **2003** | 4241 | 14.0 | 62.5 | 23.5 |
| **2004** | 4326 | 17.5 | 63.9 | 18.6 |
| **2005** | 4276 | 9.8 | 62.3 | 27.9 |
| **2006** | 4281 | 8.8 | 63.8 | 27.4 |
| **2007** | 4366 | 10.3 | 67.3 | 22.4 |
| **2008** | 4360 | 11.9 | 67.0 | 21.1 |
| **2009** | 4369 | 11.3 | 66.8 | 21.9 |
| **2010** | 4494 | 17.4 | 61.9 | 20.8 |
| **2011** | 4545 | 19.8 | 61.8 | 18.3 |
| **2012** | 4403 | 10.0 | 59.8 | 30.2 |

| | N Trees | 0-10% | >10-25% | >25% |
|---|---|---|---|---|
| **1998** | 3288 | 28.4 | 56.1 | 15.5 |
| **1999** | 4255 | 21.6 | 57.1 | 21.2 |
| **2000** | 4330 | 19.2 | 60.2 | 20.6 |
| **2001** | 4346 | 19.8 | 62.7 | 17.4 |
| **2002** | 4333 | 16.2 | 63.0 | 20.9 |
| **2003** | 4241 | 14.0 | 62.5 | 23.5 |
| **2004** | 4326 | 17.5 | 63.9 | 18.6 |
| **2005** | 4276 | 9.8 | 62.3 | 27.9 |
| **2006** | 4281 | 8.8 | 63.8 | 27.4 |
| **2007** | 4366 | 10.3 | 67.3 | 22.4 |
| **2008** | 4360 | 11.9 | 67.0 | 21.1 |
| **2009** | 4369 | 11.3 | 66.8 | 21.9 |
| **2010** | 4494 | 17.4 | 61.9 | 20.8 |
| **2011** | 4545 | 19.8 | 61.8 | 18.3 |
| **2012** | 4403 | 10.0 | 59.8 | 30.2 |

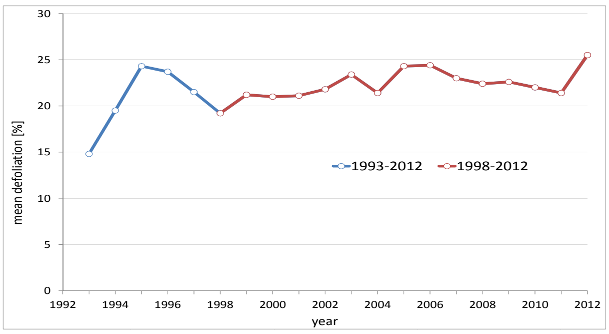


**Figure 3.1.3.8-1:** Mean defoliation in two periods (1993-2012 and 1998-2012)

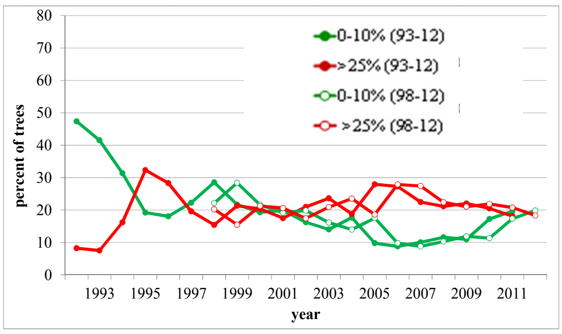


**Figure 3.1.3.8-2:** Shares of trees of defoliation 0-10% and >25% in two periods (1993-2012 and 1998-2012)

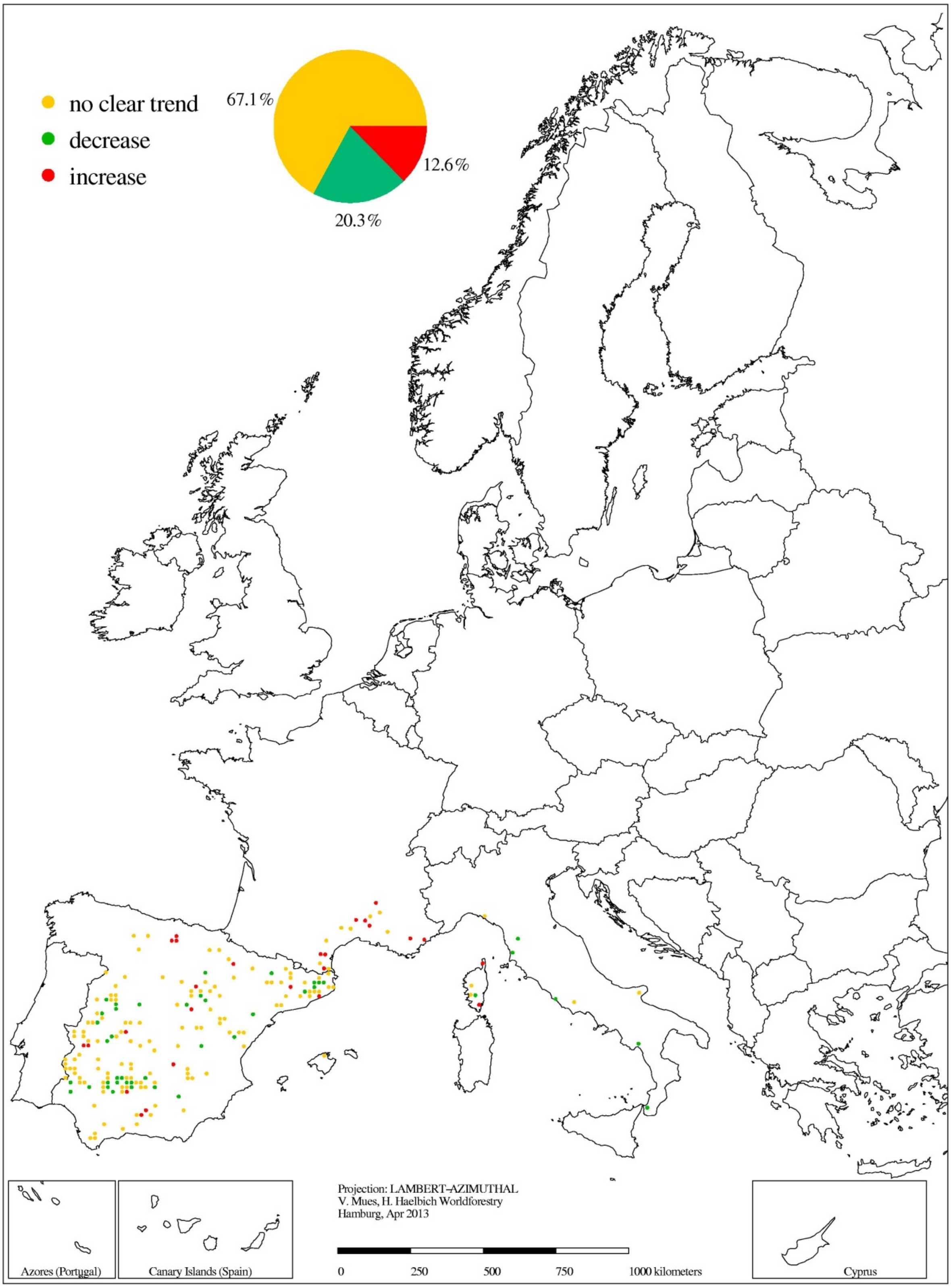


**Figure 3.1.3.8-3:** Development of mean plot defoliation (slope of linear regression) of evergreen oak species over the years 2002-2012

## 3.2 Damage cause assessment

Crown condition is the most widely applied indicator for forest health and vitality in Europe. In order to interpret the crown condition accurately, it is necessary to assess tree parameters that have an influence on tree vitality. Parameters assessed in addition to crown condition include discoloration and damages caused by biotic and abiotic factors. Through the assessment of damage and its influence on crown condition, it is possible to draw conclusions on cause-effect mechanisms. Since 2005, tree crowns on Level I plots have been examined based on an amended method for damage assessment, which allows to obtain more information on injury symptoms, possible causes of damage, and extent of the injury.

The aim of the damage cause assessment is to collect as much information as possible on the causal background of tree damages in order to enable a differential diagnosis and to better interpret the unspecific parameter 'defoliation'.

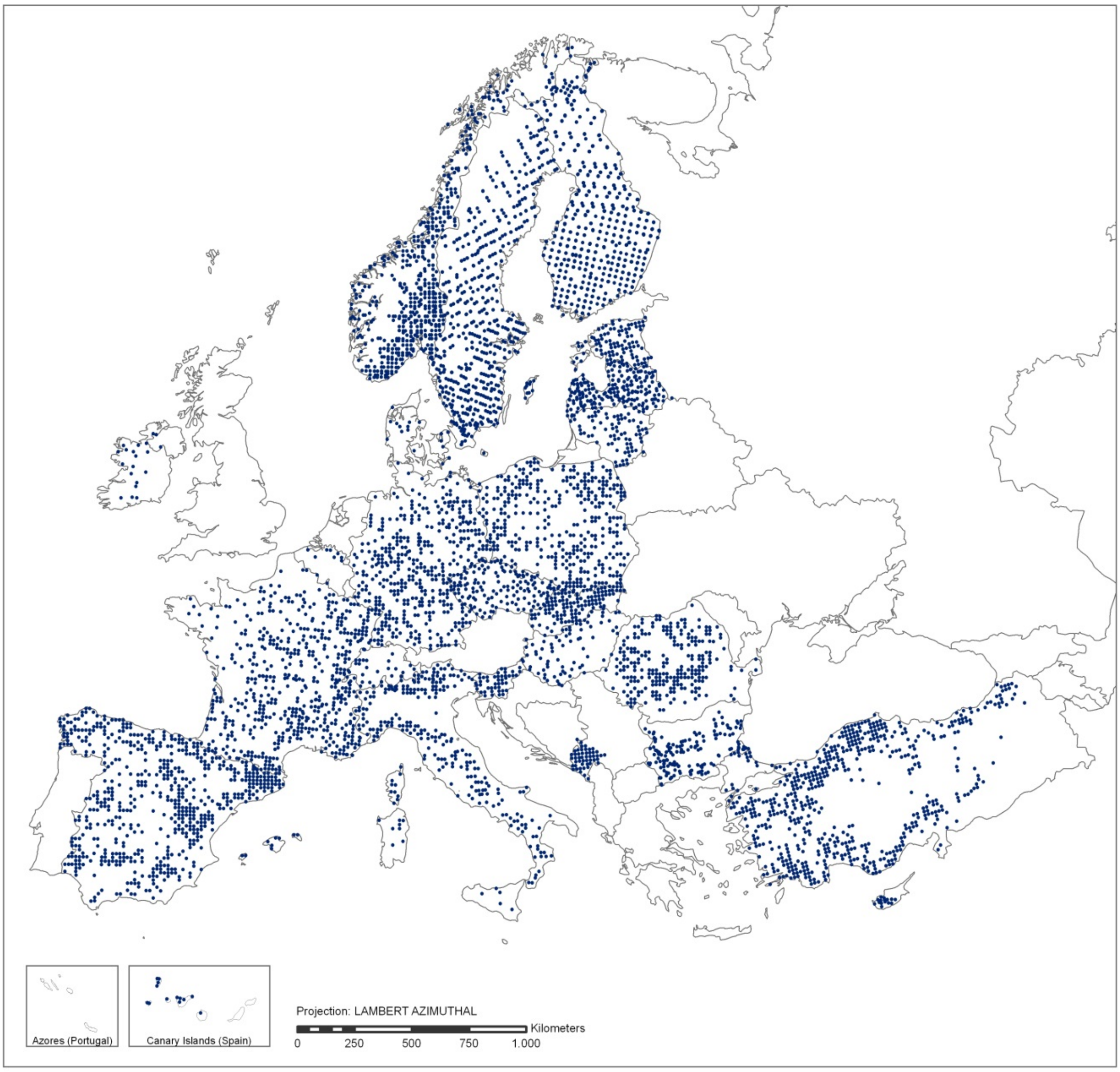


**Figure 3.2.1-1:** Plots with damage cause assessment in 2012

## 3.2.1 Background of the survey in 2012

Assessment of damage causes is part of the visual assessment of crown condition. All trees included in the crown condition sample (Level I plots) are required to be regularly assessed for damage causes. In 2012, damage causes were assessed on about 6 000 plots in 25 countries across Europe (Fig. 3.2.1-1). The number of trees showing damage was 46 500. As a particular tree may be affected by more than one damage agent the total number of damage cases recorded was 62 000.

## 3.2.2 Assessment parameters

The assessment of damage to trees based on the ICP Forests methodology includes three steps: symptom description, determination of causes, and quantification of the symptoms. Several symptoms of damage can be described for each tree. The symptom description should focus on important factors which may influence crown condition.

### Symptoms

Symptom description aims at describing visible damage causes for single trees. The description indicates affected parts of the assessed trees and type of symptoms observed. Symptom description should focus on important factors that may influence the crown condition.

Three main categories are distinguished for indicating the affected part of each tree: (a) leaves/needles, (b) branches, shoots, & buds, and (c) stem & collar. For each affected tree area, further specification is required (Tab. 3.2.2-1). Symptoms are grouped into broad categories like wounds, deformations, necrosis etc. This allows a detailed description of the occurring symptoms.

### Extent

The damage extent is classified in eight classes (Tab. 3.2.2-2). In trees where multiple damages occurred (and thus multiple extent classes), only the highest value was evaluated.

**Table 3.2.2-1: Affected parts of a tree**

| Affected part | **Specification of affected part** | **Location in crown** |
|---|---|---|
| Leaves/needles | Current needle year<br>Older needles<br>Needles of all ages<br>Broadleaves (incl. evergreen spec.) | Upper crown<br>Lower crown<br>Patches<br>Total crown |
| Branches, shoots & buds | Current year shoots<br>Twigs (diameter < 2 cm)<br>Branches diameter 2 – < 10 cm<br>Branches diameter ≥ 10 cm<br>Varying size<br>Top leader shoot<br>Buds | Upper crown<br>Lower crown<br>Patches<br>Total crown |
| Stem & collar | Crown stem: main trunk or bole within the crown<br>Bole: trunk between the collar and the crown<br>Roots (exposed) and collar (≤ 25 cm height)<br>Whole trunk | |
| *Dead tree* | *see below* | |
| *No symptoms on any part of tree* | *see below* | |
| *No assessment* | *see below* | |

**Table 3.2.2-2: Damage extent classes**

| **Class** |
|---|
| 0% |
| 1 – 10% |
| 11 – 20% |
| 21 – 40% |
| 41 – 60% |
| 61 – 80% |
| 81 – 99% |
| 100% |

### Causal agents

For each symptom description a causal agent must be determined. The determination of the causal agent is crucial for the study of the cause-effect mechanism. Causal agents are grouped into nine categories (Tab. 3.2.2-3). In each category a more detailed description is possible through a hierarchical coding system.

**Table 3.2.2-3: Main causal agents**

| Agent group |
|---|
| Game and grazing |
| Insects |
| Fungi |
| Abiotic agents |
| Direct action of men |
| Fire |
| Atmospheric pollutants |
| Other factors |
| (investigated but) unidentified |

## 3.2.3 Results in 2012

## 3.2.3.1 Agent groups

The distribution of the agent groups in 2012 shows that over 16 000 trees displayed symptoms caused by insects (Fig. 3.2.3.1-1) corresponding to 25% of the records (Tab. 3.2.3.1-1). Roughly half of the insect-caused symptoms were attributed to defoliators and to the other half to borers and mining insects. Significantly fewer trees, namely over 8 000, displayed damage caused by fungi. In about 9 000 trees, an abiotic symptom (i.e. drought, frost) was found. Altogether, ca. 21 000 trees showed no signs of damage. Multiple agent groups were recorded for a number of trees. The damages due to air pollution refer to “direct smoke damages”, indirect effects were not assessed.

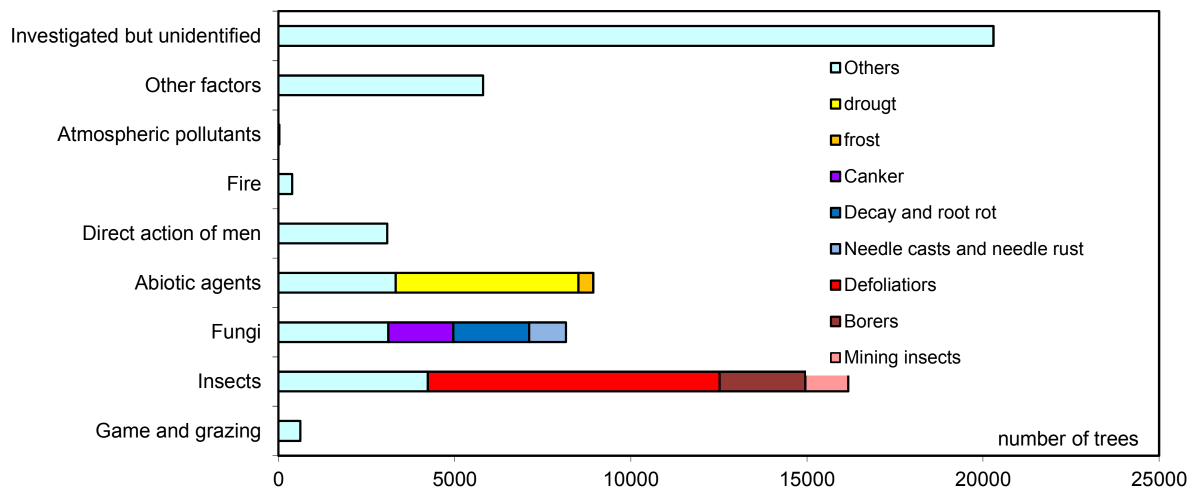


**Figure 3.2.3.1-1:** Frequency of agent groups

**Table 3.2.3.1-1:** Percentages of damage types by agent group and country for the year 2012

| share of damages by agent group and country for the year 2012 | Game and grazing | Insects | Fungi | Abiotic agents | Direct action of men | Fire | Atmospheric pollutants | Other factors | Investigated but unidentified |
|---|---|---|---|---|---|---|---|---|---|
| Belgium | 0 | 8 | 21 | 3 | 7 | 0 | 0 | 0 | 61 |
| Bulgaria | 0 | 25 | 32 | 7 | 9 | 0 | 0 | 2 | 25 |
| Cyprus | 0 | 88 | 0 | 6 | 0 | 0 | 0 | 6 | 0 |
| Czech Rep. | 43 | 1 | 1 | 34 | 6 | 0 | 0 | 8 | 7 |
| Denmark | 4 | 77 | 5 | 4 | 4 | 0 | 0 | 1 | 5 |
| Estonia | 1 | 8 | 27 | 5 | 8 | 0 | 0 | 1 | 50 |
| Finland | 1 | 5 | 21 | 13 | 6 | 0 | 0 | 13 | 41 |
| France | 0 | 34 | 16 | 17 | 1 | 0 | 0 | 2 | 30 |
| Germany | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 |
| Hungary | 0 | 26 | 5 | 11 | 2 | 0 | 0 | 6 | 50 |
| Ireland | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 98 |
| Italy | 1 | 22 | 6 | 6 | 0 | 0 | 0 | 5 | 60 |
| Latvia | 20 | 21 | 11 | 7 | 31 | 0 | 0 | 1 | 9 |
| Lithuania | 6 | 11 | 14 | 22 | 18 | 0 | 0 | 5 | 24 |
| Poland | 1 | 21 | 7 | 5 | 7 | 0 | 0 | 24 | 35 |
| Romania | 3 | 35 | 8 | 12 | 5 | 1 | 0 | 6 | 30 |
| Slovak Rep. | 1 | 35 | 22 | 9 | 11 | 0 | 0 | 21 | 1 |
| Spain | 1 | 29 | 11 | 38 | 4 | 3 | 0 | 12 | 2 |
| Sweden | 5 | 0 | 8 | 17 | 23 | 1 | 0 | 2 | 44 |
| **EU** | **1** | **25** | **13** | **14** | **5** | **1** | **0** | **9** | **32** |
| Andorra | 0 | 13 | 62 | 12 | 0 | 0 | 0 | 0 | 13 |
| Montenegro | 0 | 33 | 9 | 17 | 5 | 3 | 0 | 1 | 32 |
| Norway | 1 | 44 | 17 | 13 | 5 | 0 | 0 | 0 | 20 |
| Slovenia | 0 | 24 | 14 | 7 | 8 | 0 | 0 | 4 | 43 |
| Switzerland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 |
| Turkey | 0 | 27 | 4 | 9 | 3 | 0 | 0 | 12 | 45 |
| **Total Europe** | **1** | **25** | **13** | **14** | **5** | **1** | **0** | **9** | **32** |

### Agent Group 'Game and grazing'

In 2012 only minor damage from 'game and grazing' was observed on the assessed trees throughout Europe. Tab. 3.2.3.1-1 displays that only 1% of all recorded damages were caused by this agent group. It has however to be taken into account that only trees in KRAFT classes 1-3 are regularly assessed for damage types and browsing whereas in the herb and shrub layer no assessment was carried out. In 2012 the share of plots with trees damaged by game and grazing by 25% and lower was 82.6% (Fig. 3.2.3.1-2).

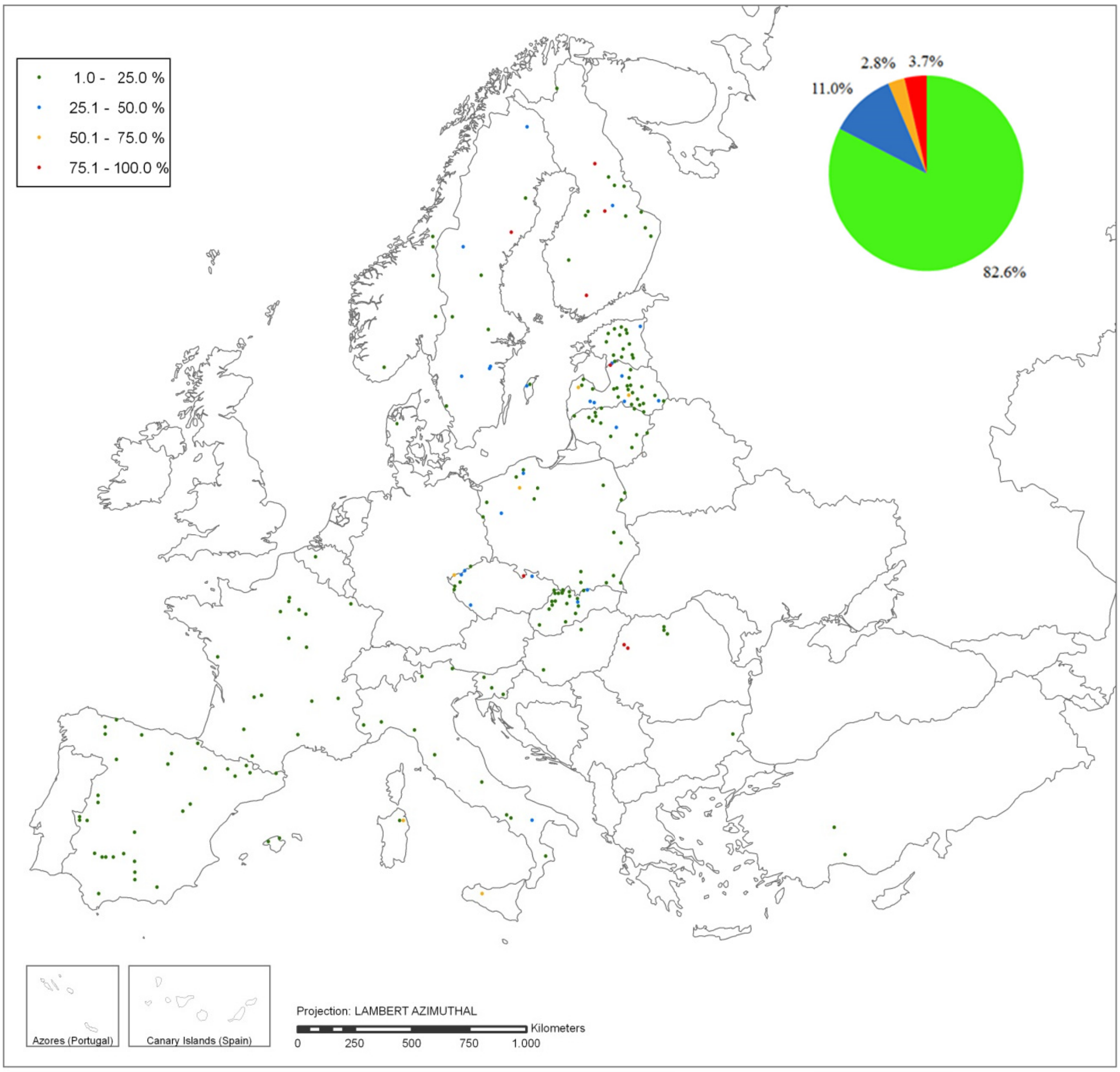


**Figure 3.2.3.1-2:** Shares of trees per plot with recorded agent group 'game and grazing', 2012

## Agent Group 'Insects'

'Insects' were the most frequently detected agent group (25% of all damage types) in 2012. They were observed in different intensities throughout Europe. On 48.5% of all affected plots, more than 25% of the trees were damaged by insects. Plots with over 75% of the trees affected account for nearly 21% of all plots. They occur in Slovakia, at the eastern edge of the Pyrenean Mountains, Italy and Cyprus (Fig. 3.2.3.1-3).

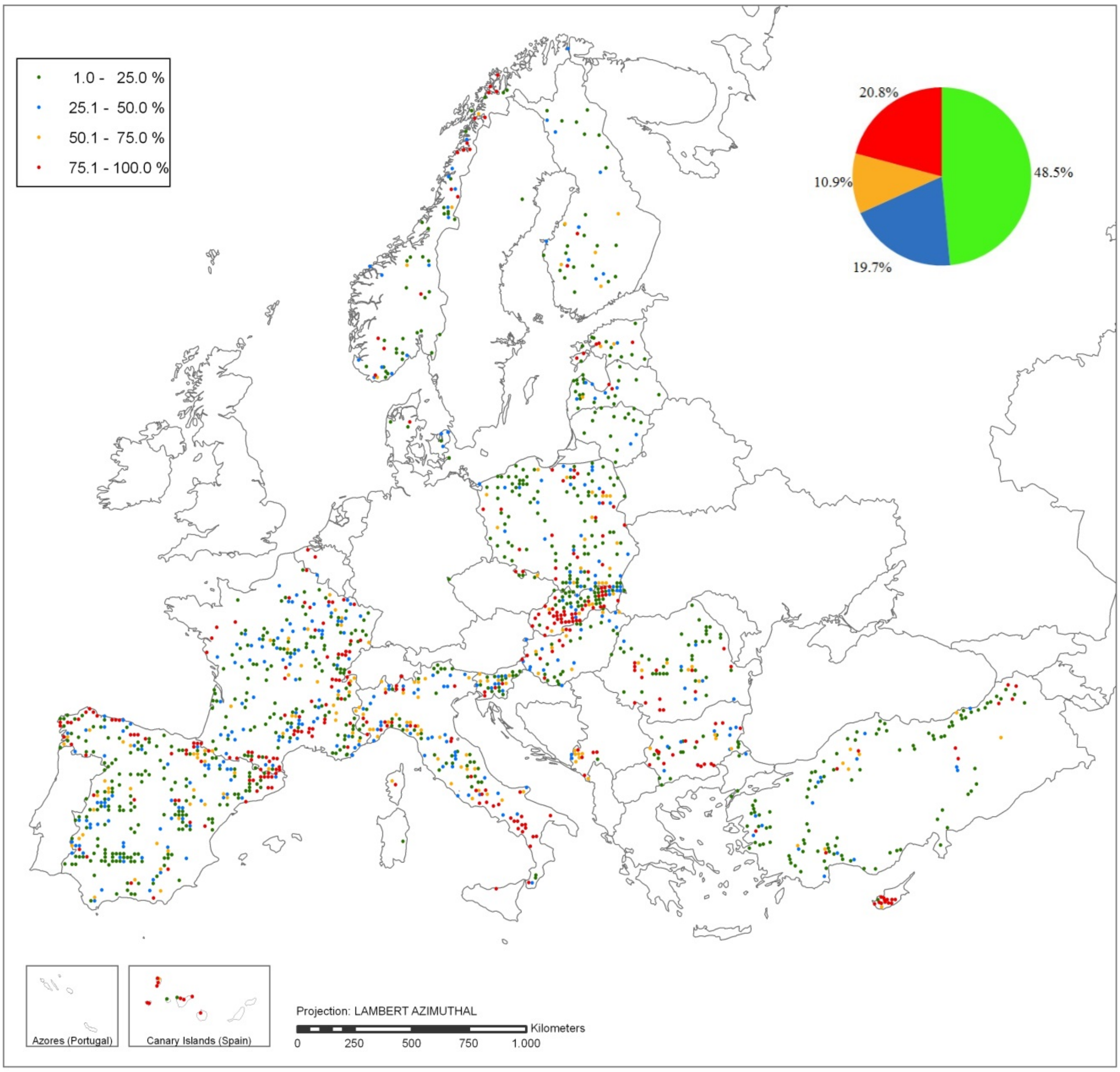


**Figure 3.2.3.1-3:** Shares of trees per plot with recorded agent group 'insects', 2012

### Agent Group 'Fungi'

Most affected plots (65.5%) showed only a small share of damaged trees. On 9% of all affected plots, between 50 and 75% of the trees showed damage caused by fungi, and on 7.6% of all plots more than 75% of the trees were damaged. A particularly high share of plots damaged by fungi was found in Estonia and western Bulgaria (Fig. 3.2.3.1-4).

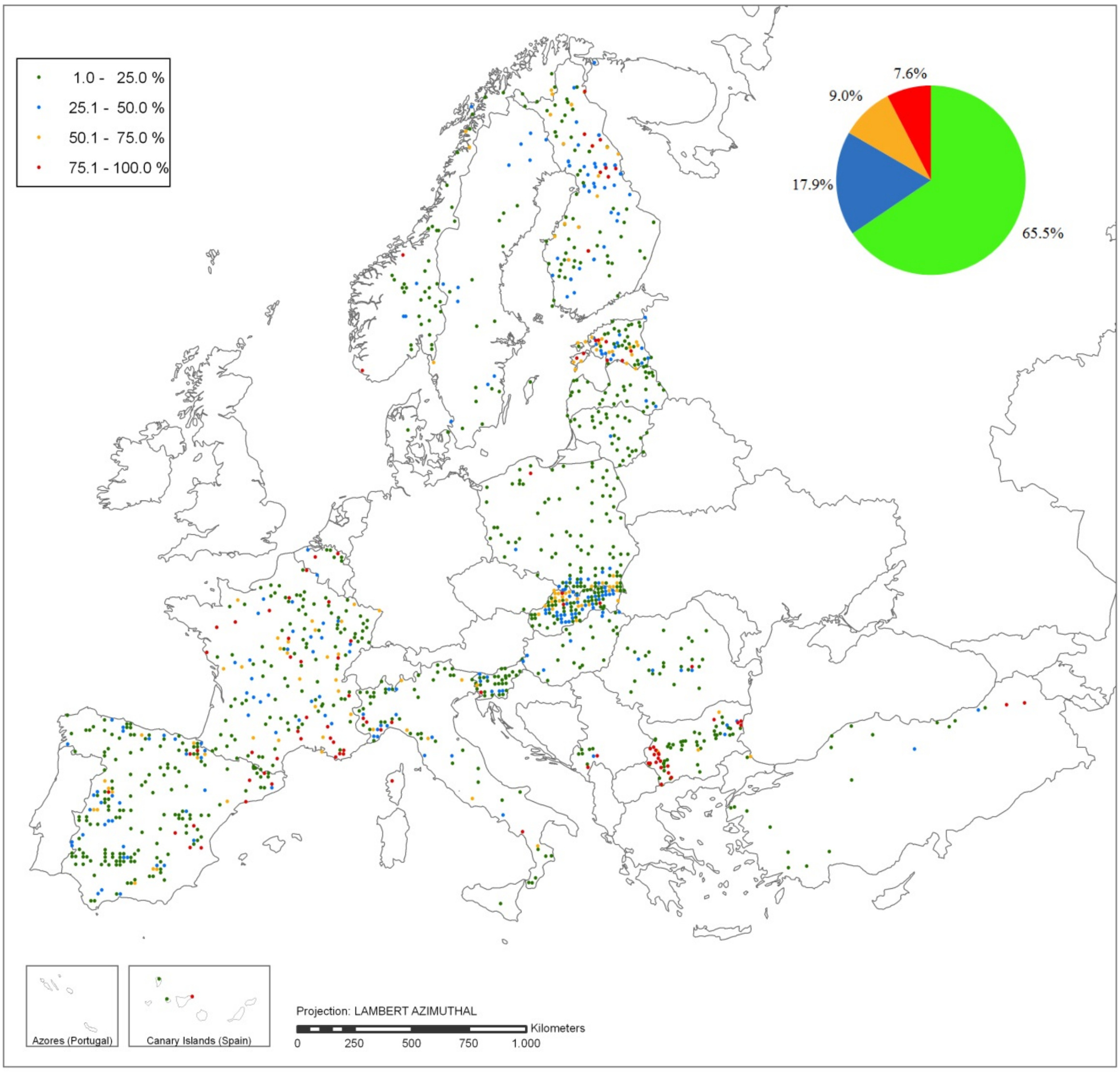


**Figure 3.2.3.1-4:** Shares of trees per plot with recorded agent group 'fungi', 2012

## Agent Group 'Abiotic agents'

In 2012, the share of trees with damage caused by "abiotic agents" was 14%. The most frequent causes were drought and frost. 66% of all affected plots showed a small share of damaged trees. Plots with a higher share of damaged trees were found mainly in southern Europe. In particular, these plots occurred at the eastern edge of the Pyrenean Mountains. A cluster of severe damage is in southern France (Fig. 3.2.3.1-5).

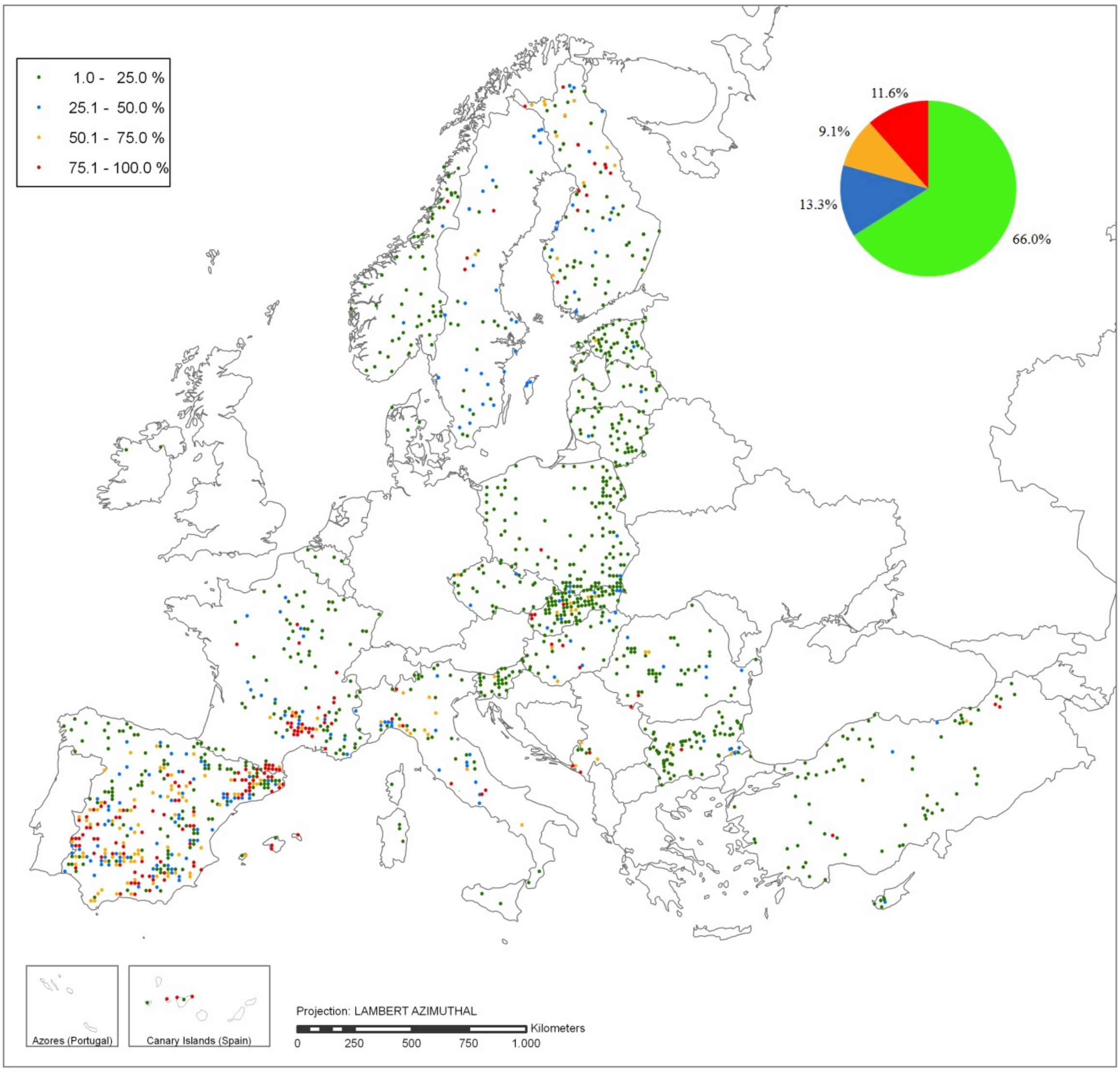


**Figure 3.2.3.1-5:** Shares of trees per plot with recorded agent group 'abiotic agent', 2012

## Agent Group 'Direct action of men'

To this group belong different damage types including improper silvicultural treatment, soil compaction, mechanical injure caused by skidding and others. For the majority of the plots (82%) the share of trees affected by the damage caused by direct action of men was 25% and lower. The percentage of plots more affected is very low. These plots were found in Slovakia and northern Poland. Some plots with 25 to 50% trees damaged were observed in Sweden and Finland (Fig. 3.2.3.1-6).

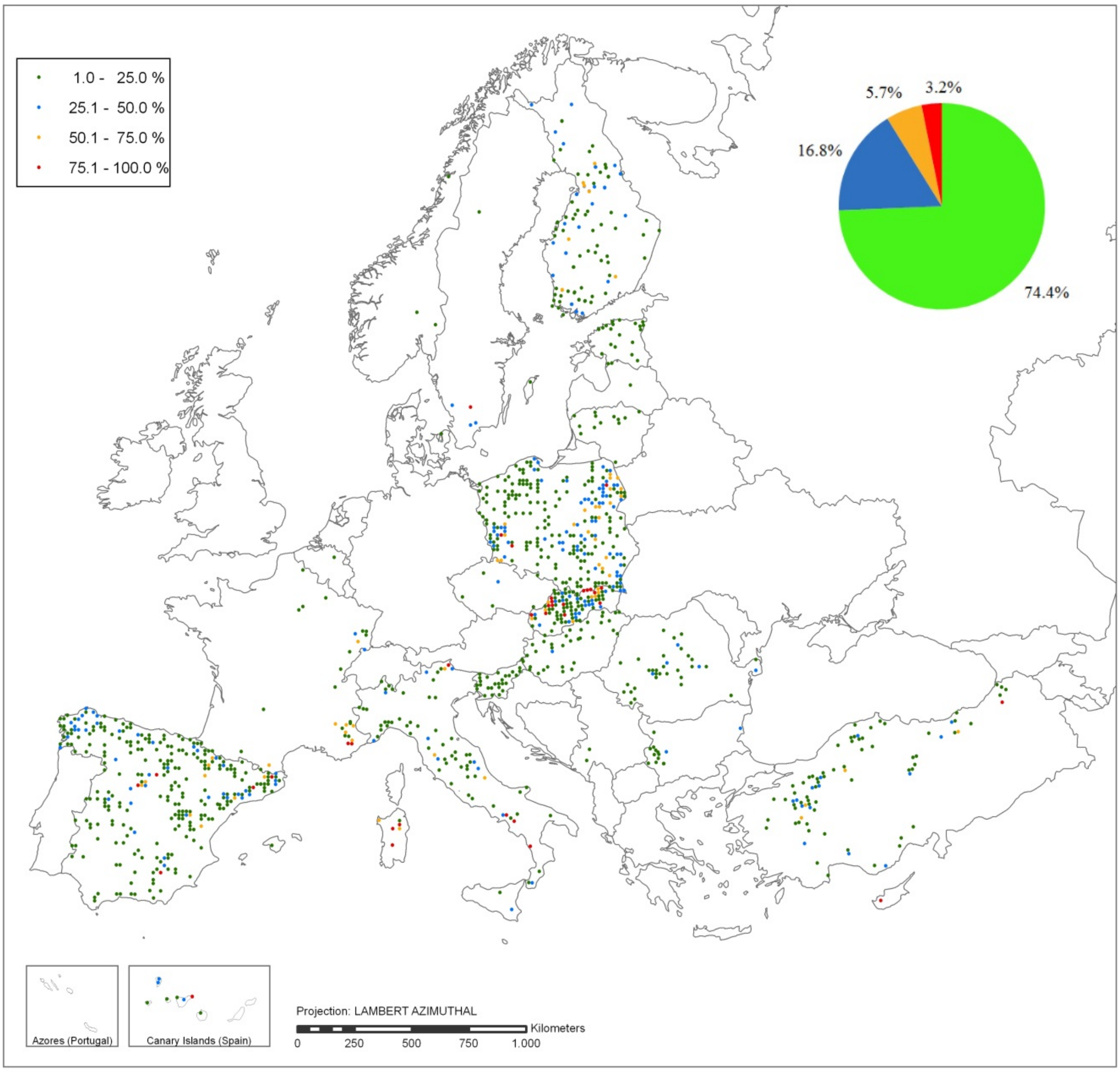


**Figure 3.2.3.1-6:** Shares of trees per plot with recorded agent group 'direct action of men', 2012

### Agent Group 'investigated but unidentified'

Due to the large variety of damage agents and symptoms damage could not exactly be specified on about 21 000 trees investigated (Fig. 3.2.3.1-1). The share of trees showing unidentified damage per plot is very different. Plots with 1 to 25% trees affected makes up 54.5% of all plots, followed by plots on which the share of trees with unidentified damage lay in 2012 between 25.1 and 50% (Fig. 3.2.3.1-7). Severely damaged plots by unidentified agents were observed in Estonia and Italy. In southern France and Turkey clusters of heavily damaged plots by unknown factors were observed whereas plots with shares of trees lying between 25 and 50% are rather evenly distributed over Europe's forests.

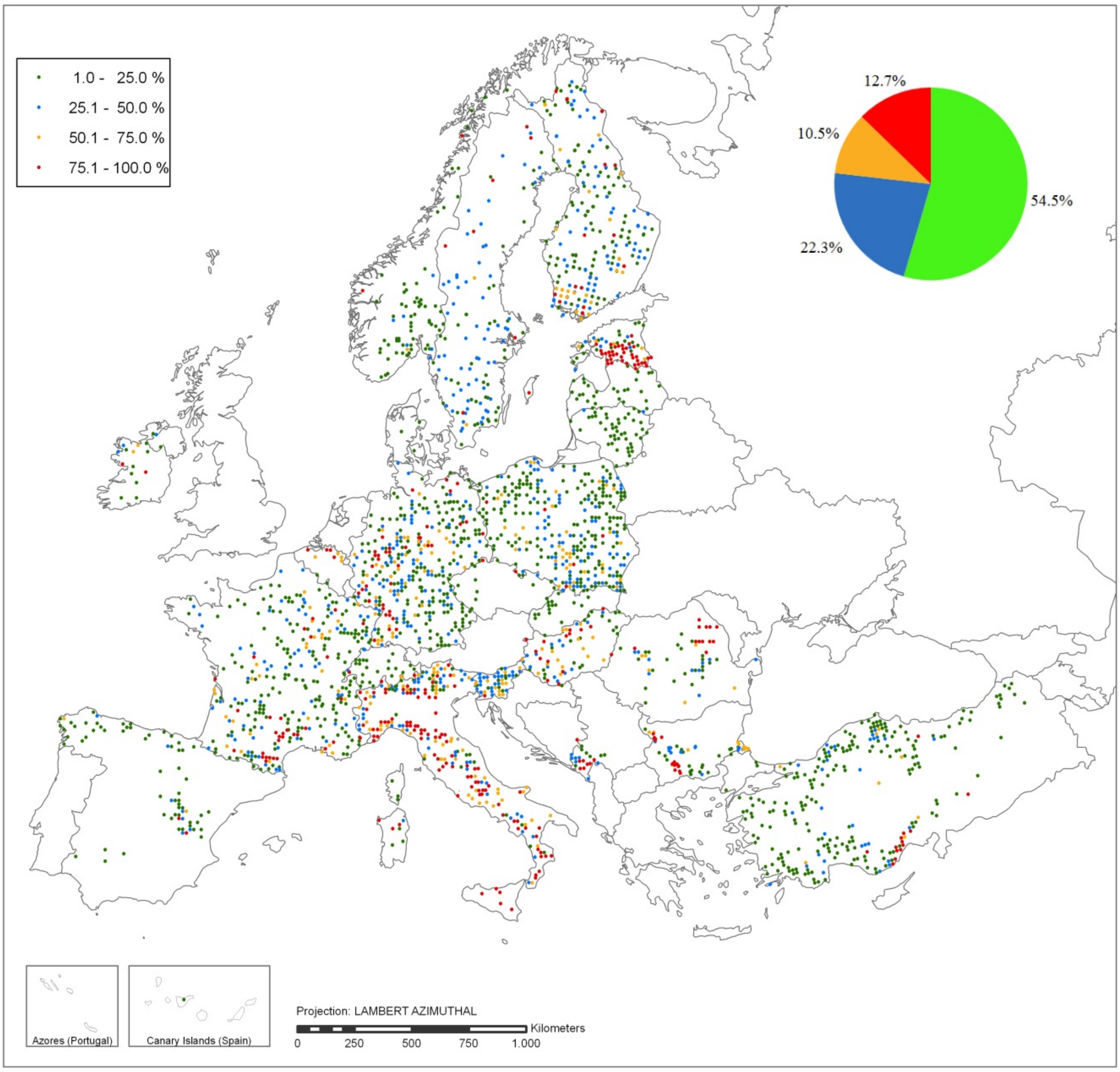


**Figure 3.2.3.1-7:** Shares of trees per plot with recorded agent group 'investigated but unidentified', 2012

## 3.3 Methods of the national surveys

National surveys are conducted in many countries in addition to the transnational surveys. The national surveys in most cases rely on denser national grids and aim at the documentation of forest condition and its development in the respective country. Since 1986, densities of national grids with resolutions between 1 x 1 km and 32 x 32 km have been applied due to differences in the size of forest area, in the structure of forests and in forest policies.

Results of crown condition assessments on the national grids are presented in Chapter 5 and Annex II. Comparisons between the national surveys of different countries should be made with great care because of differences in species composition, site conditions and methods applied.

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URL: http://www.sisef.it/iforest/contents/?ifor0480-002

# 4 SULPHATE AND NITROGEN DEPOSITION TO FORESTS AND TREND ANALYSES

Georg Becher, Peter Waldner, Karin Hansen, Richard Fischer, Martin Lorenz, Walter Seidling[3]

## 4.1 Introduction

The atmospheric deposition of sulphur (S) and nitrogen (N) compounds affects forest ecosystems through several processes. Deposition of acidifying compounds, inorganic nitrogen as a nutrient and base cations to forests in Europe is a major driver for many processes in forests.

In the frame of the LRTAP convention deposition measurements are carried out within both, the EMEP as well as in the ICP Forests programme of the WGE. One of the tasks of EMEP is a set of tools to derive maps of pollution levels and loads from emission inventories using transmission modelling. The bulk or wet deposition measurements of EMEP are used as validation for the maps in order to improve the tools.

The main objective of deposition measurements within ICP Forests are quantitative on-site (Level II) measurements of atmospheric deposition to forests across Europe usable for process oriented investigation of the causal chain between deposition and effects in forest ecosystems that are carried out on the ICP Forests Level II plots as well as assessing its changes over time. The objective of this chapter is to describe the bulk and throughfall deposition of sulphate and inorganic nitrogen (nitrate and ammonium) and its trends on ICP Forests Level II plots.

## 4.2 Methods

Continuous sampling of throughfall (TF) and bulk deposition (BD) is carried out on ICP Forests intensive monitoring plots (Level II) and at nearby open fields, respectively. The methods used in the countries (France: Ulrich & Lanier, 1993; Norway: Kvaalen et al., 2002; Moffat et al., 2002; Italy: Mosello et al., 2002; Switzerland: Thimonier et al., 2005; Finnland: Lindroos et al., 2006; Denmark: Gundersen et al., 2009; Czech Republic: Boháčová et al., 2010; Latvia: Lazdiņš, 2010; UK: Vanguelova et al., 2010; Swedish Throughfall Monitoring Network (SWETHRO): Pihl Karlsson et al., 2011; Belgium: Verstraeten et al., 2012) follow the ICP Forests Manual (earlier versions and ICP Forests, 2010). Collectors (approximately 10 to 20 replicates) are placed in the forest based on a random or fixed design in order to cover the spatial variation. Tests to determine the minimal number of samplers required to cover spatial variations to gain a representative plot mean have been carried out on a number of plots (e.g. Switzerland: Thimonier, 1998; UK: Houston et al., 2002; Belgum: Staelens et al., 2006). Samples are collected at least monthly,

[3] For contact information, please refer to Annex III-4.

filtered, and then stored at about 4°C before chemical analyses are performed to determine the concentrations of the macronutrients. The laboratory results are checked for internal consistency based on the conductivity, the ion balance, the concentration of organic N and the Na/Cl ratio, and analyses are repeated if suspicious concentrations are identified. The QA/QC procedures further include the use of control charts for internal reference material to check long-term comparability within national laboratories as well as participation in periodic working ring tests (e.g. Marchetto et al., 2006) to check international comparability.

Data was submitted annually by countries to the Programme Coordinating Centre (PCC), checked for consistency and stored in ICP Forests database.

Data from each sampling period were interpolated to regular monthly and annual data by: (i) splitting each sampling period overlapping two consecutive months and distributing precipitation quantity in proportion to the duration of the new sampling periods; (ii) setting deposition = 0 for periods with missing concentrations and mean precipitation < 0.1 mm day$^{-1}$; (iii) calculating bulk and throughfall deposition (qc, in kg ha$^{-1}$) by multiplication of the precipitation quantity (q, in L m$^{-2}$) and the concentrations (c, in mg L$^{-1}$); (iv) summing up fluxes by months and years, respectively.

The current deposition has been determined for plots with continuous measurements during 2011. We analysed temporal trends for plots with continuous measurements from 2006 to 2011 (6 years). We used the following completeness criteria of continuous measurement: (i) sampling during more than 330 days per year, (ii) missing concentration values for less than 35 days per year. Sampling periods with mean precipitation below 0.1 mm day$^{-1}$ were counted as non-missing even if no chemical analyses could be performed. Trend analyses were carried out with the Partial Mann-Kendall (PMK) tests (Libiseller & Grimvall, 2002) using interpolated monthly deposition data. Trend slopes were estimated following Sen (1968). These trend analyses were carried out in R (R Development Core Team, 2009) using the 'rkt' package (Marchetto, 2013).

## 4.3 Results

### 4.3.1 Current deposition

Annual throughfall (TF) and bulk deposition (BD) of sulphur and nitrogen was calculated for 221 plots in 24 countries with continuous measurement in 2011 (Figure 4.3.1-1 and Figure 4.3.1-2). High sulphur deposition (Figure 4.3.1-1) has been measured in northern central Europe especially in a region covering Belgium/Netherlands, Central Germany, Czech Republic and Poland, reaching up to the southern Baltic and the Central Hungarian area. Furthermore, high values have also been observed in some Mediterranean regions in Spain, France, Southern Italy and Greece. High sulphur depositions along the coast mostly occur with high Cl deposition, which is typical for sulphur that originates from sea salt.

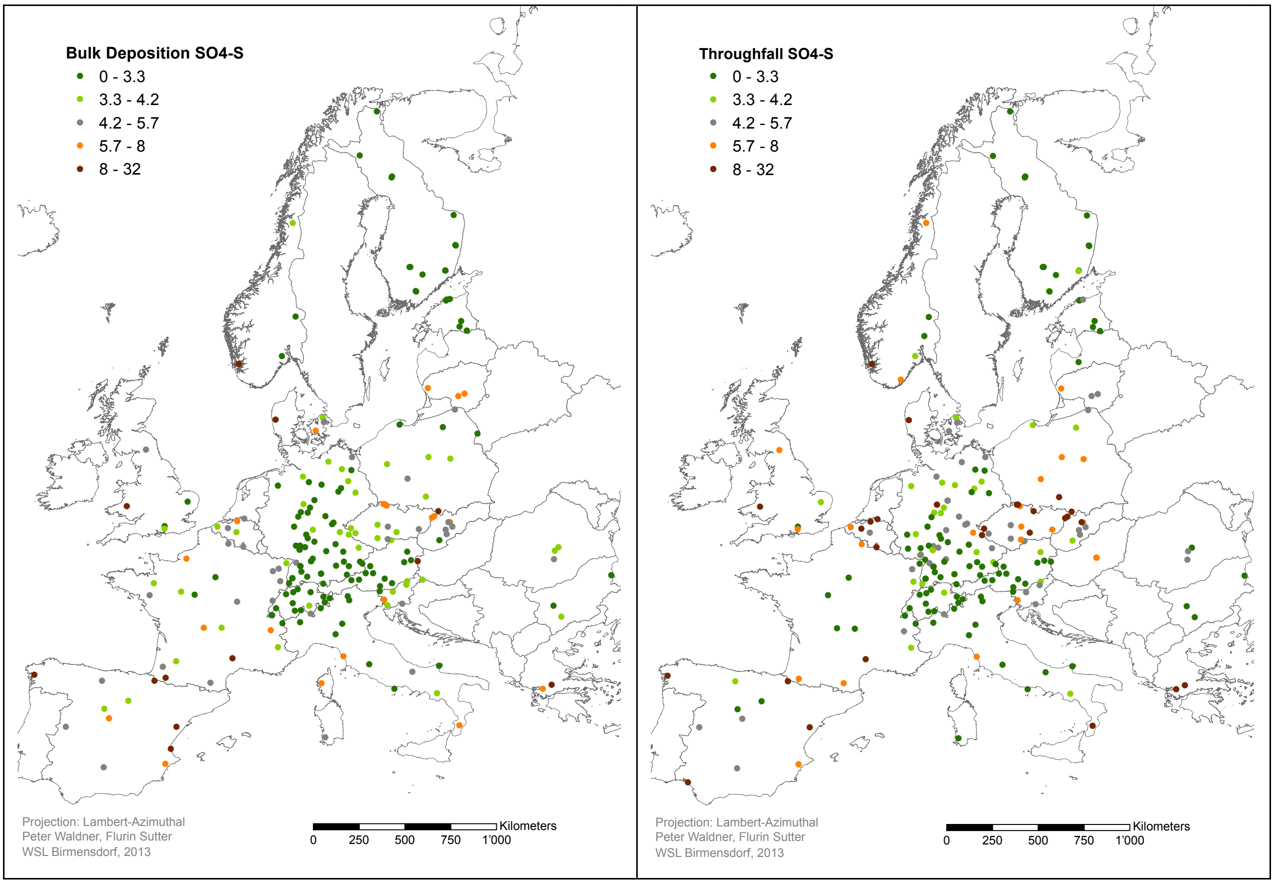


**Figure 4.3.1-1** Annual sulphate sulphur ($SO_4^-$-S) bulk and throughfall deposition in 2011 (in kg ha-$^{1}$).

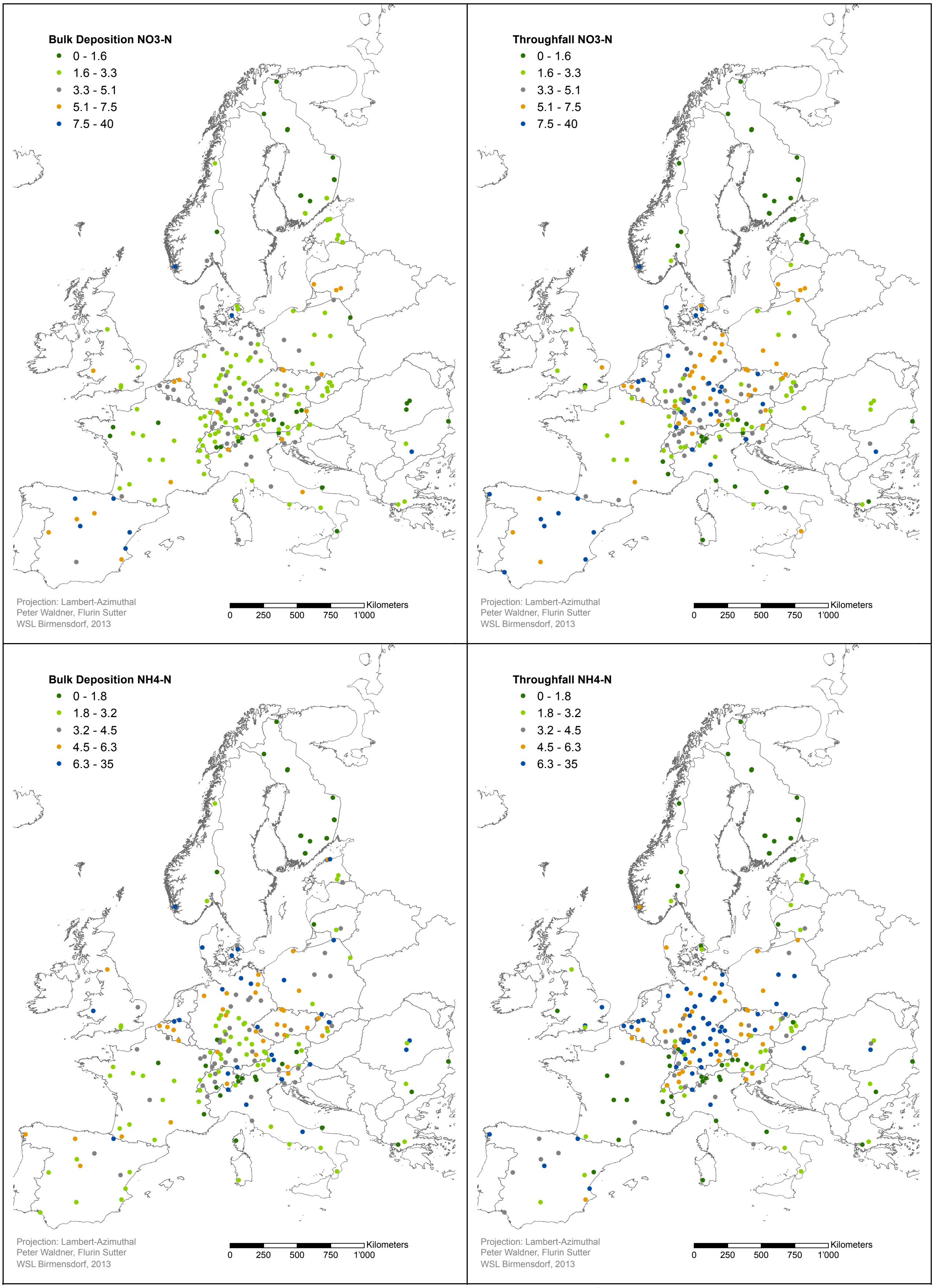


**Figure 4.3.1-2** Annual nitrate ($NO_3^-$-N) and ammonium ($NH_4^+$-N) bulk and throughfall deposition in 2011 (in kg $ha^{-1}$)

High nitrogen deposition (Figure 4.3.1-2) is also recorded in northern central Europe, as for sulphur, but extends further to the South down to southern Germany and the Swiss Plain and also further to the West, to northern France and central UK. In contrast to sulphur, the regions south of the Alps show relatively high bulk and throughfall deposition of nitrate and ammonium as well. In the Mediterranean area, relatively high values have been recorded at some sites in Spain.

## 4.3.2 Temporal trends

Trends for the period were calculated for 127 and 115 plots with continuous throughfall and bulk deposition measurements from 2006 to 2011, as well as for 83 and 78 plots with continuous throughfall and bulk deposition measurements from 2002 to 2011 (10 years), respectively (Figure 4.3.2-1, Figure 4.3.2-2 and Figure 4.3.2-3).

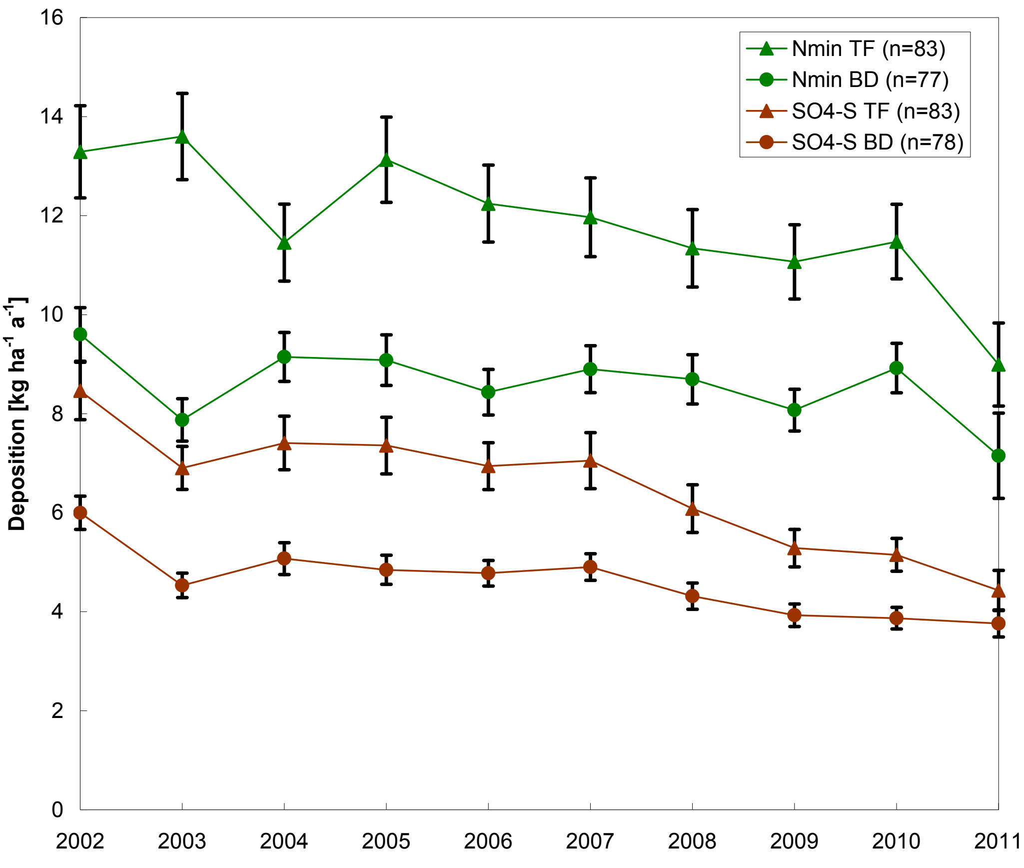


**Figure 4.3.2-1**: Mean sulphate ($SO_4^{--}$-S) and inorganic nitrogen ($NO_3^-$-N + $NH_4^+$-N) bulk and throughfall deposition on plots with continuous deposition measurements from 2002 to 2011 (n=number of plots).

The mean of the annual deposition of plots with continuous measurements from 2002 to 2011 decreased from about 8 and 6 kg S $ha^{-1}$ $a^{-1}$ to about 6 and 5 kg S $ha^{-1}$ $a^{-1}$ for throughfall and bulk deposition, respectively (Figure 4.3.2-1). The sulphur deposition showed a decreasing trend on the majority of plots for both periods 2002 to 2011 as well as 2006 to 2011 (Figure 4.3.2-2).

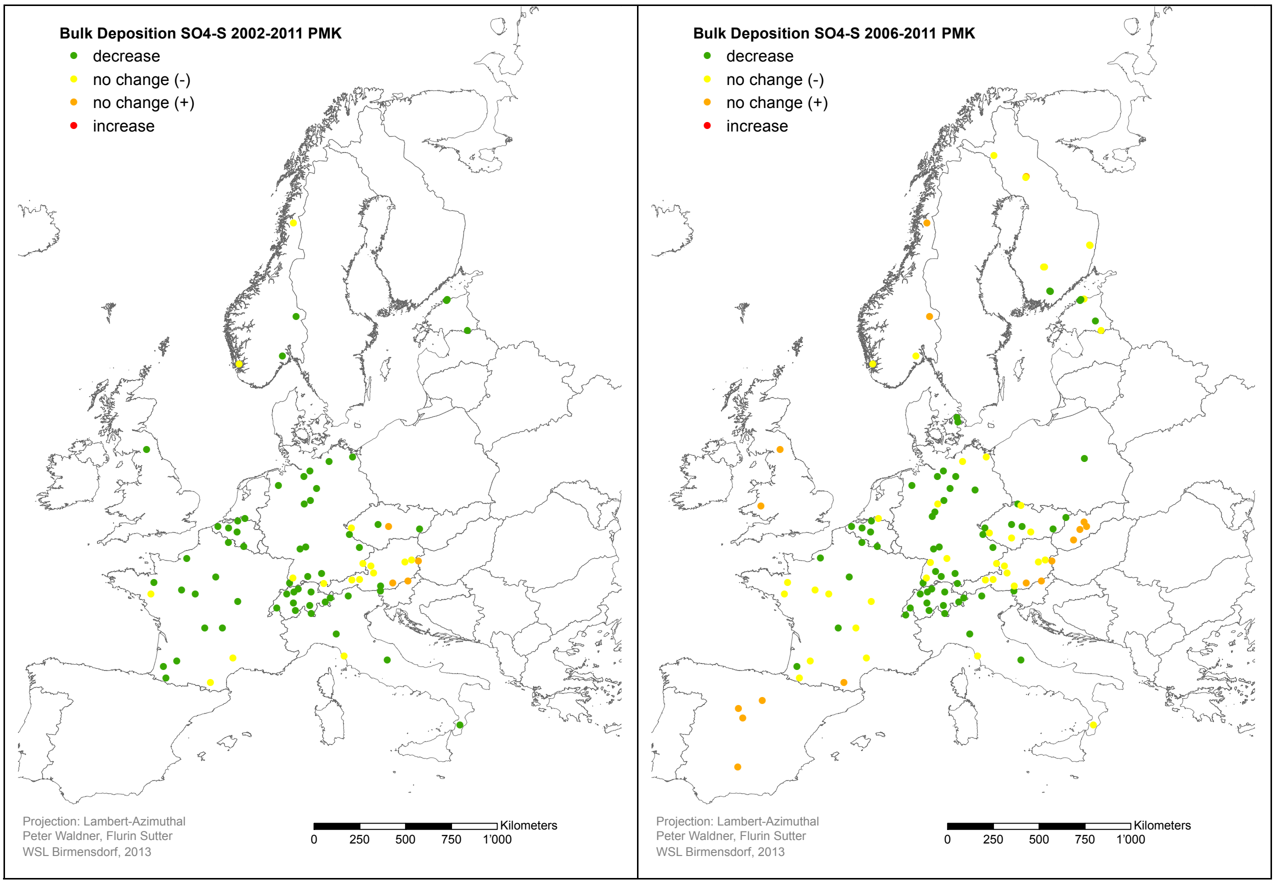


**Figure 4.3.2-2** Trend of sulphate ($SO_4^{-2}$–S) throughfall deposition on plots with continuous measurements from 2002 to 2011 and from 2006 to 2011. Non-significant positive trends are indicated with 'no change (+)' and non-significant negative trends with 'no change (-)'

The mean of annual throughfall deposition of inorganic nitrogen on plots with continuous measurements from 2002 to 2011 decreased from about 13 to about 11 kg N $ha^{-1}$ $a^{-1}$ in 2011 (Fig. 4.3.2-1); however, this decrease is not statistically significant. For nitrogen significant decreasing trends have been detected for fewer plots than for sulphate sulphur (Fig. 4.3.2-3).

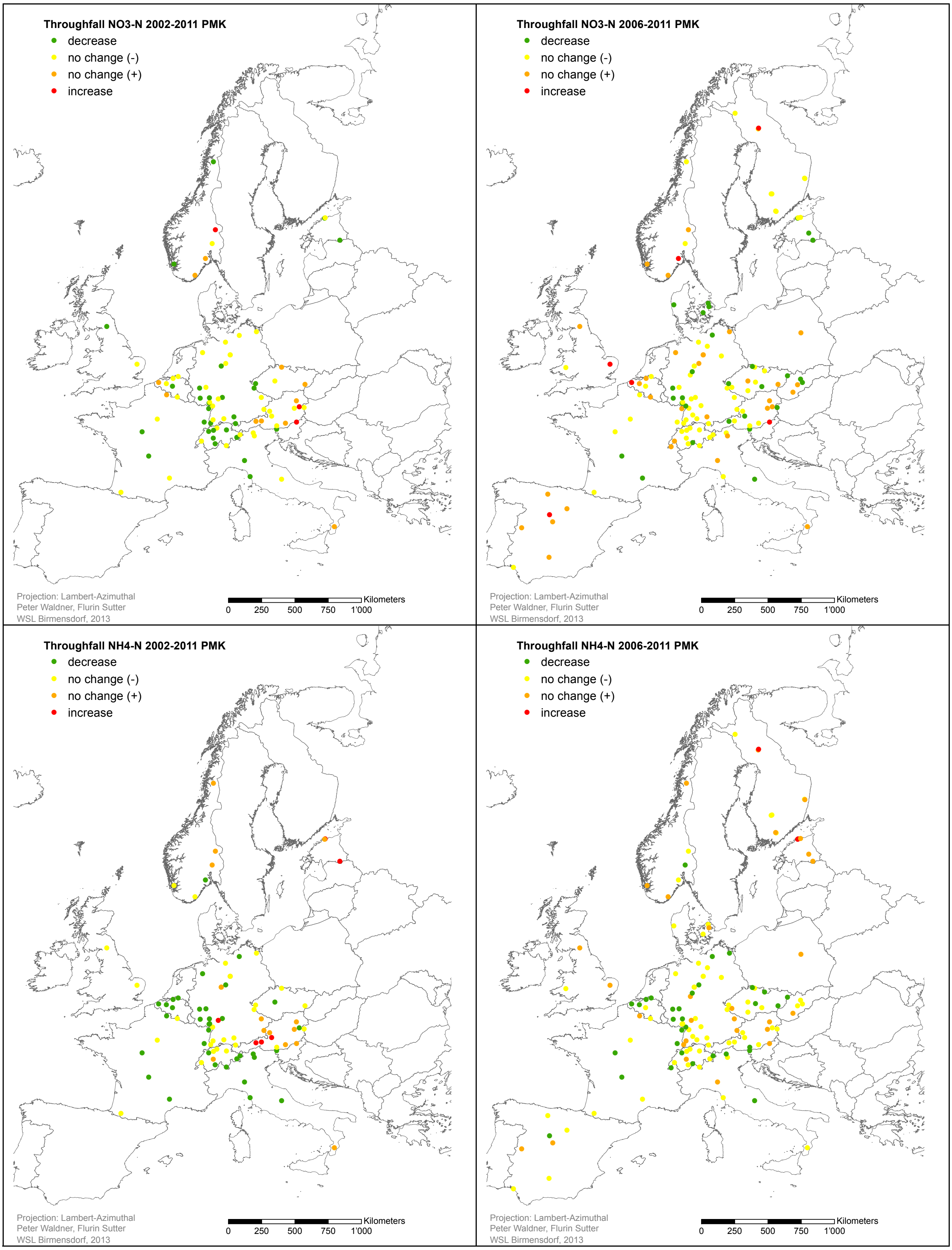


**Figure 4.3.2-3:** Trend of nitrate ($NO_3^-$-N) and ammonium ($NH_4^+$-N) throughfall deposition of plots with continuous measurements from 2002 to 2011 and 2006 to 2011. Non-significant positive trends are indicated with 'no change (+)' and non-significant negative trends with 'no change (-)'

## 4.4 Discussion

The patterns of atmospheric N and S deposition of the year 2011 as well as the trends of bulk and throughfall deposition for the periods 2002 to 2011 and 2006 to 2011 show similar patterns than that of ICP Forests deposition measurements in earlier years. The trends are also in agreement with other studies of either national ICP Forests data, EMEP data or other deposition measurements (e.g. Meesenburg et al. (1995), Rogora et al. (2006), Staelens et al. (2012), Pihl Karlsson et al. (2011), Kvaalen et al. (2002), Vanguelova et al. (2010), Graf Pannatier et al. (2011), Marchetto et al. (2013), Verstraeten et al. (2012), Johnson et al. (2013), Hunova et al. (2004), Oulehle et al. (2011), Fagerli et al. (2008)).

The atmospheric deposition values presented here are restricted to bulk and throughfall deposition fluxes of inorganic compounds. The total deposition to forests also includes organic compounds, stemflow, as well as canopy uptake. Especially for nitrogen, the exchange in the canopy causes the total deposition to typically be different from the throughfall fluxes.

## 4.5 Conclusions

Atmospheric deposition of N and S compounds to forests at the ICP Forests Level II plots cover a relatively wide range and are still relatively high at certain plots. There is a main tendency of decreasing atmospheric depositions in the last 6 and 10 years especially for S compounds. However, trend slopes vary from plot to plot. Significant decreasing trends have not been observed for all plots and especially for nitrogen compounds there were plots with significant increasing trends as well, especially for the period 2006 to 2011.

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# 5 NATIONAL REPORTS

## 5.1 Introduction

Twenty-eight countries have submitted an annual national report with the results of their 2012 national crown condition surveys. All written reports have been slightly edited for consistency and are presented below. Numerical results are compiled in Annex II.

Please note that in the national surveys the study design and number of plots can differ from the required 16 x 16 km grid used for the transnational analysis of forest conditions in Chapter 3 (Level I). It is, therefore, not possible to directly compare the results of the national surveys of individual countries in this chapter.

Missing values in the tables and figures in Annex II-1 to II-8 may indicate that data for certain years are missing or they indicate substantial differences in the samples, e.g., due to changes in the grid or the participation of a new country, as described in this chapter. For an explanation of the defoliation and discoloration classes used in this chapter, please refer to Table 3.1.1-3 on page 14.

## 5.2 Andorra

The assessment of crown condition in Andorra in 2012 was conducted, as for previous years, on the three plots of the transnational ICP Forests grid, and included 72 trees, 42 *Pinus sylvestris* and 30 *Pinus uncinata*.

The results obtained in 2012 continued to show an improving tendency in forest condition, as registered for the last three years. These results showed, for both species, a majority of trees classified in defoliation and discoloration classes 0 and 1.

In 2012 compared to 2011 the amount of pine trees damaged decreased from the classes 0 and 2 in favor of the classes 1 and 3, but the classes 0 and 1 are still in majority.

Related to defoliation, a decrease was registered in not defoliated and moderately defoliated trees and an increase in slightly defoliated trees. There were no trees registered with severe defoliation.

Results for discoloration showed a very important decrease in discoloration class 0 (no discoloration) from 58.3% in 2011 to 13.9% in 2012, an important increase in class 1 (slight discoloration) from 34.7% in 2011 to 77.8% in 2012, and a less important increase in class 2 (moderate discoloration). Severe discoloration was not reported. The severe climate conditions of 2012 could explain the deterioration of discoloration.

In 2012, the assessment of damage causes showed, as in previous surveys, that the main causal agent was the fungus *Cronartium flaccidum* which affected 6.9% of the sampled trees and was distributed in all plots.

## 5.3 Belgium

### Belgium/Flanders

The survey was conducted on 71 plots of the regional 4 x 4 km grid. One transnational 16 x 16 km plot was excluded from the survey because of a clear-cut. The plot design of the Flemish forest inventory was introduced but the 'Level I'-plots are not part of the NFI. Sample trees were selected on circular plots with a fixed radius of 18 m and the former cross cluster sampling was abandoned. Instead of a fixed number of 24 trees, the number of trees varied between 9 and 132 per plot. Of a total of 1778 assessed trees, 56.3% were broad-leaved species and 43.7% were conifers. The main species were *Quercus robur*, *Q. rubra*, *Fagus sylvatica*, *Populus sp.*, *Pinus sylvestris* and *P. nigra subsp. laricio*. A sample with 'other broadleaves' consists of species like *Alnus glutinosa*, *Castanea sativa*, *Q. petraea*, *Fraxinus excelsior*, *Betula pendula*, *Acer pseudoplatanus*, and others.

25.0% of the trees were in defoliation classes 2-4. The share of trees with moderate or severe defoliation was 18.5% and 5.0% respectively. 10.2% were considered as healthy and the mortality rate was 1.5%. Broad-leaved tree species revealed a higher defoliation than conifers. 29.0% of the broadleaves and 20.0% of the conifers showed more than 25% defoliation.

The proportion of moderately to severely defoliated 'other broadleaves' was 34.0%. There was a considerable increase of damage in one *Alnus glutinosa* plot. Defoliation was caused by *Phytophthora alni* infection, resulting in 21 dead trees and 74.2% of the trees being damaged. Because of the large number of sample trees in this plot, the results influenced the whole survey. The most affected other species were *Quercus robur*, *Pinus nigra subsp. laricio* and *Populus sp*. The crown condition of *Populus sp.* was comparable to last year but the condition of *Q. robur* and *P. nigra* deteriorated. The share of trees in defoliation classes 2-4 was 25.8% for *Populus sp*., 34.7% for *Q. robur* and 39.9% for *P. nigra*.

The condition of *Fagus sylvatica* improved, with only 8.3% of the trees showing more than 25% defoliation. Other less affected species were *Q. rubra* and *P. sylvestris*, with 9.7% and 14.0% moderately to severely defoliated trees.

Damage by defoliators was observed in several oak plots. On 41.4% of the *Q. robur* trees, more than 10% of defoliation was caused by insects. In one plot, consecutive years of severe defoliation by *Thaumatopoea processionea* resulted in tree death.

Symptoms of fungi were recorded frequently on *Populus sp*. (*Melampsora larici-populina,* rust infection), *Q. robur* (*Microsphaera alphitoides*, powdery mildew) and *P. nigra* (*Scirrhia pini*, red needle blight). Severe discoloration by *Scirrhia pini* was recorded on 35.9% of the *P. nigra* trees. There was a higher incidence of *S. pini* compared to previous years. *Microsphaera alphitoides* infection resulted in 32.0% of *Q. robur* trees with discoloration on more than 10% of the leaf area. The wet summer of 2012 stimulated the spread of fungal diseases like *M. alphitoides*.

### Belgium/Wallonia

The survey in 2012 concerned 816 trees on 36 plots, on a regional 8x8 km systematic grid. The percentage of trees with a defoliation ≥25% shows different long term trends for conifers and broad-leaved:

The conifers, which were two times more defoliated in the beginning of the nineties, showed a rate of 21.6% in 2012, lower than the previous year but higher than in the last decade.

The broad-leaved showed an increase from 10% in 1990 to about 20% in 2005. These damages were mainly due to the degradation of the beech (Scolytidae in 2000-2002, drought in 2003 followed by fruiting in 2004) and of the European oak (drought in 2003). The rate decreased from 2006 till 2008 with 15.2%, but severely increased in 2009 with 32%, and in 2010 with 33.4%. In 2012 the rate had increased to 39.2% which is the highest level ever observed!

Concerning the mean defoliation observed for the four main species, after an improvement since 2006 for beech and European oak, mean defoliation increased to about 27.5% for beech and 27.9% for European oak in 2012. Sessile oak was in a bad condition in 2012 with 22.2%, 5% higher than last year. Spruce showed a non-significant increase, with 16.1% in 2012.

Climatic conditions in 2012 do not explain the bad condition of trees; rainfall was at a high level from April to July, with just a dryer period in August and September, with normal temperatures. But the trend is negative since 2008, and we suppose a cumulative effect of stresses in the previous years.

## 5.4 Bulgaria

The realization of the Program for large-scale monitoring of forests in Bulgaria in 2012 was implemented on 159 sample plots, with a total number of 5612 sample trees. Observations on defoliation, biotic and other stress factors were carried out on sample plots of the following coniferous tree species: *Pinus sylvestris* L., *Pinus nigra* Arn., *Picea abies* (L.) Karst., *Abies alba* Mill., and the broadleaf species: *Fagus sylvatica* L., *Quercus frainetto* Ten., *Quercus petraea* (Matt.) Liebl., *Quercus cerris* L., *Quercus rubra* L., *Tilia platyphyllos* Scop. and *Carpinus betulus* L. The total number of observed coniferous sample trees is 2406 and the number of observed broadleaf trees is 3206.

The predominant part of observed trees has defoliation ranging from 25% to 67.7%. Within the interval class 2-4, the percentage of medium defoliated trees is the highest with 25.2%. In comparison with the results of the observations carried out in 2011 the percentage of healthy trees and trees slightly affected by defoliation has decreased by 7.5%. The difference is greater in the 3rd and 4th class, where the percentages of severely defoliated and dead trees have increased respectively by 2.5% and 3.5%. The observed broadleaf tree species are in a slightly better condition than the conifers. 78.0% of the observed *Fagus sylvatica* L. trees up to 60 years old and 85.5% of the *Fagus sylvatica* L. trees over 60 years old have up to 25% (0+1 class) defoliation. Defoliation up to 25% also prevails in observed *Quercus cerris* L. trees (64.8% among trees up to 60 years old and 57.5% among trees over 60 years old). The defoliation of *Quercus frainetto* Ten. has increased, as in the 4th class of trees up to 60 year old, the percentage of defoliation has increased from 0.7% to 6.3%, despite the fact that the number of healthy trees has also increased – from 2.4% to 16.4%. Deterioration in the condition of the observed stands from this tree species aged above 60 years has also been observed. The highest percentage of defoliation is in the 2nd class. The condition of *Quercus cerris* L. is also similar. In comparison with 2011, a significant deterioration in the condition of *Quercus petraea* (Matt.) Liebl. trees has been observed with a decreased number of healthy trees and greatly increased number of dead trees. Among coniferous tree species *Abies alba* Mill. is in the best condition, as 90.3% of the observed trees are healthy and slightly defoliated (1.6% more than in 2011). A decrease by 14.9% of defoliation in the 0 class has been observed in *Picea abies*; in all other classes the defoliation has increased. *Pinus sylvestris* L. and *Pinus nigra* Arn. are in a similar condition, as the percentage of healthy and slightly defoliated trees is greater. In comparison with 2011 an increase in dead *Pinus nigra* Arn. trees by 1.3% and in dead *Pinus sylvestris* L. trees by 2.9% has been observed.

The described biotic damages and their causes have not resulted in significant changes in the condition of the studied trees.

## 5.5 Croatia

The percentage of trees of all species within classes 2-4 in 2012 (28.5%) was higher than in 2011 (25.4%), and highest in the last ten years. In the forest condition survey in 2012, there was an increase of 8 plots in comparison to year 2011. Exactly 100 sample plots (2400 trees) on the 16 x 16 km grid network were included in the survey after an extensive field inspection of non-active plots. The mean annual temperature in Croatia in 2012 was higher than normal, and precipitation was normal to very low. These climatic conditions had an obvious impact on tree crown condition classes 2-4 (23.7%), which was also highest in the last ten years of survey. For conifers, the percentage of trees in classes 2-4 was 54.7%, a significant increase from year 2011 (45.1%). There were 369 conifer trees and 2031 broadleaves in the sample.

*Pinus nigra*, with 70.6% trees in the classes 2-4, along with *Abies alba* (67.9%) were our most defoliated tree species.

With broadleaved trees, the deterioration of crown condition was most prominent in pedunculate oak. The percentage of *Quercus robur* trees in classes 2-4 was fairly constant at around 25-30% until the year 2000. Afterwards it decreased to values below 20% (15.4% in 2003, 18.5% in 2004). In 2005 a slight increase was recorded with 22.1%, followed by 22.2% in 2008, 22.8% in 2009, 26.0% in 2010 and 22.3% in 2011. This year the value was 27.8% of moderately to severely defoliated oak trees.

*Fagus sylvatica* remains one of the lowest defoliated tree species with 13.7% trees in defoliation class 2-4. In the last ten years of monitoring, this percentage varied from 5.1% in 2003 to 13.8% in year 2011.

## 5.6 Cyprus

The annual assessment of crown condition was conducted on 15 Level I plots during the period September - October 2012. The assessment covered the main forest ecosystems of Cyprus and a total of 360 trees (*Pinus brutia*, *Pinus nigra* and *Cedrus brevifolia*) were assessed. Defoliation, discoloration and the damaging agents were recorded.

A comparison of the results of the conducted survey with those of the previous year (2011) shows a significant improvement among all species. From the total number of trees assessed (360 trees), 25.8% of them were not defoliated, 63.6% were slightly defoliated, 10% were moderately defoliated, and 0.6% were severely defoliated.

A comparison with the results of the previous year, the 2012 results show an increase of 13.3% in class 0 (not defoliated). A decrease of 7.5% in class 1 (slightly defoliated) and a decrease of 5.8% in class 2 (moderately defoliated) have been observed. No changes have been observed in class 3 and no dead trees have been recorded (class 4, Dead). The observed improvement of crown in 2012 is mainly due to the sufficient rainfall of the period 2008 - 2011.

In the case of *Pinus brutia*, 27% of the sample trees showed no defoliation, 61.3% were slightly defoliated, 11.3% were moderately defoliated and 0.3% were severely defoliated. For *Pinus nigra*, 27% of the sample trees showed no defoliation, 61.3% showed slight defoliation while the rest (11.3%) were moderately defoliated and 0.3% were severely defoliated. For *Cedrus brevifolia*, 19.4% of the sample trees showed no defoliation, 77.8% were slightly defoliated and 2.8% were moderately defoliated. No dead trees have been observed.

From the total number of trees assessed (360 trees), 100% of them were not discolored.

From the total number of sample trees surveyed, 68.3% showed signs of insect attacks and 6.9% showed signs of attacks by “other agents, T8” (lichens, dead branches and rat attacks). Also 6.7% showed signs of both factors (insect attacks and other agents).

The major abiotic factors causing defoliation in some plots during 2012 were the combination of climatic and edaphic conditions which resulted to secondary attacks by *Leucaspis* spp. and defoliator insects to half of the trees.

## 5.7 Czech Republic

In the older age category of coniferous species (forest stands at 60 years of age and more) very moderate deterioration in the development of total defoliation occurred in 2012 compared to the previous year due to a less pronounced decrease in percent defoliation in class 0 and an increase in percent defoliation in class 1. Norway spruce (*Picea abies*) with the highest species representation in this age category (63%) contributed to this change to the greatest extent. No pronounced changes were observed in the other tree species in this age category (*Pinus sylvestris*, *Abies alba* and *Larix decidua*). Compared to the previous year, in 2012 the development of total defoliation was also worse in the younger age category of coniferous species (forest stands younger than 59 years of age); it was partly much worse than in the older age category. Spruce also contributed to this change to the largest extent because percent defoliation in class 0 decreased from 59.9% in 2011 to 53.3% in 2012 while at the same time percent defoliation in class 1 increased from 29.7% in 2011 to 37.3% in 2012.

The development of total defoliation of broadleaved species in the older age category (forest stands of 60 years of age and more) showed a moderate improvement due to a decrease in percent defoliation in classes 1 and 2 and a simultaneous increase in percent defoliation in class 0. European beech (*Fagus sylvatica*) contributed to this change to the greatest extent as its percentage in defoliation class 0 increased from 23.9% in 2011 to 29.9% in 2012 at a simultaneous decrease in percent defoliation in classes 1 and 2. Only a very moderate improvement was observed in oak (*Quercus* sp.). Similarly like in older broadleaves, in younger broadleaves (forest stands younger than 59 years) there was a moderate decrease in total defoliation due to a decrease in defoliation class 2 and an increase in percent defoliation in classes 1 and 0. The contribution of beech to this change was also greatest in which its percentage in defoliation class 0 increased very distinctly from 54.9% in 2011 to 81.6% in 2012 and its percentage in classes 1 and 2 decreased at the same time. Like in the older category, only a very moderate improvement was recorded in oak.

Younger coniferous species (less than 59 years) show lower defoliation in the long run than forest stands of younger broadleaves. In older stands (60 years old and more) this comparison gives an opposite result: older conifers have pronouncedly higher defoliation than the stands of older broadleaves. The share of pine of both age categories with higher percent defoliation is crucial in the group of coniferous species.

A distinct improvement in defoliation of beech stands was caused by the regeneration of crowns severely damaged by late spring frost in the preceding year. A moderate worsening of defoliation in coniferous species was probably also influenced by adverse weather conditions. Average monthly temperatures in the period of March – September were above average compared to the long-term normal temperatures (deviation in the range of 0.5 – 2.7°) while average monthly precipitation amount was mostly below average in the same period in this comparison, reaching 38 – 100% of the normal precipitation (except July with 144%). This adverse ratio of temperature to precipitation amount was highest in March when precipitation reached only 38% of the normal amount and average temperature was higher by 2.7° C than the long-term average. Higher temperatures particularly at lower altitudes above sea level have a negative influence on the health status of spruce stands.

No pronounced change has been recorded in the emissions of main pollutants (particulate matter, SO2, NOx, CO, VOC, NH3) in the last ten years; total emissions of the majority of these compounds have moderately decreased in the long run in spite of some fluctuations and the emissions of particulate matter and NH3 have been at a constant level.

## 5.8 Denmark

The Danish forest condition monitoring in 2012 was carried out in the National Forest Inventory (NFI) and on the remaining Level I and II plots. Monitoring showed that most tree species had satisfactory health status. As in previous years an exception is *Fraxinus excelsior* where the problem with extensive dieback continued. Average defoliation was 29% for all monitored ash trees, and 42% of the trees had more than 30% defoliation. In some ways, even these data do not completely reflect the situation, because many diseased ash stands are clear cut. This is reflected in timber statistics, where the amount of ash harvested rose significantly in 2010 and 2011.

*Picea abies* stayed at a low average defoliation of 6%, and the health situation for *P. abies* in Denmark is still very good based on monitored stands. However, it should be recalled that the main calamities of Norway spruce in Denmark are wind throw and bark beetle (*Ips typographus*) attack. These problems are rarely reflected in defoliation scores, as such stands are removed by forest management. Other conifers such as *Picea sitchensis* and *Pinus* sp. had a slightly higher defoliation at 9.5% and 11% respectively, but the health of conifers in general can be considered satisfactory. The average defoliation score of *Fagus sylvatica* decreased to 9%, and the health of beech is clearly influenced by average precipitation in the growth season, which has increased in the past decade. Average defoliation of *Quercus* (*Q. robur* and *Q. petraea*) increased to 18% due to widespread attacks by defoliators such as *Operophtera brumata*, and the frequency of damaged trees rose from 15% to 22%, reflecting the importance of spring defoliation by caterpillars for the health of oak.

Based on defoliation assessments on NFI plots and Level I & II, the results of the crown condition survey in 2012 showed that 77% of all coniferous trees and 68% of all deciduous trees were undamaged. 18% of all conifers and 21% of all deciduous trees showed warning signs of damage. The mean defoliation of all conifers was 7% in 2012, and the share of damaged trees was less than 5%. Mean defoliation of all broadleaves was 12%, and 11% of the trees were damaged, which is similar to 2011. The main damage causes were ash dieback and defoliation of oak.

## 5.9 Estonia

Forest condition in Estonia has been systematically monitored since 1988. In 2012 altogether 2348 trees, thereby 1465 pines (*Pinus sylvestris*), 582 spruces (*Picea abies*) and 227 birches (*Betula pendula*),were examined on 97 permanent Level I sample plots from July to October.

The total share of not defoliated trees (49.4%) was by 1.4% lower than in 2011. The percentage of trees in classes 2 to 4, moderately to dead, was 7.8%. Thereby the percentage of conifers in classes 2 to 4, moderately to dead, was in 2012 6.7%.

In Estonia the most defoliated conifer tree species has traditionally been Scots pine (*Pinus sylvestris*), but a little improvement in crown conditions as compared to 2011 happened. Some decrease in defoliation of Norway spruce (*Picea abies*) occurred, the share of not defoliated trees (defoliation class 0) was 54.3%.

The percentage of broadleaves in classes 2 to 4, moderately to dead, was in 2012 15.0%, but in 2011 only 3.0%. Thus serious changes in crown conditions as compared to 2011 happened. The share of not defoliated birches was in 2011 74% and in 2012 59%.

Numerous factors determine the condition of forests. Climatic factors, disease and insect damage as well as other natural factors have an impact on tree vitality.

In 2012 8.2% of the trees had some kind of insect damages, 28.3% were with identifiable symptoms of disease and 4.8% with identifiable abiotic damages. Pine shoot blight was the most significant reason of biotic damage of pine and winter moth was the main reason of increased birch defoliation.

## 5.10 Finland

The large-scale crown condition survey (Level I) has been carried out in Finland on a systematic network of permanent sample plots for 26 years, since 1986. Before 2009, a subsample of the permanent plots was established during 1985–1986 in connection with the 8th National Forest Inventory (NFI).

The integration between ICP Level I and NFI was accomplished in 2009 in Finland. The sampling design of the current NFI is a systematic cluster sampling. The distance between clusters, the shape of a cluster, the number of field plots in a cluster and the distance between plots within a cluster vary in different parts of the country according to spatial variation of forests and density of the road network. Principally, every fourth cluster is marked as a permanent cluster. Annually, a new set of permanent plots, established during the 9th NFI in 1996-2003, is assessed in the forest condition survey. The trees are sampled by the relascope. Tallied dominant and co-dominant Norway spruce, Scots pine and birch trees from six pre-selected permanent plots from each cluster are assessed. The same permanent plots will be assessed in five-year intervals. In 2009-2010 all trees were assessed, but since 2011 a maximum of six trees per appropriate species were included in the sample, resulting in a reduced number of assessed trees, owing to limited resources.

Please note that because the plots assessed during 2009-2012 are completely different samples each year, the results are not directly comparable with each other or with the results from the previous years. Also please note that the number of assessed trees was greatly reduced in 2011 and 2012, as compared to 2009 and 2010.

The results of the 2012 forest condition survey are reported from pre-selected 785 permanent sample plots. The number of observation trees was 4676. Of the 4637 trees assessed for defoliation, 61.9% of the conifers and 45.7% of the broadleaves were not defoliated (leaf or needle loss 0-10%). The proportion of slightly defoliated (11-25%) conifers was 37.3%, and that of at least moderately defoliated (over 26%) 14.6%. For broadleaves the corresponding proportions were 32.9% and 12.8%, respectively. The proportion of moderately defoliated trees, especially broadleaves, was somewhat higher than in 2011.

The average tree-specific degree of defoliation was 14.2% in Scots pine, 21.7% in Norway spruce, and 15.4% in broadleaves (*Betula pendula* and *B. pubescens*). Compared to the previous year, especially the Norway spruces, but also broadleaves (*Betula* sp.) were statistically significantly more defoliated than in 2011.

Abiotic and biotic damage was also assessed in connection with the large-scale monitoring of forest condition. 25.8 (31)% of the Scots pines, 33.3 - 28% of the Norway spruces and 25.2 - 23% of the broadleaves were reported to have visible symptoms attributed to abiotic or biotic damaging agents. The number of symptomatic trees was almost at the same level (27.6%) compared to the previous year (28.6%). Scots pines had more abiotic (excess water, wind and snow) damage than in 2011. On the other hand less damage by the common pine sawfly (*Neodiprion sertifer*) was observed (0.7% in 2012 as compared to 3.1% in 2011). Norway spruces had more abiotic (wind and snow) damage, but especially *Chrysomyxa ledi* (6.3%) (and also unidentified rust fungi) were more common in 2012 than in 2011. More injuries attributed to snow and climatic factors were recorded in birch trees in 2012 than in 2011.

## 5.11 France

In 2012, the forest damage monitoring in the French part of the systematic European network comprised 11 648 trees on 563 plots. The increase in plot number is due to a correction in the network taking into account the increasing forest area in France since several years.

The climatic conditions of the year were reasonably favourable to the forest vegetation due to quite a rainy spring.

The foliage of most broadleave and conifer species seemed to slightly decrease in young stands and to increase in older ones. *Quercus pubescens* and evergreen oak, species which are frequent in the South East of France, still had the worst crown condition of all monitored species in 2012, and did not show any sign of improvement.

Death of sampled trees stayed at a relatively low level. The number of discolored trees was still low except for poplars, beech, wild cherry and Aleppo pine.

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

## 5.12 Germany

Forest condition has slightly improved in comparison to the previous year. Beech trees recovered from previous year’s deficient crown condition. The crown condition of Scots pine improved as well, while spruce showed hardly any change. In contrast, oak trees further worsened, starting from an already high degree of defoliation.

On average over all tree species, 25% (2011: 28%) of the forest area was assessed as damaged, i.e. showing more than 25% of crown defoliation (damage classes 2 to 4). 36% (2011: 35%) were in the warning stage. 39% (2011: 37%) showed no defoliation. The mean crown defoliation decreased from 20.4 to 19.2%.

Spruce: The percentage of damage classes 2 to 4 is 27%, which means no change compared to the previous year. 35% (2011: 33%) of the trees were in the warning stage. 38% (2011: 40%) showed no defoliation. Mean crown defoliation increased from 19.1 to 19.3%.

Scots pine: The share of damage classes 2 to 4 decreased from 13% to 11%. 39% (2011: 42%) are in the warning stage. 50% (2011: 45%) showed no defoliation; this is the best result since the beginning of the surveys. Accordingly the mean crown defoliation of Pine decreased to 14.5% which is the lowest score since the beginning of the surveys in 1984.

Beech: The share of damage classes 2 to 4 decreased by 19 percentage points from 57 to 38%. 40% (2011: 31%) were classified in the warning stage. The share of trees without defoliation increased from 12 to 22%. Mean crown defoliation decreased from 30.4 to 24.3%. The high defoliation rates in 2011 were mainly due to the intense fruiting of the beech trees. In 2012 almost no fruiting was recorded and the trees were able to recover. However the defoliation rates of beech are still higher than they were in the period before 2004. In 2004, the crown condition of beech trees worsened due to the extreme drought and heat in the summer of 2003 and did not yet completely regenerate.

Oaks: The share of damaged trees increased to 50% (2011: 41%). The share of the warning stage was 33% (2011: 38%). Only 17% (2011: 21%) of the oaks showed no defoliation. Mean crown defoliation was 29.4% (2011: 26.3%). High defoliation rates in oaks have already been recorded during the past ten years. This is partly due to defoliation by a number of insects belonging to different species. The "oak defoliator community" includes caterpillars of different moth species, namely the green oak leaf roller (*Tortrix viridana*), the mottled umber moth (*Erannis defoliaria*) and the winter moth (*Operophthera brumata*) and, regionally, also the gypsy moth (*Lymantria dispar*). Recently published research regarding the susceptibility of oaks for herbivory by the green oak leaf roller showed biochemical and genetic differences between oak types within the same species (*Quercus robur*). It has been found that oaks tolerant against herbivory use the strategy to emit deterring volatiles to avoid the moths laying their eggs, whereas susceptible oaks (meaning most defoliated) emit volatiles to attract predators of the moth's larvae. Furthermore, a different food quality for the moth's larvae between tolerant and susceptible oak leaves has been found: larvae prospered better on susceptible than on tolerant oaks. Most conspicuous is the result that *T. viridana* uses the predators-attracting volatiles of the susceptible oaks to find most suitable hosts for its offspring. Thus, it appears that the plants' volatiles thought to function as defensive compounds actually act as a boomerang signal that attracts this pest species.

Some *laender* report significant damage caused by the oak processionary *moth (Thaumetopoea processionea)*. Until recently, this species was considered to be mainly a human health problem. From the third larval stage on the caterpillars are covered in hairs containing toxins that cause skin irritations and allergic reactions. In recent years, this species has extended its range to more northern and eastern regions of Germany. Shoots appearing after insect damage events are often affected by mildew.

Figure 5.12-1 shows the input of acid deposition for selected Level-II plots in Germany over a minimum of 15 years. The acid deposition is composed of the input of H+, NH4-N and canopy uptake (CU); while NH4-N acidifies the soil due to its complete transformation to NO3-N, CU describes the canopy uptake of H and NH4-N. This term is calculated using the total leaching of Ca2+, Mg2+, K+ and Mn2+ minus the canopy leaching of those elements associated with foliar excretion of weak acids (Draaijers and Erisman 1995[1]).

[1] Draijers, G.P.J., & Erisman, J.W. (1995). A canopy budget model to assess atmosheric deposition from throughfall measurements. *Water Air Soil Pollution, 85,* 2253-2258.

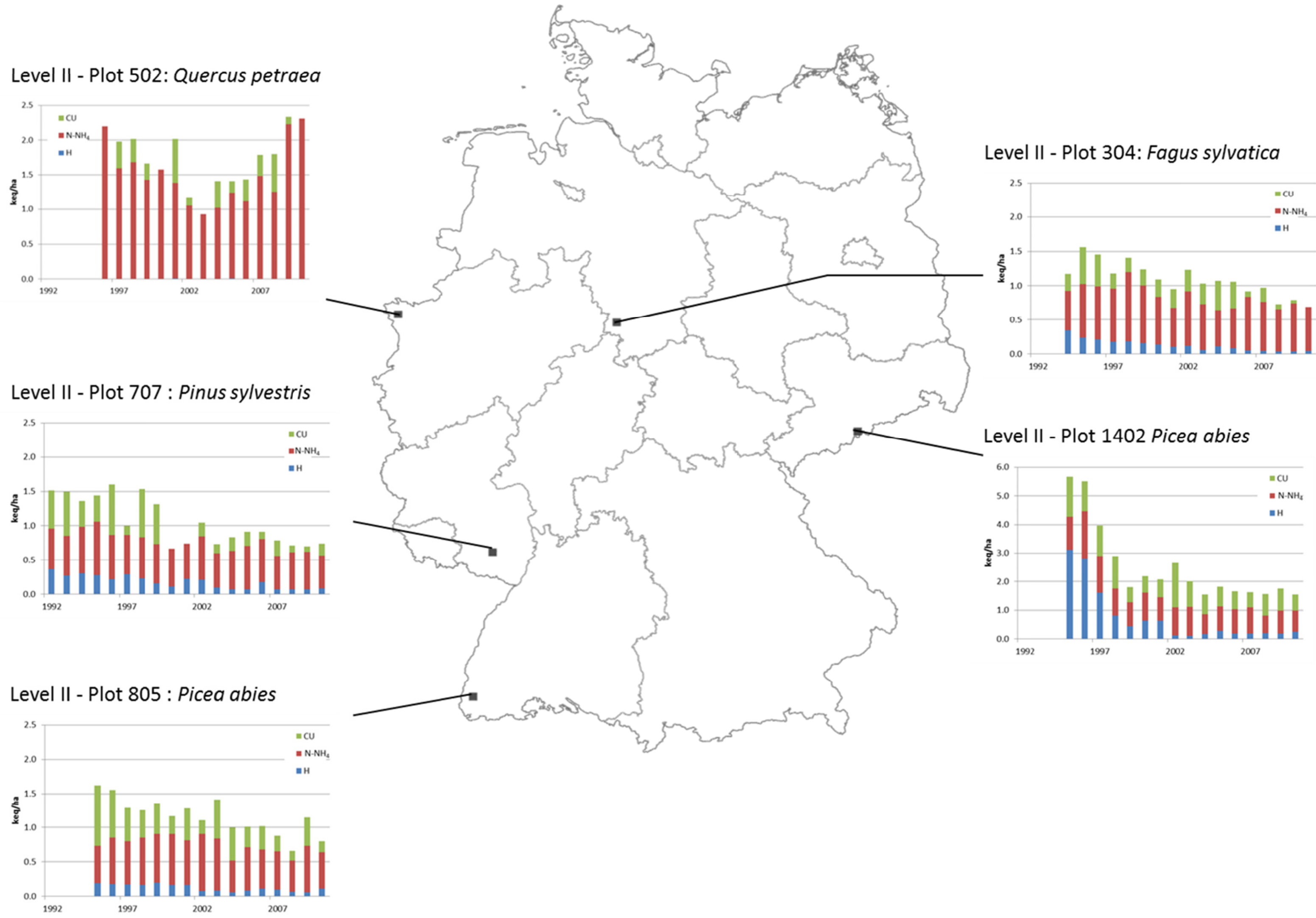



**Figure 5.12-1:** Total acid deposition after Draaijers and Erisman (1995) for selected Intensive Monitoring Plots (Level II) in Germany; Canopy uptake (CU, green), ammonium (N-NH4, red), and protons (H, blue)

Generally the acid deposition decreases in most of the plots, whereas the single components develop differently. The reduction concerns especially H and CU, however, the input of NH4-N does not change noticeably. The decrease of H is particularly obvious for plot 1402, which was exposed to strong transboundary SO2 immissions. In this region (Ore Mountains) sulphur immissions were reduced somewhat later than in other parts of Germany.

With decreasing emission of NOy and SO2 the main component of acid input is nowadays NH4-N, a remarkable change to the 1980s and early 1990s when H played the dominant role.

In some plots however, acid deposition remained constant as illustrated for plot 502. This plot has currently the highest acid deposition of all Level II plots, mainly caused by NH3 emissions from fertilization and animal farming.

## 5.13 Hungary

In 2012 the forest condition survey – based on the 16x16 km grid – included 1793 sample trees on 78 permanent plots in Hungary (three of them are temporarily unstocked). The assessment was carried out during the period of 15 July – 15 August. 88.7% of all assessed trees were broadleaves (a little increasing during the last years), 11.3% were conifers.

Overall health condition of the Hungarian forests compared to the previous year got worse but it was better than in 2010. The share of trees without visible damages decreased from 62.3% to 60%, the mean defoliation of all species was 17.2%, this is 1.5 percentage points higher than in 2011.

The percentage of all trees within ICP Forests defoliation classes 2-4 (moderately damaged, severely damaged and dead) in 2012 (20.2%) is higher than in 2011 (18.9%) but lower than in 2010 (21.8%). In Hungary the dead trees remain in the sample as long as they are standing, but the newly (in the surveyed year) dead trees can be separated. In 2012 the rate of newly dead trees was 0.8% of all trees that is almost the same as in the previous year. The number of all dead trees decreased just a little.

In the classes 2-4 the most damaged species were *Quercus pubescens* (47.1%), *Pinus nigra* (45.2%), *Quercus robur* (34.3%), and *Robinia pseudoacacia* (29.8%), the percentages show the rate of sample trees belonging to category 2-4. *Quercus cerris* (14%) and *Carpinus betulus* (16.7%) had the lowest defoliation in class 2-4. Generally almost all species' rates increased in these categories.

Discoloration can be rarely observed in the Hungarian forests, 94.9% of sample trees did not show any discoloration, compared to the previous year the change is less than 1% in all categories. Generally the discoloration got lower.

According to the classification defined in the ICP Forests Manual on crown condition the damage caused by defoliator insects had the highest rate, 24.8% of all the damages. This damage occurred especially on the following species: *Quercus petraea*, *Quercus robur*, and other *Quercus* species and *Pinus sylvestris*. The mean damage values of these trees were 9%, 7.8%, 10.4%, 13.5%. The most damaged species is *Robinia pseudoacacia* (13.9%) but only 15% of the trees were affected.

The rate of assessed damages attributed to fungus was 14.0%. Fungal damages were assessed mostly on the stem and root (wet rot causing fungus) (66.2%), on needles (12.3%) and on leaves (10.9%). The mean damage value was 20.2%.

11.7% of the assessed damages were abiotic, this is half of what it was in the previous year. The general intensity was 15.7%. The most important identifiable cause was drought (48%), but this damage appeared at the same time as the surveys were starting, so this damage could be higher than this survey shows.

## 5.14 Ireland

Ireland completed a Level I forest condition survey in 2012. Twenty plots were surveyed in 2012 for crown damage in the form of crown defoliation and, where recorded, the damaging agents were reported where possible as was the extent of the damage through the affected tree crown. Surveys were conducted by a trained assessor and both training days and data quality assurance and data quality control measures were employed. All of the twenty surveyed plots coincide with areas surveyed through Ireland's National Forest Inventory. Four tree species are included in the survey, Sitka spruce (*Picea sitchensis*), lodgepole pine (*Pinus contorta*), Norway spruce (*Picea abies*) and Japanese larch (*Larix kaempferi*).

The annual assessment of crown condition was conducted on the Level I plots in Ireland between July 25th and October 25th, 2012. Overall mean percent defoliation was low in 2012 at 4.3% and represents an improvement in crown condition from recent year's survey. In terms of species, defoliation decreased in the order of Japanese larch (13.8%*), lodgepole pine (7.0%), Sitka spruce (3.4%) and Norway spruce (1%). (*Tree sample numbers were low for Japanese larch; just four samples).

The number of Level I plots has been rationalised in Ireland in recent years with all of the sample plots migrating on a phased basis to coincide with locations of National Forest Inventory plots in Ireland. The location of the new Level I plots has been selected objectively according to the methods outlined in the manual of ICP Forests. This has been carried out due to increases in forest cover in Ireland since the Level I crown condition survey commenced in 1987. Acknowledgement is made to the Forest Service, Department of Agriculture, Food and the Marine.

## 5.15 Italy

The survey of Level I in 2012 took into consideration the condition of the crown of 5081 selected trees in 245 plots belonging to the EU network 16x16 km. The number of plants is reduced compared to the survey of 2011, following the merger according to the methods of the National Forest Inventory. The results given below relate to the distribution of frequencies of the indicators used, especially transparency - which in our case we use for the indirect assessment of defoliation and the presence of agents known causes attributable to both biotic and abiotic. For the latter, not so much the indicators we analysed the frequencies of affected plants, but the comments made as to each plant may have multiple symptoms and more agents.

Defoliation data are reported according to the usual categorical system (class 0: 0-10%; class 1: >10-25%; class 2: >25-60%; class 3: >60%; class 4: tree dead): most (77.3%) are included in the classes 1 to 4; 35.7% are included in the classes 2 to 4.

By analysing the sample for groups of species, conifers and broadleaves, it appears that conifers have a lower transparency than deciduous foliage: 32.7% of conifers and 19.2% of broadleaves are without any defoliation (Class 0).

The conifers falling in the defoliation classes 2 to 4 are 31.0% compared to the 37.5% of broadleaves.

From a survey of the frequency distribution of the parameter for transparency, species were divided into two age categories (<60 and ≥60 years), among the young conifers (<60 years), *Pinus pinea* and *Pinus sylvestris* are represented by 58.5% and 37.0% of trees in the classes 2 to 4, *Picea abies* (30.2%), *Pinus nigra* (19.9%) of trees in the classes 2 to 4, but the best crown conditions had *Larix decidua* (15.6%).

Among the old conifers (≥60 years), these species appear to be of worse quality of foliage: *Picea abies* (40.3%), *Abies alba* (36.2%), *Pinus nigra* (34.1%), *Pinus cembra* (29.2%) of trees are in the classes 2 to 4, while *Larix decidua* (22.9%) is one conifer species in better condition of trees in the classes 2 to 4.

Among the young broadleaves (<60 years), *Castanea sativa*, *Quercus pubescens* and *Ostrya carpinifolia* have respectively 74.6%, 49.5% and 46.9% of trees in the classes 2 to 4, while others have a frequency range between 25.1% and 27.2% in classes 2 to 4 distributed in different species: *Quercus cerris* (25.1%), *Fagus sylvatica* (27.2%).

Among the old broadleaves (≥60 years) in the classes 2 to 4, *Castanea sativa* has (87.9%), *Quercus pubescens* (63.9%), *Fagus sylvatica* (15.5%), *Ostrya carpinifolia* (29.7%) and *Quercus ilex* (13.6%) has the lowest level of defoliation of trees in the classes 2 to 4.

Starting from 2005, a new methodology for a deeper assessment of damage factors (biotic and abiotic) was introduced. The main results are summarized below.

Most of the observed symptoms were attributed to insects (19.2%), subdivided into defoliators (14.4%), aphids (2.5%) Of the symptoms attributed to fungi (5.2%), the most significant were attributable to “dieback and canker fungi” (3.4%). Of those assigned to abiotic agents, the most significant were “drought/aridity” (3.4%).

## 5.16 Latvia

The forest condition survey 2012 in Latvia was carried out on two plot sets – on 88 ICP Level I plots on the transnational grid 16 x 16 km, and on 115 NFI plots, 203 plots in total. The national report of 2012 is based on data from both datasets.

In total, defoliation of 3879 trees was assessed, of which 75% were conifers and 25% broadleaves. Of all tree species, 11.8% were not defoliated, 79% were slightly defoliated and 9.2% moderately defoliated to dead. Comparing to 2011, the proportion of not defoliated trees has decreased by 2%, the proportion of moderately defoliated to dead trees has decreased by almost 5% but the proportion of slightly defoliated trees has increased by almost 7%. Unlike the previous year, when the proportion of trees in defoliation classes 2-4 remained to be about 5-7% higher for conifers than for broadleaves, this year the proportion of trees in defoliation classes 2-4 was higher for broadleaves. It is important to mention that 293 trees were excluded from survey this year and replaced by new ones, the main reason for replacement being nonconformity with the requirements for crown assessment (e.g., heavy crown breaks or trees no longer in Kraft classes 1, 2 or 3).

Mean defoliation of *Pinus sylvestris* was 19.7% (22.4% in 2011). The share of moderately damaged to dead trees constituted 8.4% (16.4% in 2011). Mean defoliation of *Picea abies* was 16.8% (20.7% in 2011). The share of moderately damaged to dead trees for spruce constituted 6.4%. Considerable decrease in the defoliation level for *Pinus sylvestris* and *Picea abies* can most likely be attributed to the change of the dataset used for national reporting and to the exclusion of a large number of damaged and suppressed trees from the survey. The mean defoliation level of *Betula* spp. was 20.8% (18.0% in 2011), showing a slight increase of the defoliation level. The share of trees in defoliation classes 2-4 increased to 12.6% compared to 8.3% in 2011. The mean defoliation level for *Populus tremula* was 21.1%. The worst crown condition of all assessed tree species remained for *Fraxinus excelsior* with a mean defoliation of 28.3% (31.8% in 2011) but these results were based on a very small number of assessed trees.

Visible damage symptoms were observed to a similar extent than in the previous year – 12.6% of the assessed trees (12.2% in 2011). Most frequently recorded damages were caused by direct action of men (34.2% of all cases), insects (23.0%), animals (21.2%), fungi (11.7%) and abiotic factors (7.6%). Other damage causes were recorded for 0.6% of all cases and unknown cause for

1.6% of all cases. The distribution of damage causes was considerably different than last year when damage by abiotic factors constituted 21.3% of all cases, by direct action of man 17.7% and by fungi 15.1%. The proportion of insect damages has increased considerably since last year. Differences in the distribution of damage causes are most likely induced by the change of dataset and expected maximum of outbreak of *Lymantria monacha* that started in the vicinity of Riga city in 2011. The greatest share of trees with damage symptoms was recorded for *Populus tremula* (19%) and the smallest for *Betula* spp. (10.5%).

## 5.17 Lithuania

In 2012 the forest condition survey was carried out on 1011 sample plots from which 79 plots were on the transnational Level I grid and 932 plots on the National Forest Inventory grid. In total 5732 sample trees representing 18 tree species were assessed. The main tree species assessed were *Pinus sylvestris*, *Picea abies*, *Betula pendula*, *Betula pubescens*, *Populus tremula*, *Alnus glutinosa*, *Alnus incana*, *Fraxinus excelsior*, *Quercus robur*.

The mean defoliation of all tree species slightly increased to 22.6% (21.2% in 2011). 16.3% of all sample trees were not defoliated (class 0), 59.2% were slightly defoliated and 24.5% were assessed as moderately defoliated, severely defoliated and dead (defoliation classes 2-4).

Mean defoliation of conifers slightly increased to 23.0% (21.1% in 2011) and for broadleaves to 22.1% (21.3% in 2011).

*Populus tremula* had the lowest mean defoliation and the lowest share of trees in defoliation classes 2-4. Mean defoliation of *Populus tremula* was 17.1% (17.3% in 2011) and the proportion of trees in defoliation classes 2-4 was only 3.6% (4.4% in 2011). Due to spring frost in 2009 condition of *Alnus glutinosa* was the worst in 2009 – 2010. Condition of *Alnus glutinosa* has finally regenerated in 2012. Mean defoliation decreased to 18.7% (25.1% in 2009; 23.4% in 2010; 19.4% in 2011) and the share of trees in defoliation classes 2-4 was 10.3% (27.9% in 2009; 25.0% in 2010; 9.5% in 2011).

Condition of *Fraxinus excelsior* remained the worst among all observed tree species. This tree species had the highest defoliation since year 2000. Assessed mean defoliation was 39.0% (43.5% in 2011). The share of trees in defoliation classes 2-4 increased up to 55.7% (58.3% in 2011). The reasons for such significantly bad condition has not been defined yet.

19.6% of all sample trees had some kind of identifiable damages symptoms. The most frequent damages were caused by abiotic agents (about 6.0%) in the period of 2010 – 2012 and closely connected with the storm that hit the South-Eastern part of Lithuania on 08.08.2010. The highest share of damages symptoms were assessed for *Fraxinus excelsior* (44.3%), *Populus tremula* (30.6%) and *Alnus incana* (28.4%), the least for *Alnus glutinosa* (12.7%) and for *Pinus sylvestris* (14.9%).

In general, mean defoliation of all tree species has varied inconsiderably from 1997 to 2012 and the condition of Lithuanian forests can be defined as relatively stable.

## 5.18 Republic of Moldova

The climate conditions of this year were unfavorable for growth during the whole vegetation period; the drought observed in the biggest part of the country had a negative influence on plantations' sanitary conditions. Thus, the percentage of trees in the 2-4 defoliation class rose by 7.2% compared with the previous year. At the same time, the percentage of trees in the 0 class rose by 15.9% and makes up 29.1%. The percentage of trees in the 3-4 defoliation class rose insignificantly by 1.2% and makes this year 3.9%.

According to the data obtained this year, the percentage of trees in the 2-4 defoliation class rose for almost all species of broadleaves as well as of conifers. In the oak plantations this indicator is 25%, which is 5.4% more than in the previous year. The same trend is characteristic for conifers also. Thus, conifer trees in the 2-4 defoliation class make 44.3%. That is 12.2% greater than in the previous year. In the black locust plantations the number of trees in the 2-4 defoliation class grew by 7% and made up 43.4%. This indicator for the ash plantations grew by 8.4% and made up 26.4%.

## 5.19 Norway

The results for 2012 show a small decrease in crown defoliation for all tree species compared to the year before. The mean defoliation for *Picea abies* was 15.0%, *Pinus sylvestris* was also 15.0%, and for *Betula* spp. 20.9%. After a peak in 2007 and in 2011 with high defoliation for all of the three monitored tree species Norway spruce, Scots pine and birch, and then a decrease in defoliation the following tree years (2008-2010), this last year 2012 again showed a decrease in the defoliation of these tree species. During the last ten years birch had the lowest defoliation in 2001. Norway spruce and Scots pine show only minor changes in defoliation within the last five years (2008-2012).

Of all the coniferous trees, 49.6% were rated not defoliated in 2012, which is an increase by 2.5%-points compared to the year before. Only 40.4% of the *Pinus sylvestris* trees were rated as not defoliated which is an increase by 1.5%-points. 56.1% of all Norway spruce trees were not defoliated, an increase by 3%-points compared to the year before. For *Betula* spp. 28.3% of the trees were observed in the class not defoliated, also representing an increase by 7.3%-points compared to the year before. For birch trees, the class 'moderately defoliated' decreased from 26.9 to 23.1% in 2012, and 'severely damaged' also decreased from 5.2 to 3.9% in 2012. For other classes of defoliated trees, only small changes were observed.

In crown discoloration we observed 9.2% discolored trees for *Picea abies*, a decrease by 2.4%-points from 11.6% in 2011. For *Pinus sylvestris*, only 2.7% of the assessed trees were discolored, a decrease by about 1%-points from the year before. For *Betula* spp., the discoloration decreased much and was now only 4.3% in 2012 compared with 11.4% in 2011. For birch, the observed trees in the most serious class 'Severely discoloration' were only 0.2% in 2012 compared with 3.3% in 2011!

The mean mortality rate for all species was 0.2% in 2012. The mortality rate was 0.2%, 0% and 0.3% for spruce, pine and birch, respectively. The mortality rate of birch has been more normal during the last four years and was heavily reduced from the high level of 1-2% which occurred in the tree year period 2006-2008 probably due to serious attacks of insects and fungi.

In general, the observed crown condition values result from interactions between climate, pests, pathogens and general stress. According to the Norwegian Meteorological Institute the summer (June, July and August) of 2012 was regarded as about normal. The temperature was 0.4 ºC less than normal, and the precipitation was 5% more than normal as an average for the whole country. In south-east Norway, where summer drought is a frequent problem for trees, however the precipitation in 2012 was 40% higher than normal. The highest precipitation in south-east Norway was in 2011 with 95% higher than normal, and the second highest was in 1950 with 65% higher than normal. There are of course large climatic variations between regions in Norway which range from 58 to 71 ºN.

## 5.20 Poland

In 2012 the forest condition survey was carried out on 1965 plots. Forest condition (all species total) revealed a slight deterioration as compared to the previous year. 11.3% (14.0% in 2011) of all sample trees were without any symptoms of defoliation, indicating a decrease by 2.7 percent points compared to 2011. The proportion of defoliated trees (classes 2-4) decreased by 0.6 percent points to an actual level of 23.4% of all trees. The share of trees defoliated by more than 25% decreased by 2.0 percent points for conifers and increased by 2.0 percent points for broadleaves.

8.7% of the conifers were not suffering from defoliation. For 22.2% of the conifers defoliation of more than 25% (classes 2-4) was observed. With regard to the three main coniferous species *Abies alba* remained the species with the lowest defoliation (18.9% in classes 2-4), although indicating a worsening compared to the previous year. A share of 21.8% (17.3% in 2011) of fir trees up to 59 years old and 18.3% (16.1% in 2011) of fir trees 60 years old and older was in defoliation classes 2-4. The highest defoliation was observed in *Picea abies* (29.8% indicated a worsening compared to the previous year). A share of 24.8% (23.4% in 2011) of spruce trees up to 59 years old and 33.2% (28.1% in 2011) of spruce trees 60 years old and older was in defoliation classes 2-4.

16.1% of assessed broadleaved trees were not defoliated. The proportion of trees with more than 25% defoliation (classes 2-4) amounted to 25.5%. As in the previous survey the highest defoliation amongst broadleaved trees was observed in *Quercus* spp. indicating deterioration in older stands. In 2012 a share of 28.2% (28.0% in 2011) of oak trees up to 59 years old and 42.9% (32.2% in 2011) of oak trees 60 years old and older was in defoliation classes 2-4. *Fagus sylvatica* remained the broadleaves species with the lowest defoliation, indicating a slight improvement in older stands. A share of 10.2% (9.8% in 2011) of beech trees up to 59 years old and 9.2% (11.8% in 2011) of beech trees 60 years old and older was in defoliation classes 2-4.

In 2012, discoloration (classes 1-4) was observed on 1.5% of the conifers and 1.8% of the broadleaves.

## 5.21 Romania

In the year 2012, the assessment of crown condition on Level I plots in Romania was carried out on the 16 x 16 km transnational grid net, during 15th of July and 15th of September. The total number of sample trees was 5784, which were assessed on 241 permanent plots. From the total number of trees, 1100 were conifers and 4684 broadleaves. Trees on 21 plots were harvested during the last year and several other plots were not reachable due to natural hazards.

For all species, 50.2% of the trees were rated as healthy, 35.9% as slightly defoliated, 13.0% as moderately defoliated, 0.7% as severely defoliated and 0.2% were dead. The percentage of damaged trees (defoliation classes 2-4) was 13.9%.

For conifers 14.9% of the trees were classified as damaged (classes 2-4). *Picea abies* was the least affected coniferous species with a share of damaged trees of 11.9% (defoliation classes 2-4), whereas *Abies alba* had 25%. For broadleaves 13.7% of the trees were assessed as damaged or dead (classes 2-4). Among the main broad-leaved species, *Fagus sylvatica* had the lowest share of damaged trees (10.1%), followed by *Carpinus sylvatica* (15.0%). The most affected species was *Quercus robur*, 74% of the trees were rated as damaged or dead.

Compared to 2011, the overall share of damaged trees (classes 2-4) remained rather unchanged. Forest health status was slightly influenced, mainly for conifers, by the relatively unfavourable weather conditions during the draughty summer season.

Concerning the assessment of biotic and abiotic damage factors, most of the observed symptoms were attributed to defoliator insects (46.9%), fungi (7%), abiotic factors (18%) and forest fires (2.9%).

## 5.22 Serbia

In the region of the Republic of Serbia, ICP Plots were installed on a 16 x 16 km grid consisting of 103 sampling plots and a newly added 4 x 4 grid, including 27 new plots. Altogether the number of plots is 130 (not included in the assessment were AP Kosovo and Metohija). Observations at

Level I were performed according to the ICP Forests Manual of Methods. Actual monitoring has been performed in 2012 on 118 plots due to the clear cutting of few spots.

During 2012, the researchers of the NFC Serbia - Institute of Forestry with collaborators from other institutions in Serbia have worked on all sampling points and made visual assessments of the crown condition and collected all other necessary field data.

The total number of trees assessed on all sampling points was 2786 trees, of which 337 were conifer trees and a considerably higher number, i.e. 2449, were broadleaf trees. The conifer tree species are: *Abies alba*, number of trees and percentage of individual tree species 69 (20.5%), *Picea abies* 145 (43.0%), *Pinus nigra* 67 (19.9%), *Pinus sylvestris* 56 (16.6%) and the most represented broadleaf tree species are: *Carpinus betulus*, number of trees and percentage of individual tree species 117 (4.8%), *Fagus moesiaca* 830 (33.9%), *Quercus cerris* 510 (20.8%), *Quercus frainetto* 371 (15.2%), *Quercus petraea* 160 (6.5%) and other species 461 (18.8%).

The results of the available data processing and the assessment of the degree of defoliation of individual conifer and broadleaf species % are: *Abies alba* (None 94.2, Slight 2.9, Moderate 0.0, Severe 2.9 and Dead 0.0); *Picea abies* (None 86.9, Slight 11.0, Moderate 1.4, Severe 0.0, Dead 0.7); *Pinus nigra* (None 38.8, Slight 14.9, Moderate 35.8, Severe 10.5, Dead 0.0); *Pinus sylvestris* (None 83.9, Slight 14.3, Moderate 0.0, Severe 1.8, Dead 0.0).

The degree of defoliation calculated for all conifer trees is as follows: no defoliation 78.3% trees, slight defoliation 10.7% trees, moderate 7.7% trees, severe defoliation 3.0% trees and dead 0.3% trees.

Individual tree species defoliation (%) is: *Carpinus betulus* (None 76.9, Slight 12.0, Moderate 8.5, Severe 0.9, Dead 1.7); *Fagus moesiaca* (None 88.9, Slight 8.8, Moderate 1.6, Severe 0.5, Dead 0.2); *Quercus cerris* (None 61.6, Slight 25.1, Moderate 9.4, Severe 3.5, Dead 0.4); *Quercus frainetto* (None 74.7, Slight 16.7, Moderate 7.3, Severe 0.8, Dead 0.5); *Quercus petraea* (None 50.0, Slight 33.8, Moderate 15.0, Severe 0.6, Dead 0.6) and the rest (None 51.2, Slight 28.8, Moderate 13.9, Severe 3.9, Dead 2.2).

The degree of defoliation calculated for all broadleaf species is as follows: no defoliation 70.8% trees, slight defoliation 19.0% trees, moderate 7.6%, severe defoliation 1.8% trees and dead 0.8% trees.

The data above show the presence of sample trees with moderate and severe degrees of defoliation, but this does not always signify the reduction of the vitality score caused by the effect of adverse agents (climate stress, insect pests, pathogenic fungi). This can only be a temporary phase of natural variability of crown density.

## 5.23 Slovak Republic

The 2012 national crown condition survey was carried out on 108 Level I plots on the 16 x 16 km grid net. The assessments covered 4787 trees, 3898 of which had been assessed as dominant or co-dominant trees according to Kraft. Of the 3898 assessed trees, 37.9% were damaged (defoliation classes 2-4). The respective figures were 43.5% for conifers and 33.9% for broadleaved trees. Compared to the year 2011 the share of trees defoliated by more than 25% increased by 3.2 percent points. Mean defoliation for all tree species together was 25.5%, with 27.2% for conifers and 24.4% for broadleaved trees. Results show that crown condition in the Slovak Republic is worse than on European average. It is mainly due to the worse condition of coniferous species.

Compared to the 2011 survey, worsening (average defoliation) was observed in all broadleaved tree species except for *Fagus sylvatica.* Since 1987, the lowest damage was observed for *Fagus sylvatica* and *Carpinus betulus*, with exception of fructification years. The most severe damage has been observed in *Abies alba*, *Picea abies* and *Robinia pseudacacia*.

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

As a part of the crown condition survey, damage types were assessed. 84.9% of all sampling trees (4822) had some kind of damage symptoms. The most frequent damage was caused by insects (46.1%) and fungi (32.9%). Additional damage causes were other factors (28.8% - mainly epiphytes and competition). Epiphytes had the most important influence on defoliation.

## 5.24 Slovenia

In 2012 the Slovenian national forest health inventory was carried out on 44 systematically arranged sample plots (grid 16 x 16 km). The assessment encompassed 1053 trees, 393 coniferous and 660 broadleaved trees. The sampling scheme and the assessment method was the same as in the previous years (at each location four M6 (six-tree) plots), with the exception of two sample plots, where after felling no appropriate new trees were present on the plot which could be included in the assessment. This is also the reason why only 1053 trees were assessed and not 1056.

The mean defoliation of all tree species was estimated to be 24.9%. Compared to the 2011 survey, the situation is better by 0.5% (mean defoliation in 2011 was 25.4%). In year 2012 mean defoliation for coniferous trees was 24.6% (in year 2011 it was 25.2%) and for broadleaves 25.1% (year before 25.5%). One of the reasons for lower defoliation in year 2012 could be that year 2011 was the fructification year of beech.

In 2012 the share of trees with more than 25% of defoliation (damaged trees) reached 29.0%. In comparison to the results of 2011, when the share of trees with more than 25% of unexplained defoliation was 31.4%, the value decreased by 2.4%.

Especially significant is the change of damaged trees for conifers where the share of damaged trees increased from 33.6% in 2011 to 37.0% in 2012, while the share of damaged broadleaves decreased from 30.0% in 2011 to 23.0% in 2012.

In the year 2011 broadleaves were more damaged than conifers. But in the year 2012 the proportion has changed and conifers are more damaged then broadleaves.

In general, the mean defoliation of all tree species has slightly increased since 1991. The situation improved in the year 2010 and in 2011 the mean defoliation increased by 0.7%, but decreased again in the year 2012. The condition of Slovenian forests can be defined as relatively stable.

## 5.25 Spain

Results obtained in the 2012 inventory show that the general health condition of trees present a clear worsening process. 82.5% of the surveyed trees were healthy, compared to 88.2% in the previous year, reaching similar levels as in 2007 (82.4%). 15.9% of the trees were included in defoliation classes 2 and 3, indicating defoliation levels higher than 25%, whereas in 2011 this percentage was 10.2% (15.8% in 2007). The number of damaged trees has clearly increased whereas the number of dead ones keeps the same as in the previous year, namely 1.6%, showing different trends between broadleaves (1.1%) and conifers (2.1%).

This overall worsening is much more relevant in broadleaves, with a percentage of 76.5% of healthy trees (86.8% previous year) than in conifers (88.5% this year and 89.6% in 2011). The mortality of trees was mainly due to sanitary cuts, forest management operations and to decline processes related to the strong hydric shortage which affected trees during previous years.

Concerning other possible damaging agents, there is a clear increment in the amount of abiotic damages (mainly drought), whereas damages linked with biotic agents play a not so important role. According to the field records, there is a random behaviour in the insect populations, decreasing the importance of leaf feeders in broadleaves (but not the importance of insects who attack alder trees), a different trend in pine processionary moth (increments in east and south of Spain, decrease in the west and in the north plateau), a slow increasing trend in conifer bark beetles and a clear one in broadleaves borers. Fungi show a general decrease in their impact, excepting Dutch elm disease. But the most frequent damaging factors are drought related damages, which have a high impact in the central, east and south part of the Iberian Peninsula, excepting Catalonia. “Seca” syndrome damages are concentrated in the existing focus, not showing a remarkable increment.

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

## 5.26 Sweden

The national results are based on assessment of the main tree species Norway spruce (*Picea abies*) and Scots pine (*Pinus sylvestris*) in the National Forest Inventory (NFI), and concerns, as previously, only forest of thinning age or older. In total, 7496 trees on 3241 sample plots were assessed. The Swedish NFI is carried out on permanent as well as on temporary sample plots. The permanent sample plots, which are 60 percent of the total sample, are remeasured every 5$^{th}$ year.

The proportion of trees with more than 25% defoliation is for Norway spruce 22.8% and for Scots pine 10.0%. In northern Sweden an improvement is seen on Norway spruce while a decline is observed on Scots pine. In southern Sweden a worsening is seen on both spruce and pine. The majority of changes seen in defoliation levels during recent years are minor. However, during the latest years a clear increase of defoliated Scots pine is seen in southern Sweden.

The last year's outbreak of bark beetles on Norway spruce in central Sweden has declined.  There are however windthrown trees, suitable for colonization, left in the forest since the winterstorm in 2011, resulting in a risk of further damage in the near future. In northern Sweden resin top disease (*Cronartium flaccidum*) is still a problem in young Scots pine stands. A special target inventory was undertaken and the results from the inventory show that damage was found in the entire northern Sweden, but also that no clear changes can be seen since previous inventories carried out in 2007/2008. The results show no evident spreading of the disease from the worst affected areas in the northeast. In the northeastern parts of Norrbotten 29% of young pine forests showed damage (defined as more than 10% of the trees being affected). The level of the damage is probably mostly controlled by the presence of favorable conditions for the fungus, typically due to the weather conditions.

The decline in Ash (*Fraxinus excelsior*) is continuing in southern Sweden. The large larch bark beetle (*Ips cembrae*) has been found in a few areas in southern Sweden. Still, the most important damage problems are, as previously, due to pine weevil (*Hylobius abietis*) (in young forest plantations), browsing by ungulates, mainly elk (in young forests), and root rot caused by *Heterobasidion annosum*.

## 5.27 Switzerland

In 2012 the Swiss national forest health inventory was carried out on 47 plots of the 16 x 16 km Level I grid using the same sampling and assessment methods as in the previous years. Crown condition in 2012 remained quite similar than in 2011. In 2012 31.4% of the trees had more than 25% of unexplained defoliation (i.e. subtracting the known causes such as insect damage; or frost damage) as compared to 30.8% in 2011. In 2012 41.8% of the trees had more than 25% total defoliation (2010: 41.3%).

The defoliation values which were high in the previous year did not decrease substantially in 2012 despite less dry weather conditions and lower seed production. One possible explanation for a still high defoliation might be a less pronounced leave bud production due to a quite dry late summer and autumn in 2012. The mortality rate of 0.004 was in the range of the long-term mean and was lower than the rate of trees growing in (0.02). The stem growth on the Swiss Level II was higher in 2012 compared to the values in 2011 that had been below the long-term average.

In Switzerland, about 2.5% of the trees are Ash trees (*Fraxinus excelsior*). Since its first appearance in 2007 a significant increase of the fungus *Hymenoscyphus pseudoalbinus* affecting *Fraxinus excelsior* has been detected. In the Southern Alps (with about 1.2% Ash) the fungus is not yet present, but in the Northern parts of Switzerland about 25% of the ash trees show signs of the fungus attack. This information is based on the assessment of Level-I-plots of young growth (height greater than 10 cm with DBH less than 12 cm). The identification of the fungus on adult trees is not trivial, though no information is available for trees with more than 12 cm DBH.

## 5.28 Turkey

Crown condition of 13578 trees in 578 sample plots was evaluated in 2012. Monitoring studies had been conducted on a grid of 16 x 16 km. The average needle/leaf loss ratio of all evaluated trees was 17.8%. The ratio of healthy trees (class 0-1) was 87.6% and the remaining 12.4% had a loss ratio of greater than 25%. While annual average needle/leaf loss was unchanged compared to the previous year, there was a slight improvement in conifers and a certain amount of worsening in broadleaves. According to evaluations of the last five years, a downward trend in loss of needle/leaf is going on.

Average defoliation ratio was 19.9% in broadleaved species. Among broadleaved species evaluated for crown condition, major tree species with highest defoliation ratios were *Quercus pubescens* (29.9%), *Alnus glutinosa* (25.6%), *Quercus petraea* (24.8%) and *Castanea sativa* (23.5%) respectively. While 83.2% of broadleaved species showed no or slight defoliation (class 0-1), 16.8% of them were defoliated more than 25% (class 2-4).

In most damaged broadleaved species, the ratio of number of trees falling into class 2-4 was 43.3% for *Quercus pubescens*, 25.1% for *Quercus petraea*, 38.9% for *Alnus glutinosa* and 20.9% for *Castanea sativa*.

Among the less common broadleaved species, *Fraxinus excelsior, Prunus avium*, *Populus nigra*, *Salix alba, Pyrus communis* and *Ulmus glabra* had an average defoliation ratio of over 25%. The overall average defoliation of coniferous species was 16.6%. 90.1% of all evaluated coniferous trees had needle loss of less than 25% (class 0-1), and 9.9% of them had over 25% (class 2-4). Junipers (*Juniperus foetidissima, J. excelsa, J. oxycedrus, J. communis*) had the highest needle loss among common conifers with defoliation ratios between 17.9% and 21.6%. As for pine species, defoliation ratios of *Pinus brutia*, *P. sylvestris* and *P. nigra* were 18.1%, 18.0% and 14.5%, respectively. The number of trees classified in defoliation class 2-4 was 17.8% for junipers. This ratio for major pine species was 7.9% for *P. brutia*, 11.9% for *P. sylvestris* and 4.9% for *P. nigra*.

*Lymantria dispar*, *Tortrix viridana*, *Thaumetapoa* sp. were among the major causes of damage. As in the previous year, mistletoe (*Viscum alba*) was again the leading damaging agent.

In terms of geographical regions, defoliation ratio was higher in the Northern and North-Eastern parts of Turkey, mainly in Trace.

## 5.29 Ukraine

Assessment of indicators for monitoring Level I plots was carried out by specialists of State Forest Management Enterprises (SFME's) under the methodological guidance of experts of the Ukrainian Research Institute of Forestry and Forest Melioration (URIFFM) and officers from Regional Forest Administrations (RFA). QA/QC procedures have been done by officers from RFA and experts from URIFFM. Responsibility for maintaining of the national forest monitoring data base is assigned to URIFFM. The series of trainings for officers from RFA and for field specialists from SFME's has been conducted by experts from URIFFM for standardization in assessment of defoliation and others forest monitoring indicators.

In 2012, 36064 sample trees were assessed on 1488 forest monitoring plots in 25 administrative regions of Ukraine. Mean defoliation of conifers was 11.6% and of broadleaved trees was 12.4%. Generally the tree crown condition is satisfactory: the part of healthy (not defoliated) trees amounts to 63.1%. The trend to deterioration of tree condition was observed in 2012. For the total sample the percentage of healthy trees slightly decreased (63.1 against 64.9%). At the same time, the share of slightly to moderately defoliated trees increased from 35% to 36.9%. The part of trees with defoliation of more than 25% (class 2 -4) increased on 0.8%. For broadleaved the part of healthy trees is 60.8%, and respectively the part of defoliated trees is 39.2%. From those the part of damaged trees (with defoliation more than 25%) is 7.5%. Compared to the previous year the part of defoliated broadleaved trees increased on 2.8% in 2012. For conifers the part of healthy trees is 66.2% and the part of damaged trees (with defoliation of more than 25%) is the same as in broadleaved and amounts to 7.5%. For the sample of common sample trees (CSTs) (31201 trees) a tendency to deterioration of crown condition was observed. Mean defoliation slightly increased in 2012 (12.0%) compared to 2011 (11.5%). Some deterioration of tree condition was registered for CSTs of *Quercus robur, Fagus sylvatica, Pinus sylvestris* and *Fraxinus excelsior* and it was characterized by a statistically significant decreasing share of trees in defoliation class 0 and increase in all other classes. Changes in distribution within defoliation classes of CSTs of other main tree species were insignificant. The conditions in 2012 caused changes in ground vegetation. The trend to decreasing ground vegetation species richness was observed compared to the previous year in some regions of Ukraine. Some deterioration of tree condition and changes in ground vegetation may be explained by influence of the extremely long vegetation period 2012 with hot and dry weather conditions that caused some weakening of trees and increasing of defoliating insect’s activity.

# ANNEX

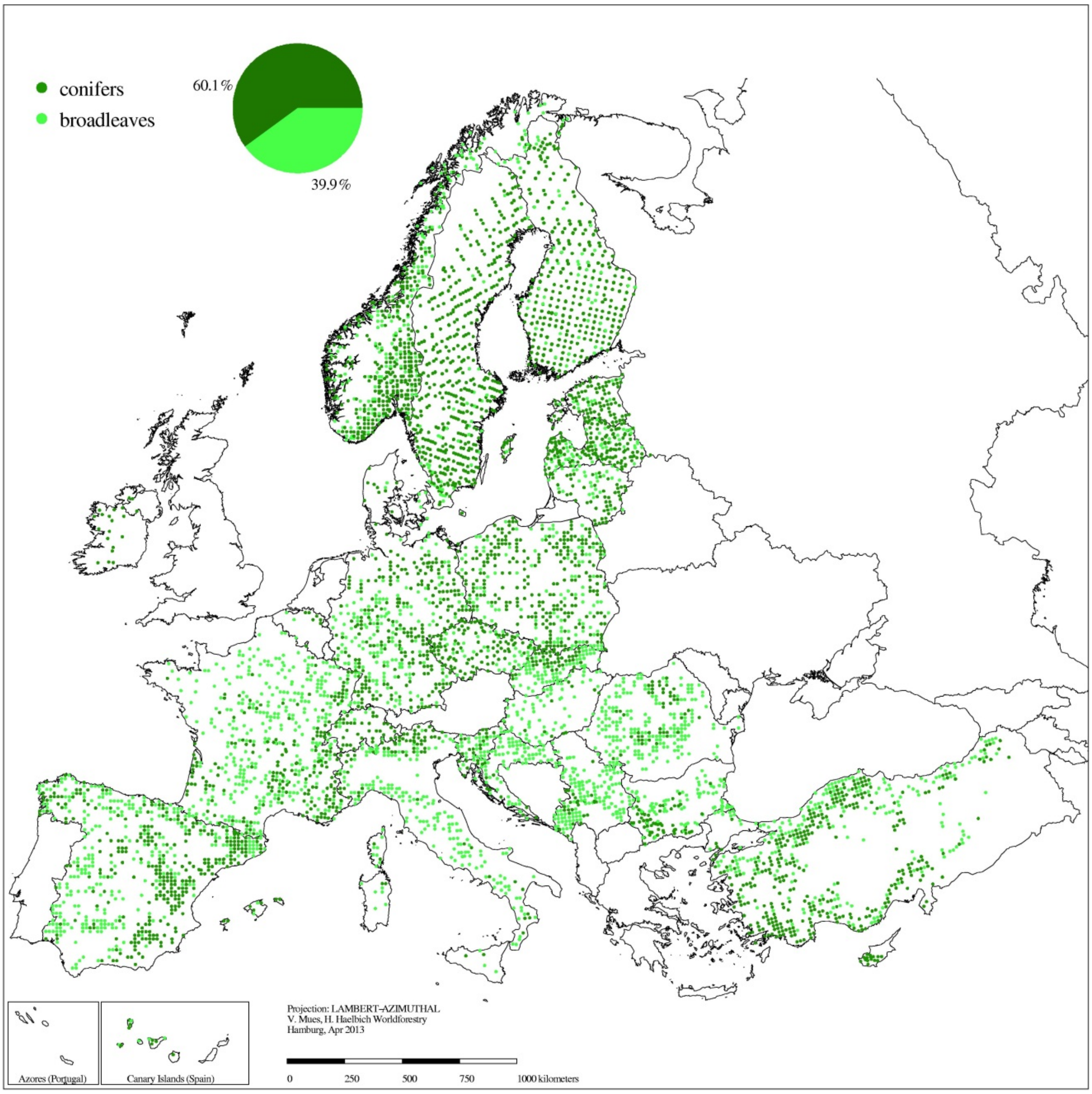
## Annex I:
## Maps of the transnational evaluations

## Annex II:
## Results from national reports

## Annex III:
## Contacts

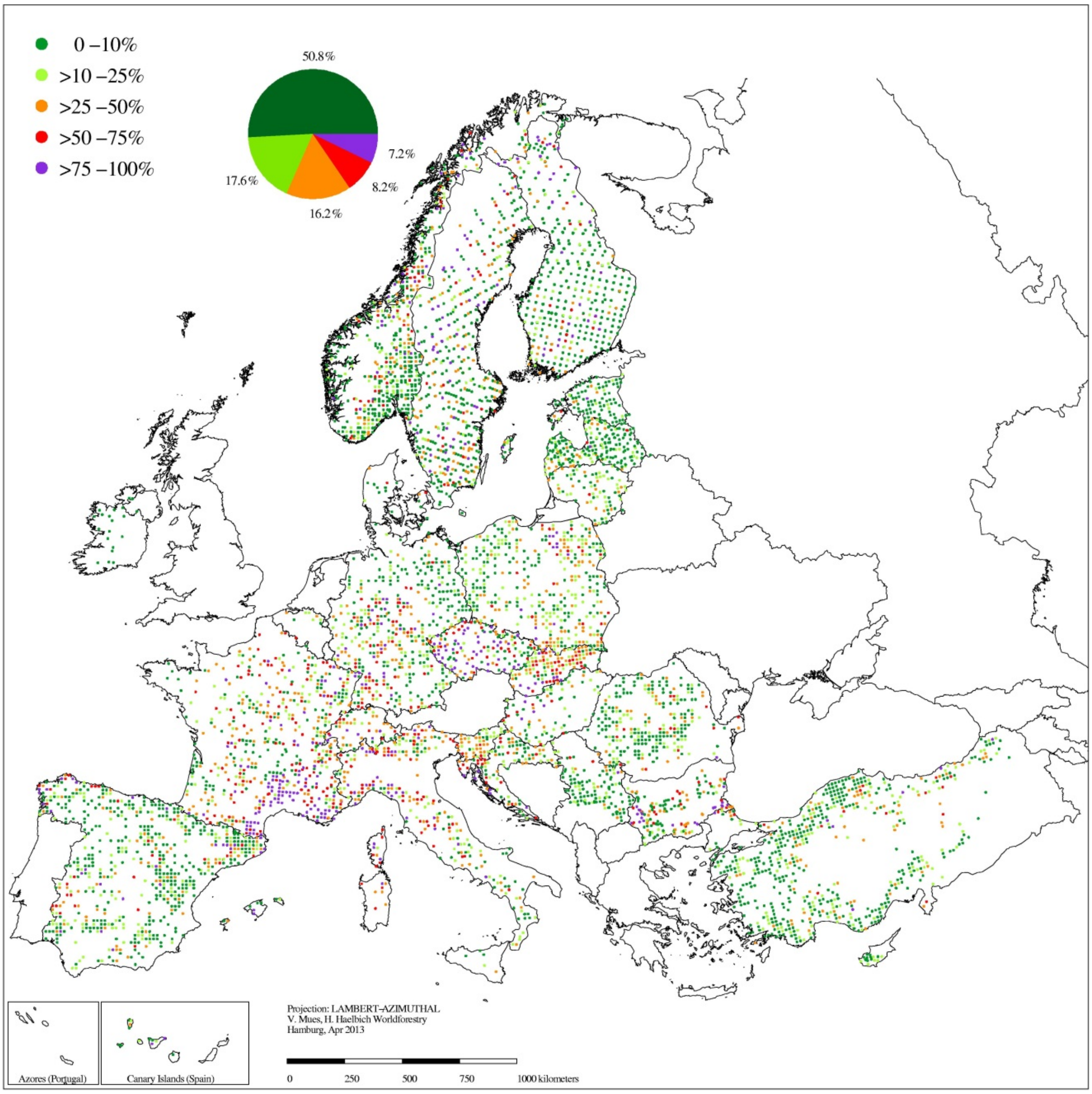
# ANNEX I: MAPS OF THE TRANSNATIONAL EVALUATIONS

## Annex I-1: Broadleaves and conifers



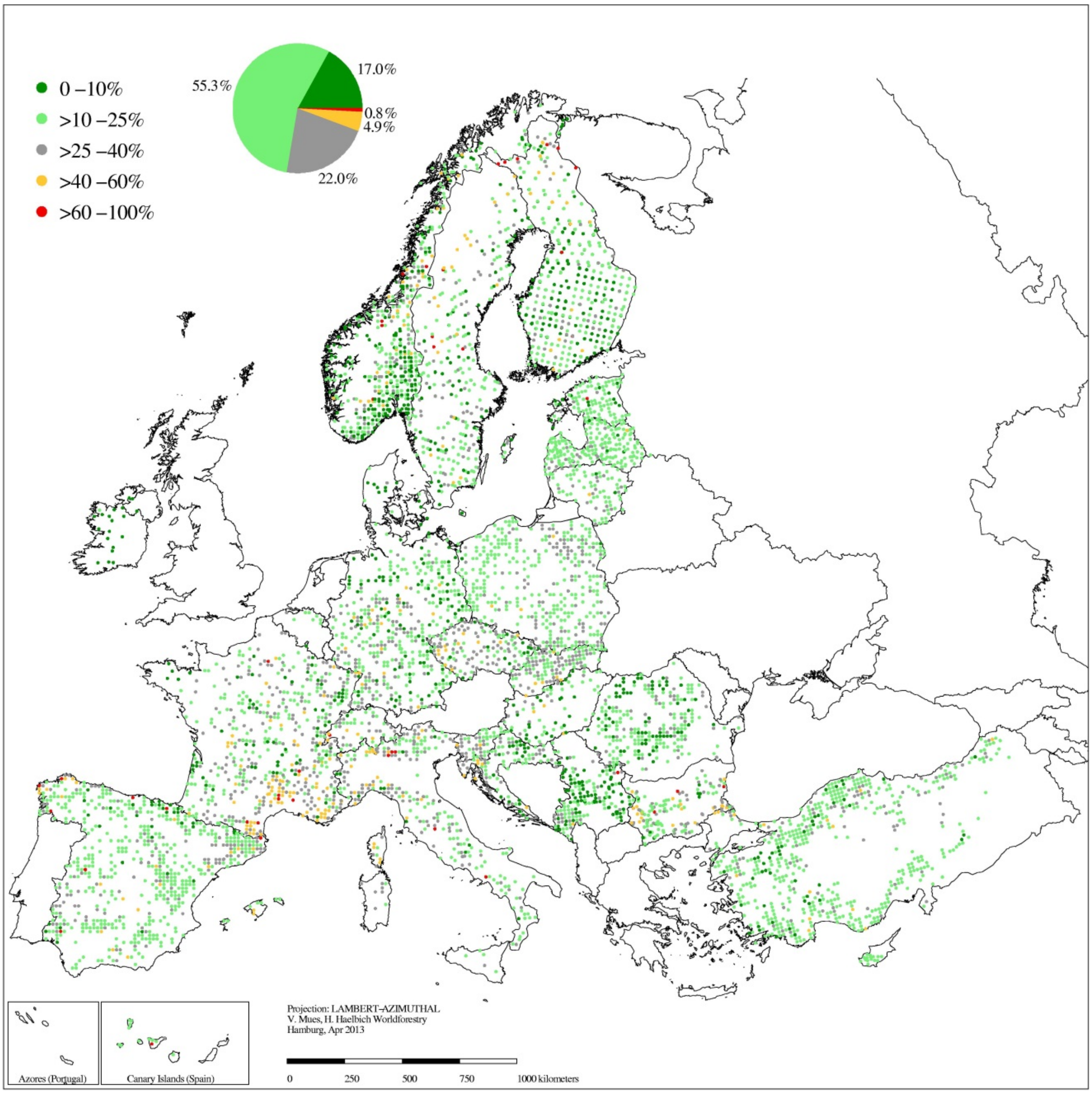

**Shares of broadleaves and conifers assessed on Level I plots in 2012**

## Annex I-2: Percentage of trees damaged (2012)



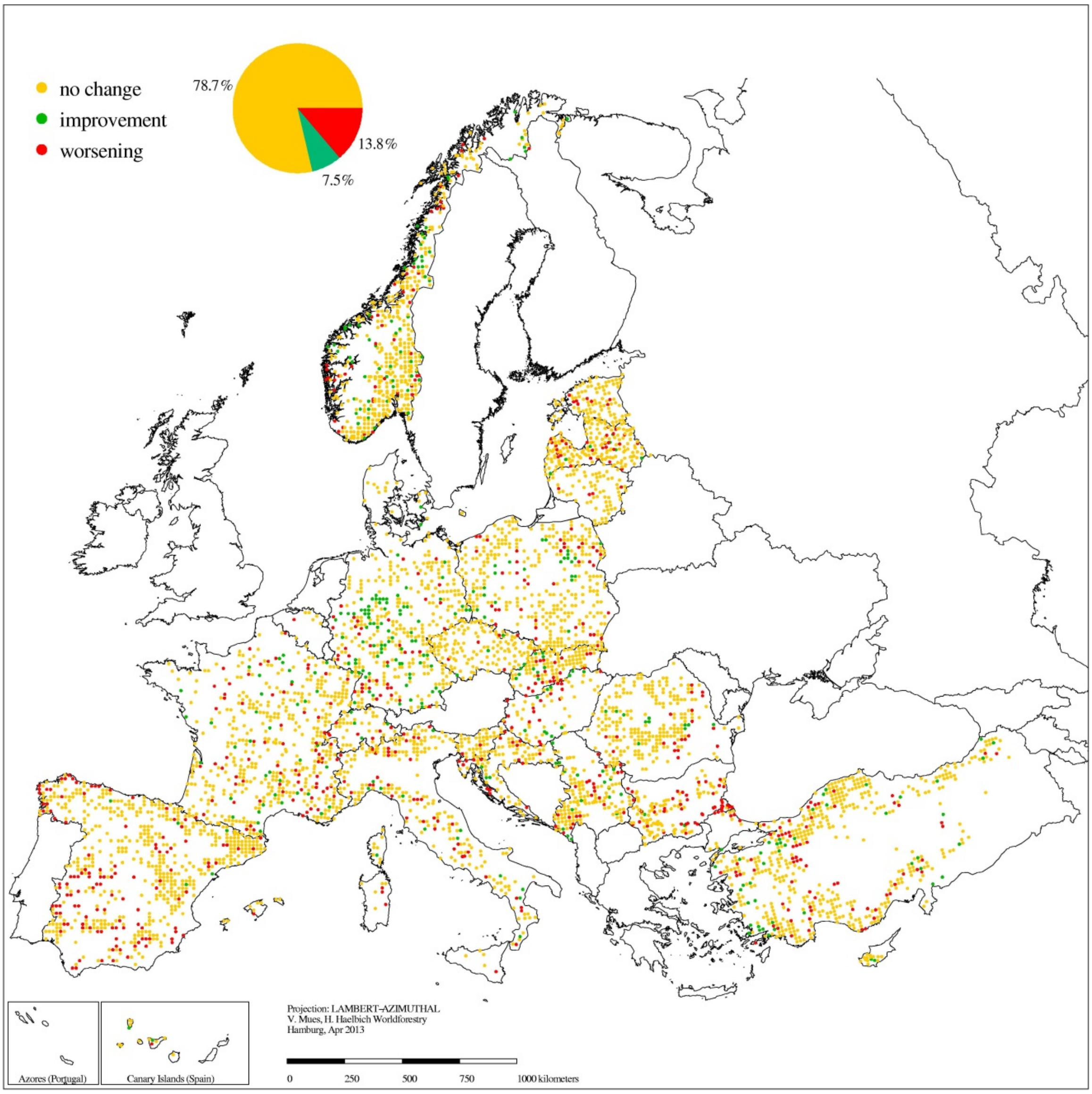

**Percentage of trees assessed as damaged (defoliation >25%) on Level I plots in 2012**

# Annex I-3: Mean plot defoliation of all species (2012)




**Mean plot defoliation of all species (2012)**

## Annex I-4: Changes in mean plot defoliation (2011-2012)




**Changes in mean defoliation of all trees assessed on Level I between 2011 and 2012**

# ANNEX II: RESULTS FROM NATIONAL REPORTS

## Annex II-1: Forests and surveys in European countries (2012)

| Participating Countries | Total area (1000 ha) | Forest area (1000 ha) | Coniferous forest (1000 ha) | Broadleaves forest (1000 ha) | Area surveyed (1000 ha) | Grid size (km x km) | No. of sample plots | No. of sample trees |
|---|---|---|---|---|---|---|---|---|
| Albania | | | | | no survey in 2012 | | | |
| Andorra | 46.8 | 17.7 | 15.4 | 2.3 | 17.7 | 16 x 16 | 3 | 72 |
| Austria | | | | | no survey in 2012 | | | |
| Belarus | | | | | no survey in 2012 | | | |
| Belgium | 3035.1 | 700.4 | 281 | 324 | | $4^2$ / $8^2$ | 107 | 2594 |
| Bulgaria | 11000 | 4148 | 1271 | 2877 | | $4^2$/$8^2$/$16^2$ | 159 | 5612 |
| Croatia | 5654 | 2061 | 321 | 1740 | | 16 x 16 | 92 | 2208 |
| Cyprus | 925.1 | 297.7 | 171.6 | 0 | 137.8 | 16x16 | 15 | 360 |
| Czech Republic | 7886 | 2647 | 2014 | 633 | 2647 | $8^2$/$16^2$ | 135 | 5309 |
| Denmark | 4310 | 586 | 289 | 263 | | $7^2$/$16^2$ | 344 | 2145 |
| Estonia | 4510 | 2212 | 1102.5 | 1119.4 | 2221.9 | 16 x 16 | 98 | 2348 |
| Finland | 30415 | 20150 | 17974 | 1897 | 19871 | $16^2$ / 24x32 | 785 | 4676 |
| France | 54883 | 15840 | 4041 | 9884 | 13100 | | 563 | 11648 |
| Germany | 35702 | 11076 | 6490 | 3857 | 10347 | $16^2$ / $4^2$ | 415 | 9992 |
| Greece | 12890 | 2034 | 954 | 1080 | no survey in 2012 | | | |
| Hungary | 9300 | 1928 | 218 | 1710 | 1928 | 16 x 16 | 78 | 1793 |
| Ireland | 6889 | 693 | 152 | 540 | 445 | | 20 | 489 |
| Italy | 30128 | 8675 | 1735 | 6940 | | | 245 | 5081 |
| Latvia | 6459 | 3162 | 1454 | 1710 | | 8x8 | 203 | 3879 |
| Liechtenstein | 16 | 8 | 6 | 2 | no survey in 2012 | | | |
| Lithuania | 6530 | 2173 | 1153 | 902 | | 4x4/16x16 | 1011 | 5732 |
| Luxembourg | 259 | 89 | 30 | 54 | no survey in 2012 | | | |
| Rep. of Macedonia | | | | | no survey in 2012 | | | |
| Rep. of Moldova | 3384 | 400.6 | 7.7 | 366.8 | | 2x2 | 622 | 14589 |
| Netherlands | 3482 | 360 | 140 | 136 | no survey in 2012 | | | |
| Norway | 32376 | 12000 | 6800 | 5200 | 12000 | $3^2$/$9^2$ | 1694 | 9722 |
| Poland | 31268 | 9200 | 6955 | 2245 | 9200 | 16 x 16 | 1965 | 39300 |
| Portugal | 8893 | 3234 | 1081 | | no survey in 2012 | | | |
| Romania | 23839 | 6233 | 1873 | 4360 | | 16 x 16 | 241 | 5784 |
| Russian Fed. | | | | | no survey in 2012 | | | |
| Serbia | 8836 | 2360 | 79 | 2181 | 1868 | 16 x 16/ 4 x 4 | 130 | 2786 |
| Slovak Republic | 4901 | 1961 | 815 | 1069 | 1961 | 16 x 16 | 108 | 3898 |
| Slovenia | 2014 | 1183 | 445 | 738 | 1183 | 16 x 16 | 44 | 1053 |
| Spain | 50471 | 18173 | 6600 | 9626 | | 16 x 16 | 620 | 14880 |
| Sweden | 40700 | 28100 | 114500 | | 17000 | varying | 3241 | 7496 |
| Switzerland | 4129 | 1279 | 778 | 501 | 1279 | 16 x 16 | 47 | 1029 |
| Turkey | 77846 | 21537 | 13158 | 8379 | 9057 | 16 x 16 | 578 | 13578 |
| Ukraine | 60350 | 9400 | 2756 | 3285 | 6033 | 16 x 16 | 1488 | 35195 |
| United Kingdom | | | | | no survey in 2012 | | | |
| TOTAL | 2336794 | 1018073.8 | 515644.16 | 274675.19 | 157618.7 | varying | 15067 | 224219 |

## Annex II-2: Percent of trees of all species by defoliation classes and class aggregates (2012)

| Participating countries | Area surveyed (1000 ha) | No. of sample trees | 0 none | 1 slight | 2 moderate | 3+4 severe and dead | 2+3+4 |
|---|---|---|---|---|---|---|---|
| Albania | | | no survey in 2012 | | | | |
| Andorra | 17.7 | 72 | 56.9 | 37.5 | 5.6 | 0.0 | 5.6 |
| Austria | | | no survey in 2012 | | | | |
| Belarus | | | | no | survey | in 2012 | |
| Belgium | | 2594 | 19.0 | 52.8 | 22.6 | 5.6 | 28.2 |
| Bulgaria | | 5612 | 23.7 | 44.0 | 25.2 | 7.1 | 32.3 |
| Croatia | | 2400 | 36.6 | 34.9 | 25.3 | 3.2 | 28.5 |
| Cyprus | 137.8 | 360 | 25.8 | 63.6 | 10.0 | 0.6 | 10.6 |
| Czech Republic | 2647 | 5309 | 15.6 | 34.1 | 48.6 | 1.7 | 50.3 |
| Denmark | 344 | 2145 | 75.2 | 17.5 | 6.0 | 1.3 | 7.3 |
| Estonia | 2221.9 | 2348 | 49.4 | 42.8 | 5.4 | 2.4 | 7.8 |
| Finland | 19871 | 4676 | 49.3 | 36.4 | 11.9 | 2.4 | 14.3 |
| France | 13100 | 11648 | 25.3 | 33.6 | 36.6 | 4.5 | 41.1 |
| Germany | 10347 | 9992 | 38.8 | 36.6 | 22.6 | 2.0 | 24.6 |
| Greece | | | no survey in 2012 | | | | |
| Hungary | 1928 | 1793 | 60.0 | 19.8 | 15.3 | 4.9 | 2018 |
| Ireland | 445 | 489 | 93.0 | 6.0 | 1.0 | 0.0 | 1.0 |
| Italy | | 5081 | 22.7 | 41.6 | 30.7 | 5.0 | 35.7 |
| Latvia | 3162.3 | 3879 | 11.8 | 79.0 | 7.8 | 1.4 | 9.2 |
| Liechtenstein | | | no survey in 2012 | | | | |
| Lithuania | | 5732 | 16.3 | 59.2 | 22.7 | 1.8 | 24.5 |
| Luxembourg | | | no survey in 2012 | | | | |
| Rep. of Macedonia | | | no survey in 2012 | | | | |
| Rep. of Moldova | | 14589 | 29.1 | 45.3 | 21.7 | 3.9 | 25.6 |
| Netherlands | | | no survey in 2012 | | | | |
| Norway | 12000 | 9722 | 44.4 | 36.8 | 15.6 | 3.2 | 18.8 |
| Poland | 9200 | 38940 | 11.3 | 65.4 | 22.1 | 1.3 | 23.4 |
| Portugal | | | no survey in 2012 | | | | |
| Romania | | 5784 | 50.2 | 35.9 | 13.0 | 0.9 | 13.9 |
| Russian Fed. | | | no survey in 2012 | | | | |
| Serbia | 1868 | 2786 | 71.7 | 18.0 | 7.6 | 2.7 | 10.3 |
| Slovak Republic | 1961 | 3898 | 11.4 | 50.7 | 36.4 | 1.5 | 37.9 |
| Slovenia | 1183 | 1053 | 18.0 | 53.0 | 24.1 | 4.5 | 29.1 |
| Spain | | 14880 | 21.8 | 60.7 | 13.5 | 4.0 | 17.5 |
| Sweden | 20600 | 7496 | 53.2 | 30.9 | 12.7 | 3.2 | 15.9 |
| Switzerland | 1279 | 1029 | 24.2 | 44.5 | 21.2 | 10.1 | 31.3 |
| Turkey | 9057 | 13578 | 32.8 | 54.8 | 9.8 | 2.6 | 12.4 |
| Ukraine | 6033 | 35195 | 63.1 | 29.4 | 6.4 | 1.1 | 7.5 |
| United Kingdom | | | no survey in 2012 | | | | |

*Andorra, Cyprus, Ireland, Sweden: only conifers assessed. Note that some differences in the level of damage across national borders may be at least partly due to differences in standards used. This restriction, however, does not affect the reliability of the trends over time.*

## Annex II-3: Percent of conifers by defoliation classes and class aggregates (2012)

| Participating countries | Coniferous forest (1000 ha) | No. of sample trees | 0 none | 1 slight | 2 moderate | 3+4 severe and dead | 2+3+4 |
|---|---|---|---|---|---|---|---|
| Albania | | | no survey in 2012 | | | | |
| Andorra | 17.7 | 72 | 56.9 | 37.5 | 5.6 | 0.0 | 5.6 |
| Austria | | | no survey in 2012 | | | | |
| Belarus | | | | no | survey | In 2012 | |
| Belgium | | 962 | 14.6 | 65.1 | 19.0 | 1.3 | 20.3 |
| Bulgaria | 1271 | 2397 | 18.2 | 46.2 | 28.6 | 6.5 | 35.7 |
| Croatia | | 369 | 23.9 | 21.4 | 45.8 | 8.9 | 54.7 |
| Cyprus | 172 | 360 | 25.8 | 63.6 | 10.0 | 0.6 | 10.6 |
| Czech Republic | 2014 | 4201 | 13.5 | 29.8 | 54.7 | 2.0 | 56.9 |
| Denmark | 289 | 1226 | 77.0 | 18.4 | 4.3 | 0.3 | 4.6 |
| Estonia | 1102.5 | 2047 | 48.9 | 44.5 | 5.1 | 1.5 | 6.6 |
| Finland | 17974 | 3758 | 48.1 | 37.3 | 12.3 | 2.3 | 14.6 |
| France | 4041 | 4072 | 38.4 | 29.4 | 29.5 | 2.7 | 32.2 |
| Germany | 6490 | 6067 | 44.1 | 36.6 | 18.0 | 1.3 | 19.3 |
| Greece | | | no survey in 2012 | | | | |
| Hungary | 218 | 203 | 56.2 | 20.7 | 16.7 | 6.4 | 21.1 |
| Ireland | 152 | 489 | 93.0 | 6.0 | 1.0 | 0.0 | 1.0 |
| Italy | | 1123 | 32.1 | 36.1 | 26.2 | 5.6 | 31.8 |
| Latvia | 1453.6 | 2901 | 12.8 | 79.3 | 7.0 | 0.9 | 7.9 |
| Liechtenstein | | | no survey in 2012 | | | | |
| Lithuania | 1153 | 3470 | 14.8 | 58.3 | 25.5 | 1.4 | 59.7 |
| Luxembourg | | | no survey in 2012 | | | | |
| Rep. of Macedonia | | | no survey in 2012 | | | | |
| Rep. of Moldova | 7.7 | 122 | 24.6 | 31.1 | 27.9 | 16.4 | 44.3 |
| Netherlands | | | no survey in 2012 | | | | |
| Norway | 6800 | 7386 | 49.6 | 34.4 | 13.3 | 2.8 | 16.1 |
| Poland | 6955 | 25750 | 8.7 | 69.0 | 21.2 | 1.1 | 22.3 |
| Portugal | | | no survey in 2012 | | | | |
| Romania | 1873 | 1100 | 56.1 | 29.0 | 13.8 | 1.1 | 14.9 |
| Russian Fed. | | | no survey in 2012 | | | | |
| Serbia | 179 | 337 | 78.3 | 10.7 | 7.7 | 3.3 | 11.0 |
| Slovak Republic | 815 | 1575 | 6.7 | 49.8 | 41.8 | 1.7 | 43.5 |
| Slovenia | 445 | 393 | 22.1 | 46.6 | 26.2 | 5.1 | 31.3 |
| Spain | | 7438 | 26.0 | 62.6 | 8.9 | 2.5 | 10.3 |
| Sweden | 14500 | 7496 | 53.2 | 30.9 | 12.7 | 3.2 | 15.9 |
| Switzerland | 778 | 750 | 23.1 | 46.3 | 22.7 | 7.9 | 30.6 |
| Turkey | 13158 | 8594 | 35.1 | 55.0 | 7.9 | 2.0 | 984 |
| Ukraine | 2756 | 14874 | 66.2 | 26.3 | 6.4 | 1.1 | 7.5 |
| UK | | | no survey in 2012 | | | | |

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

# Annex II-4: Percent of broadleaves by defoliation classes and class aggregates (2012)

| Participating countries | Broadleav. forest (1000 ha) | No. of sample trees | 0 None | 1 slight | 2 moderate | 3+4 severe and dead | 2+3+4 |
|---|---|---|---|---|---|---|---|
| Albania | | | no survey in 2012 | | | | |
| Andorra | | | only conifers assessed | | | | |
| Austria | | | no survey in 2012 | | | | |
| Belarus | | | | no | survey | In 2012 | |
| Belgium | | 1682 | 21.6 | 45.5 | 24.8 | 8.1 | 31.6 |
| Bulgaria | 2877 | 3186 | 27.8 | 42.4 | 22.2 | 7.6 | 29.8 |
| Croatia | | 2031 | 39.0 | 37.4 | 21.5 | 2.2 | 23.7 |
| Cyprus | | | only conifers assessed | | | | |
| Czech Republic | 633 | 1217 | 22.5 | 49.1 | 27.7 | 0.7 | 29.0 |
| Denmark | 263 | 919 | 72.9 | 16.2 | 8.4 | 2.5 | 10.9 |
| Estonia | 1119.4 | 301 | 53.2 | 31.9 | 7.3 | 7.6 | 14.9 |
| Finland | 1897 | 918 | 54.3 | 32.9 | 10.1 | 2.7 | 12.8 |
| France | 9884 | 7576 | 18.3 | 35.8 | 40.4 | 5.5 | 45.9 |
| Germany | 3857 | 3925 | 30.5 | 37.0 | 30.3 | 2.2 | 32.5 |
| Greece | | | no survey in 2012 | | | | |
| Hungary | 1710 | 1590 | 60.4 | 19.7 | 15.2 | 4.7 | 19.9 |
| Ireland | | 301 | no survey in 2012 | | | | |
| Italy | | 3551 | 19.6 | 43.2 | 32.1 | 5.1 | 37.2 |
| Latvia | 1710 | 978 | 8.9 | 78.6 | 10.3 | 2.6 | 12.9 |
| Liechtenstein | | | no survey in 2012 | | | | |
| Lithuania | 902 | 2262 | 18.4 | 60.5 | 18.6 | 2.4 | 21.0 |
| Luxembourg | | | no survey in 2012 | | | | |
| Rep. of Macedonia | | | no survey in 2012 | | | | |
| Rep. of Moldova | 366.8 | 14467 | 29.1 | 45.3 | 21.7 | 3.9 | 25.6 |
| Netherlands | | | no survey in 2012 | | | | |
| Norway | 5200 | 2336 | 28.3 | 44.4 | 23.1 | 4.2 | 27.3 |
| Poland | 2245 | 13550 | 16.1 | 58.4 | 23.7 | 1.8 | 25.5 |
| Portugal | | | no survey in 2012 | | | | |
| Romania | 4360 | 4684 | 48.8 | 37.6 | 12.8 | 0.8 | 13.4 |
| Russian Fed. | | | no survey in 2012 | | | | |
| Serbia | 2181 | 2449 | 70.8 | 19.0 | 7.6 | 2.6 | 10.2 |
| Slovak Republic | 1069 | 2323 | 14.6 | 51.5 | 32.6 | 1.3 | 33.9 |
| Slovenia | 738 | 660 | 15.5 | 56.8 | 23.6 | 4.1 | 28.5 |
| Spain | | 7441 | 17.6 | 58.8 | 18.1 | 5.5 | 23.6 |
| Sweden | | | only conifers assessed | | | | |
| Switzerland | 501 | 279 | 26.7 | 40.0 | 17.7 | 15.6 | 33.3 |
| Turkey | 8379 | 4784 | 28.6 | 54.6 | 13.2 | 3.6 | 16.8 |
| Ukraine | 3285 | 201321 | 60.8 | 31.7 | 6.5 | 1.0 | 7.5 |
| UK | | | no survey in 2012 | | | | |

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

## Annex II-4: Percent of broadleaves by defoliation classes and class aggregates (2012)

| Participating countries | Broadleav. forest (1000 ha) | No. of sample trees | 0 None | 1 slight | 2 moderate | 3+4 severe and dead | 2+3+4 |
|---|---|---|---|---|---|---|---|
| Albania | | | no survey in 2012 | | | | |
| Andorra | | | only conifers assessed | | | | |
| Austria | | | no survey in 2012 | | | | |
| Belarus | | | | no | survey | In 2012 | |
| Belgium | | 1682 | 21.6 | 45.5 | 24.8 | 8.1 | 31.6 |
| Bulgaria | 2877 | 3186 | 27.8 | 42.4 | 22.2 | 7.6 | 29.8 |
| Croatia | | 2031 | 39.0 | 37.4 | 21.5 | 2.2 | 23.7 |
| Cyprus | | | only conifers assessed | | | | |
| Czech Republic | 633 | 1217 | 22.5 | 49.1 | 27.7 | 0.7 | 29.0 |
| Denmark | 263 | 919 | 72.9 | 16.2 | 8.4 | 2.5 | 10.9 |
| Estonia | 1119.4 | 301 | 53.2 | 31.9 | 7.3 | 7.6 | 14.9 |
| Finland | 1897 | 918 | 54.3 | 32.9 | 10.1 | 2.7 | 12.8 |
| France | 9884 | 7576 | 18.3 | 35.8 | 40.4 | 5.5 | 45.9 |
| Germany | 3857 | 3925 | 30.5 | 37.0 | 30.3 | 2.2 | 32.5 |
| Greece | | | no survey in 2012 | | | | |
| Hungary | 1710 | 1590 | 60.4 | 19.7 | 15.2 | 4.7 | 19.9 |
| Ireland | | 301 | no survey in 2012 | | | | |
| Italy | | 3551 | 19.6 | 43.2 | 32.1 | 5.1 | 37.2 |
| Latvia | 1710 | 978 | 8.9 | 78.6 | 10.3 | 2.6 | 12.9 |
| Liechtenstein | | | no survey in 2012 | | | | |
| Lithuania | 902 | 2262 | 18.4 | 60.5 | 18.6 | 2.4 | 21.0 |
| Luxembourg | | | no survey in 2012 | | | | |
| Rep. of Macedonia | | | no survey in 2012 | | | | |
| Rep. of Moldova | 366.8 | 14467 | 29.1 | 45.3 | 21.7 | 3.9 | 25.6 |
| Netherlands | | | no survey in 2012 | | | | |
| Norway | 5200 | 2336 | 28.3 | 44.4 | 23.1 | 4.2 | 27.3 |
| Poland | 2245 | 13550 | 16.1 | 58.4 | 23.7 | 1.8 | 25.5 |
| Portugal | | | no survey in 2012 | | | | |
| Romania | 4360 | 4684 | 48.8 | 37.6 | 12.8 | 0.8 | 13.4 |
| Russian Fed. | | | | no survey in 2012 | | | |
| Serbia | 2181 | 2449 | 70.8 | 19.0 | 7.6 | 2.6 | 10.2 |
| Slovak Republic | 1069 | 2323 | 14.6 | 51.5 | 32.6 | 1.3 | 33.9 |
| Slovenia | 738 | 660 | 15.5 | 56.8 | 23.6 | 4.1 | 28.5 |
| Spain | | 7441 | 17.6 | 58.8 | 18.1 | 5.5 | 23.6 |
| Sweden | | | only conifers assessed | | | | |
| Switzerland | 501 | 279 | 26.7 | 40.0 | 17.7 | 15.6 | 33.3 |
| Turkey | 8379 | 4784 | 28.6 | 54.6 | 13.2 | 3.6 | 16.8 |
| Ukraine | 3285 | 201321 | 60.8 | 31.7 | 6.5 | 1.0 | 7.5 |
| UK | | | no survey in 2012 | | | | |

*Andorra, Cyprus, Ireland, Sweden: only conifers assessed.*

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

## Annex II-5: Percent of damaged trees of all species (2001-2012)

| Participating Countries | All species<br>Defoliation classes 2-4 | | | | | | | | | | | | Change % points 2011/12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | |
| Albania | 10.2 | 13.1 | | 12.2 | | 11.1 | | | | | | | |
| Andorra | | | | 36.1 | | 23.0 | 47.2 | 15.3 | 6.8 | 15.3 | 8.3 | 5.6 | -2.7 |
| Austria | 9.7 | 10.2 | 11.1 | 13.1 | 14.8 | 15.0 | | | | 14.2 | | | |
| Belarus | 20.7 | 9.5 | 11.3 | 10.0 | 9.0 | 7.9 | 8.1 | 8.0 | 8.4 | 7.4 | 6.1 | | |
| Belgium | 17.9 | 17.8 | 17.3 | 19.4 | 19.9 | 17.9 | 16.4 | 14.5 | 20.2 | 22.1 | 23.5 | 28.2 | 4.7 |
| Bulgaria | 33.8 | 37.1 | 33.7 | 39.7 | 35.0 | 37.4 | 29.7 | 31.9 | 21.1 | 23.8 | 21.6 | 32.3 | 10.7 |
| Croatia | 25.0 | 20.6 | 22.0 | 25.2 | 27.1 | 24.9 | 25.1 | 23.9 | 26.3 | 27.9 | 25.2 | 28.5 | 3.3 |
| Cyprus | 8.9 | 2.8 | 18.4 | 12.2 | 10.8 | 20.8 | 16.7 | 47.0 | 36.2 | 19.2 | 16.4 | 10.6 | |
| Czech Republic | 52.1 | 53.4 | 54.4 | 57.3 | 57.1 | 56.2 | 57.1 | 56.7 | 56.8 | 54.2 | 52.7 | 50.3 | -2.4 |
| Denmark | 7.4 | 8.7 | 10.2 | 11.8 | 9.4 | 7.6 | 6.1 | 9.1 | 5.5 | 9.3 | 10.0 | 7.3 | -2.7 |
| Estonia | 8.5 | 7.6 | 7.6 | 5.3 | 5.4 | 6.2 | 6.8 | 9.0 | 7.2 | 8.1 | 8.1 | 7.8 | -0.3 |
| Finland | 11.0 | 11.5 | 10.7 | 9.8 | 8.8 | 9.7 | 10.5 | 10.2 | 9.1 | 10.5 | 10.6 | 14.3 | 3.7 |
| France · | 20.3 | 21.9 | 28.4 | 31.7 | 34.2 | 35.6 | 35.4 | 32.4 | 33.5 | 34.6 | 39.9 | 41.4 | 1.5 |
| Germany a) | 21.9 | 21.4 | 22.5 | 31.4 | 28.5 | 27.9 | 24.8 | 25.7 | 26.5 | 23.2 | 28.0 | 24.6 | -3.4 |
| Greece | 21.7 | 20.9 | | | 16.3 | | | | 24.3 | 23.8 | | | |
| Hungary | 21.2 | 21.2 | 22.5 | 21.5 | 21.0 | 19.2 | 20.7 | | 18.4 | 21.8 | 18.9 | 20.2 | 1.3 |
| Ireland | 17.4 | 20.7 | 13.9 | 17.4 | 16.2 | 7.4 | 6.0 | 10.0 | 12.5 | 17.5 | | 1.0 | |
| Italy | 38.4 | 37.3 | 37.6 | 35.9 | 32.9 | 30.5 | 35.7 | 32.8 | 35.8 | 29.8 | 31.3 | 35.7 | 4.4 |
| Latvia | 15.6 | 13.8 | 12.5 | 12.5 | 13.1 | 13.4 | 15.0 | 15.3 | 13.8 | 13.4 | 14.0 | 9.2 | -4.8 |
| Liechtenstein | | | | | | | | | | | | | |
| Lithuania | 11.7 | 12.8 | 14.7 | 13.9 | 11.0 | 12.0 | 12.3 | 19.6 | 17.7 | 21.3 | 15.4 | 24.5 | 9.1 |
| Luxembourg | | | | | | | | | | | | | |
| Rep. of Macedonia | | | | | | | 23.0 | | | | | | |
| Rep. of Moldova | 36.9 | 42.5 | 42.4 | 34.0 | 26.5 | 27.6 | 32.5 | 33.6 | 25.2 | 22.5 | 18.4 | 25.6 | 7.2 |
| Netherlands | 19.9 | 21.7 | 18.0 | 27.5 | 30.2 | 19.5 | | | | | | | |
| Norway | 27.2 | 25.5 | 22.9 | 20.7 | 21.6 | 23.3 | 26.2 | 22.7 | 21.0 | 18.9 | 20.9 | 18.8 | -2.1 |
| Poland | 30.6 | 32.7 | 34.7 | 34.6 | 30.7 | 20.1 | 20.2 | 18.0 | 17.7 | 20.7 | 24.0 | 23.4 | -0.6 |
| Portugal | 10.1 | 9.6 | 13.0 | 16.6 | 24.3 | | | | | | | | |
| Romania | 13.3 | 13.5 | 12.6 | 11.7 | 8.1 | 8.6 | 23.2 | | 18.9 | 17.8 | 13.9 | 13.9 | 0.0 |
| Russian Fed. | 9.8 | 10.9 | | | | | | | 6.2 | 4.4 | 8.3 | | |
| Serbia | 14.0 | 3.9 | 22.8 | 14.3 | 16.4 | 11.3 | 15.4 | 11.5 | 10.3 | 10.8 | 7.6 | 10.3 | 2.7 |
| Slovak Republic | 31.7 | 24.8 | 31.4 | 26.7 | 22.9 | 28.1 | 25.6 | 29.3 | 32.1 | 38.6 | 34.7 | 37.9 | 3.2 |
| Slovenia | 28.9 | 28.1 | 27.5 | 29.3 | 30.6 | 29.4 | 35.8 | 36.9 | 35.5 | 31.8 | 31.4 | 29.1 | -2.3 |
| Spain | 13.0 | 16.4 | 16.6 | 15.0 | 21.3 | 21.5 | 17.6 | 15.6 | 17.7 | 14.6 | 11.8 | 17.5 | 5.7 |
| Sweden | 17.5 | 16.8 | 19.2 | 16.5 | 18.4 | 19.4 | 17.9 | 17.3 | 15.1 | 19.2 | 18.9 | 15.9 | -3.0 |
| Switzerland | 18.2 | 18.6 | 14.9 | 29.1 | 28.1 | 22.6 | 22.4 | 19.0 | 18.3 | 22.2 | 30.9 | 31.3 | -0.4 |
| Turkey | | | | | | | | 24.6 | 18.7 | 16.8 | 13.6 | 12.4 | -1.2 |
| Ukraine | 39.6 | 27.7 | 27.0 | 29.9 | 8.7 | 6.6 | 7.1 | 8.2 | 6.8 | 5.8 | 6.8 | 7.5 | 0.7 |
| UK* | 21.1 | 27.3 | 24.7 | 26.5 | 24.8 | 25.9 | 26.0 | | | 48.5 | | | |

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

# Annex II-6: Percent of damaged conifers (2001-2012)

| Participating countries | Conifers Defoliation classes 2-4 | | | | | | | | | | | | change % points 2011/12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | |
| Albania | 12.4 | 15.5 | | 14.0 | | 13.6 | | | | | | | |
| Andorra | | | | 36.1 | | 23.0 | 47.2 | 15.3 | 6.8 | 15.3 | 8.3 | 5.6 | -2.7 |
| Austria | 9.6 | 10.1 | 11.2 | 13.1 | 15.1 | 14.5 | | | | 14.5 | | | |
| Belarus | 23.4 | 9.7 | 9.5 | 8.9 | 8.4 | 7.5 | 8.1 | 8.1 | 8.3 | 7.7 | 5.8 | | |
| Belgium | 17.5 | 19.7 | 18.6 | 15.6 | 16.8 | 15.8 | 13.9 | 13.2 | 13.6 | 16.2 | 15.2 | 20.3 | 5.1 |
| Bulgaria | 39.1 | 44.0 | 38.4 | 47.1 | 45.4 | 47.6 | 37.4 | 45.6 | 33.0 | 31.1 | 33.3 | 35.1 | 1.8 |
| Croatia | 65.1 | 63.5 | 77.4 | 70.6 | 79.5 | 71.7 | 61.1 | 59.1 | 66.5 | 56.9 | 45.1 | 54.7 | 9.6 |
| Cyprus | 8.9 | 2.8 | 18.4 | 12.2 | 10.8 | 20.8 | 16.7 | 46.9 | 36.2 | 19.2 | 16.4 | 10.6 | -5.8 |
| Czech Republic | 58.1 | 60.1 | 60.7 | 62.6 | 62.7 | 62.3 | 62.9 | 62.8 | 63.1 | 60.1 | 58.9 | 56.9 | -2.0 |
| Denmark | 6.7 | 4.5 | 6.1 | 5.8 | 5.5 | 1.7 | 3.1 | 9.9 | 1.0 | 5.4 | 5.7 | 4.6 | -1.1 |
| Estonia | 8.8 | 7.9 | 7.7 | 5.3 | 5.6 | 6.0 | 6.7 | 9.3 | 7.5 | 9.0 | 8.7 | 6.6 | -2.1 |
| Finland | 11.4 | 11.9 | 11.1 | 10.1 | 9.2 | 9.6 | 10.4 | 10.1 | 9.9 | 10.6 | 11.7 | 14.6 | 2.9 |
| France | 14.0 | 15.2 | 18.9 | 18.6 | 20.8 | 23.6 | 24.1 | 25.1 | 26.8 | 27.4 | 31.9 | 32.2 | 0.3 |
| Germany a) | 20.0 | 19.8 | 20.1 | 26.3 | 24.9 | 22.7 | 20.2 | 24.1 | 20.3 | 19.2 | 20.3 | 19.3 | -1.0 |
| Greece | 17.2 | 16.1 | | | 15.0 | | | | 26.3 | 23.7 | | | |
| Hungary | 19.5 | 22.8 | 27.6 | 24.2 | 22.0 | 20.8 | 22.3 | | 27.1 | 35.1 | 28.7 | 23.1 | -5.6 |
| Ireland | 17.4 | 20.7 | 13.9 | 17.4 | 16.2 | 7.4 | 6.2 | 10.0 | 12.5 | 17.5 | | 1.0 | |
| Italy | 19.1 | 20.5 | 20.4 | 21.7 | 22.8 | 19.5 | 22.7 | 24.0 | 31.6 | 29.1 | 32.2 | 31.8 | -0.4 |
| Latvia | 15.8 | 14.3 | 12.2 | 11.9 | 13.2 | 15.2 | 16.2 | 16.7 | 14.8 | 15.0 | 16.0 | 7.9 | -8.1 |
| Liechtenstein | | | | | | | | | | | | | |
| Lithuania | 9.8 | 9.3 | 10.7 | 10.2 | 9.3 | 9.5 | 10.2 | 19.1 | 17.4 | 19.8 | 16.3 | 26.9 | 10.6 |
| Luxembourg | | | | | | | | | | | | | |
| Rep. of Macedonia | | | | | | | | | | | | | |
| Rep. of Moldova | | | 55.4 | 35.5 | 38.0 | 38.6 | 34.3 | | | 33.3 | 32.1 | 44.3 | 12.4 |
| Netherlands | 20.7 | 17.5 | 9.4 | 17.2 | 17.9 | 15.3 | | | | | | | |
| Norway | 25.1 | 24.1 | 21.2 | 16.7 | 19.7 | 20.2 | 23.0 | 19.2 | 17.9 | 16.4 | 17.3 | 16.1 | -1.2 |
| Poland | 30.3 | 32.5 | 33.2 | 33.4 | 29.6 | 21.1 | 20.9 | 17.5 | 17.2 | 20.3 | 24.2 | 22.3 | -1.9 |
| Portugal | 4.3 | 3.6 | 5.3 | 10.8 | 17.1 | | | | | | | | |
| Romania | 9.6 | 9.9 | 9.8 | 7.6 | 4.7 | 5.2 | 21.8 | | 21.7 | 16.1 | 15.9 | 14.9 | -1.0 |
| Russian Fed. c) | 9.8 | 10.0 | | | | | | | 7.3 | 5.1 | 10.6 | | |
| Serbia | 21.3 | 7.3 | 39.6 | 19.8 | 21.3 | 12.6 | 13.3 | 13.0 | 12.6 | 12.0 | 11.1 | 11.0 | -0.1 |
| Slovak Republic | 38.7 | 40.4 | 39.7 | 36.2 | 35.3 | 42.4 | 37.5 | 41.1 | 42.7 | 46.8 | 46.6 | 43.5 | -3.1 |
| Slovenia | 32.2 | 31.4 | 35.3 | 37.4 | 33.8 | 32.1 | 36.0 | 40.7 | 38.8 | 37.8 | 33.6 | 31.3 | -2.3 |
| Spain | 11.6 | 15.6 | 14.1 | 14.0 | 19.4 | 18.7 | 15.8 | 12.9 | 14.9 | 13.1 | 10.4 | 11.4 | 1.0 |
| Sweden | 18.4 | 17.7 | 20.4 | 16.0 | 19.6 | 20.1 | 17.9 | 17.3 | 15.1 | 19.2 | 18.9 | 15.9 | -3.0 |
| Switzerland | 19.1 | 19.9 | 13.3 | 27.4 | 28.2 | 22.5 | 20.7 | 18.7 | 18.8 | 20.9 | 31.5 | 30.6 | -0.9 |
| Turkey | | | | | | | 8.1 | 16.2 | 16.0 | 14.5 | 11.6 | 9.9 | -1.7 |
| Ukraine | 16.8 | 14.6 | 15.4 | 11.4 | 8.1 | 6.9 | 7.1 | 7.1 | 6.3 | 5.6 | 6.8 | 7.5 | 0.7 |
| UK* | 20.6 | 25.1 | 25.8 | 23.2 | 22.2 | 23.3 | 16.1 | | | 38.6 | | | |

*Andorra:* observe the small sample size. *Austria*: from 2003 on results are based on the 16 x 16 km transnational grid net and must not be compared with previous years. *Poland*: Change of grid net since 2006. *Russian Federation:* North-western and Central European parts only. *Ukraine*: Change of grid net in 2005. *Hungary, Romania*: Comparisons not possible due to changing survey designs. *Note that some differences in the level of damage across national borders may be at least partly due to differences in standards used. This restriction, however, does not affect the reliability of the trends over time.*

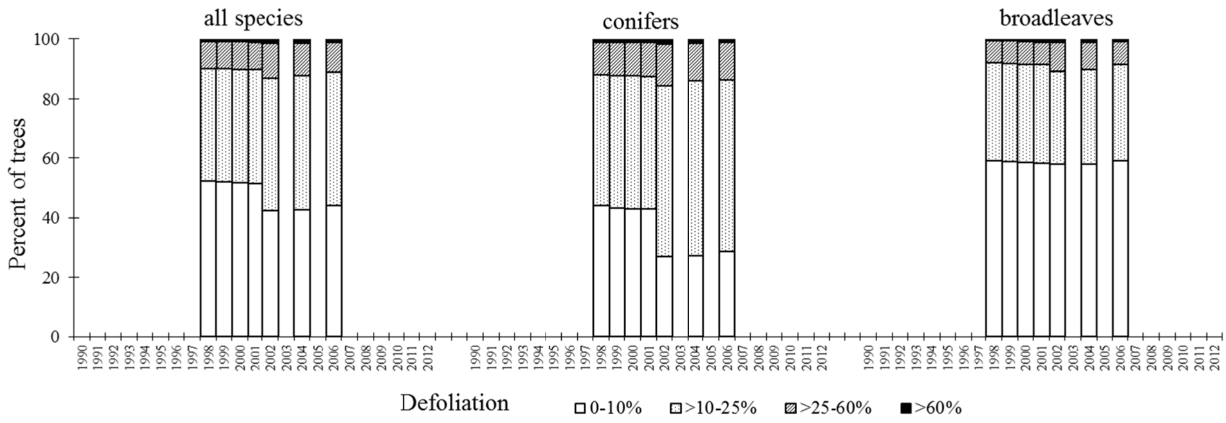
# Annex II-7: Percent of damaged broadleaves (2001-2012)

| Participating countries | Broadleaves Defoliation classes 2-4 | | | | | | | | | | | | Change % points 2011/12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | |
| Albania | 8.4 | 10.7 | | 10.3 | | 8.5 | | | | | | | |
| Andorra | only conifers assessed | | | | | | | | | | | | |
| Austria | 10.4 | 11.3 | 10.2 | 13.6 | 12.9 | 20.1 | | | | 10.5 | | | |
| Belarus | 13.3 | 9.0 | 15.8 | 12.9 | 10.6 | 8.9 | 8.2 | 7.6 | 8.7 | 6.9 | 6.4 | | |
| Belgium | 18.3 | 17.0 | 16.6 | 21.3 | 21.4 | 18.8 | 17.5 | 15.3 | 23.4 | 24.6 | 26.7 | 32.9 | 6.2 |
| Bulgaria | 26.0 | 29.0 | 27.2 | 30.1 | 23.1 | 36.4 | 21.1 | 17.8 | 12.2 | 18.2 | 12.8 | 29.8 | 17.0 |
| Croatia | 18.7 | 14.4 | 14.3 | 17.2 | 19.2 | 18.2 | 20.0 | 19.1 | 20.7 | 21.9 | 21.5 | 23.7 | 2.2 |
| Cyprus | only conifers assessed | | | | | | | | | | | | |
| Czech Republic | 21.7 | 19.9 | 24.4 | 31.8 | 32.0 | 31.2 | 33.5 | 32.2 | 32.9 | 32.2 | 31.2 | 28.4 | -2.8 |
| Denmark | 8.5 | 15.4 | 16.6 | 19.1 | 14.4 | 14.8 | 10.3 | 8.0 | 10.0 | 12.1 | 12.8 | 10.9 | -1.9 |
| Estonia | 2.1 | 2.7 | 6.7 | 5.3 | 3.4 | 8.6 | 7.6 | 3.4 | 3.5 | 2.5 | 3.0 | 14.9 | 11.9 |
| Finland | 8.8 | 8.8 | 8.3 | 8.4 | 7.2 | 10.3 | 10.9 | 10.6 | 4.7 | 9.2 | 6.0 | 12.8 | 6.8 |
| France · | 23.6 | 25.5 | 33.5 | 38.7 | 41.3 | 42.0 | 41.6 | 36.5 | 37.1 | 38.7 | 44.3 | 45.9 | 1.6 |
| Germany a) | 25.4 | 24.7 | 27.3 | 41.5 | 35.8 | 37.2 | 32.8 | 28.4 | 36.1 | 29.4 | 38.0 | 32.5 | -5-5 |
| Greece | 26.6 | 26.5 | | | 17.9 | | | | 5.2 | 23.9 | | | |
| Hungary | 21.5 | 20.8 | 22.0 | 21.0 | 20.9 | 19.0 | 20.6 | | 17.1 | 19.7 | 17.3 | 19.9 | 2.6 |
| Ireland | | | | | | | | | | | | | |
| Italy | 46.3 | 44.6 | 45.0 | 42.0 | 36.5 | 35.2 | 40.4 | 35.8 | 36.8 | 30.1 | 32.7 | 37.2 | 5.0 |
| Latvia | 14.8 | 12.8 | 13.5 | 14.3 | 12.9 | 8.5 | 11.8 | 11.5 | 11.6 | 9.4 | 8.8 | 12.9 | 4.1 |
| Liechtenstein | | | | | | | | | | | | | |
| Lithuania | 16.3 | 19.0 | 24.6 | 21.8 | 15.4 | 16.6 | 17.7 | 20.3 | 18.4 | 23.7 | 13.8 | 21.0 | 7.2 |
| Luxembourg | | | | | | | | | | | | | |
| Rep. of Moldova | 36.9 | 42.5 | 42.3 | 33.9 | 26.4 | 27.6 | 32.5 | 33.6 | 25.2 | 22.4 | 18.4 | 25.6 | 7.2 |
| Netherlands | 18.5 | 29.6 | 33.7 | 46.9 | 53.1 | 26.2 | | | | | | | |
| Norway | 33.7 | 30.4 | 29.0 | 33.2 | 27.6 | 33.2 | 36.3 | 33.8 | 31.0 | 26.8 | 32.3 | 27.3 | -5.0 |
| Poland | 31.4 | 33.1 | 39.6 | 38.7 | 34.1 | 18.0 | 18.9 | 19.1 | 18.5 | 21.5 | 23.5 | 25.5 | 2.0 |
| Portugal | 12.8 | 12.6 | 16.2 | 19.0 | 27.0 | | | | | | | | |
| Romania | 14.7 | 14.8 | 13.3 | 13.0 | 9.3 | 9.9 | 23.5 | | 18.3 | 18.0 | 13.4 | 13.6 | 0.2 |
| Russian Fed. c) | | 16.0 | | | | | | | 4.4 | 3.2 | 4.3 | | |
| Serbia b) | 6.7 | 0.6 | 21.5 | 13.5 | 15.7 | 11.0 | 15.7 | 11.3 | 9.9 | 10.7 | 7.2 | 10.2 | 3.0 |
| Slovak Republic | 26.9 | 14.5 | 25.6 | 19.9 | 13.6 | 17.0 | 16.6 | 20.8 | 24.5 | 32.9 | 26.4 | 33.9 | 7.5 |
| Slovenia | 26.7 | 25.9 | 22.6 | 24.2 | 28.5 | 27.6 | 35.7 | 34.6 | 33.3 | 28.1 | 30.0 | 27.7 | -2.3 |
| Spain | 14.4 | 17.3 | 19.1 | 16.1 | 23.3 | 24.4 | 19.5 | 18.4 | 20.7 | 16.1 | 13.2 | 23.6 | 10.4 |
| Sweden | 14.1 | 9.6 | 11.1 | 8.3 | 9.2 | 10.8 | | | | | | | |
| Switzerland | 16.3 | 16.0 | 18.1 | 32.8 | 27.9 | 22.6 | 26.1 | 19.6 | 17.4 | 25.2 | 29.6 | 33.3 | 3.7 |
| Turkey | | | | | | | | 38.3 | 23.4 | 21.2 | 17.2 | 16.8 | -0.4 |
| Ukraine | 53.3 | 36.7 | 35.3 | 43.2 | 9.2 | 6.2 | 7.1 | 9.1 | 7.2 | 6.4 | 6.7 | 7.5 | 0.8 |
| United Kingdom * | 21.9 | 30.3 | 23.2 | 30.6 | 28.2 | 29.2 | 35.3 | | | 56.1 | | | |

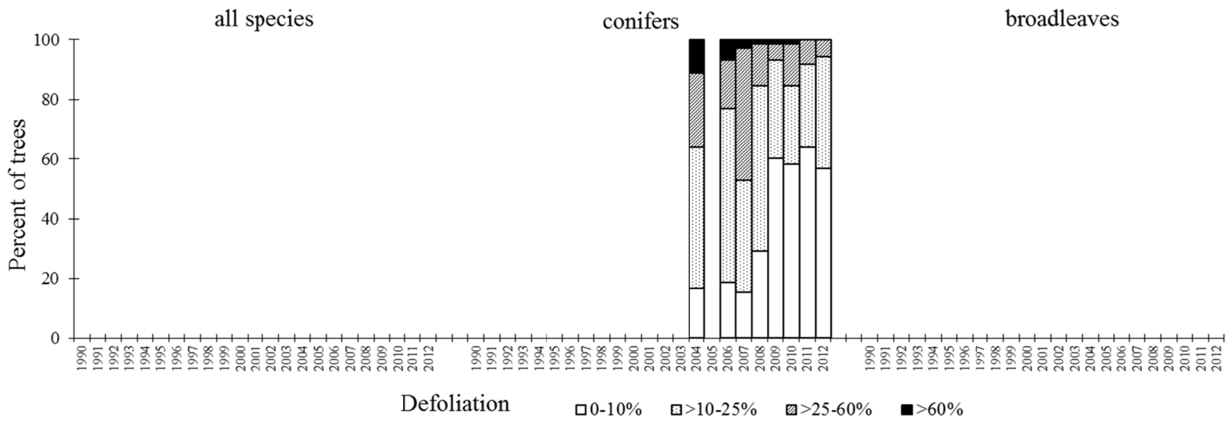
*Note that some differences in the level of damage across national borders may be at least partly due to differences in standards used. This restriction, however, does not affect the reliability of the trends over time.*

## Annex II-8: Changes in defoliation (1990-2012)

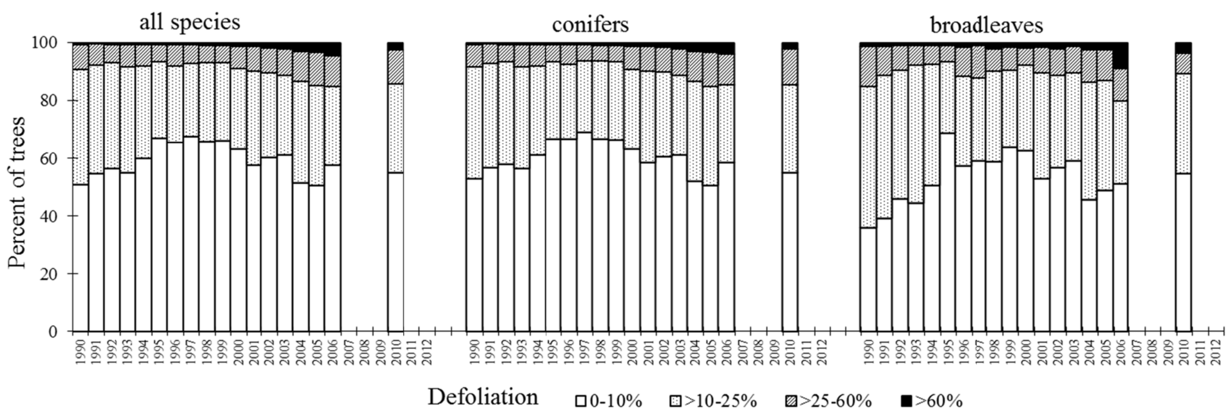
### Albania



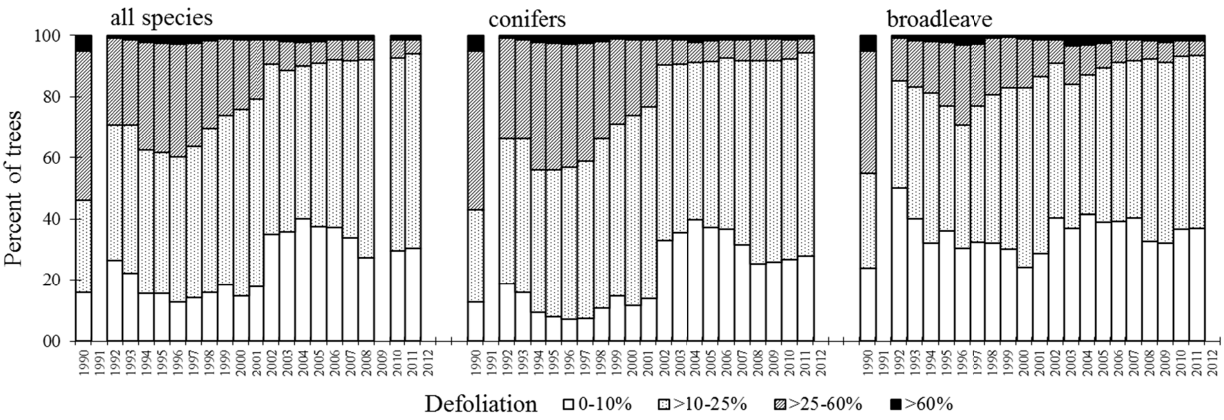

### Andorra



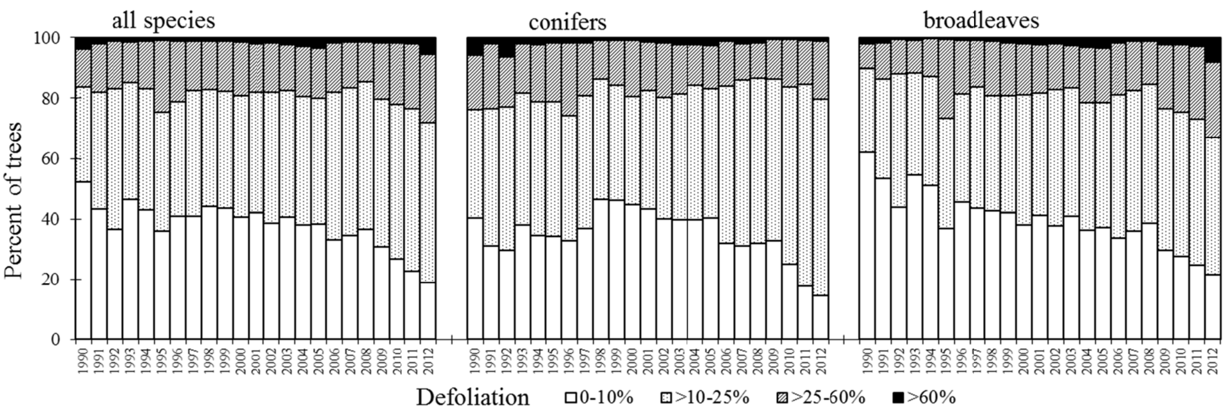

### Austria



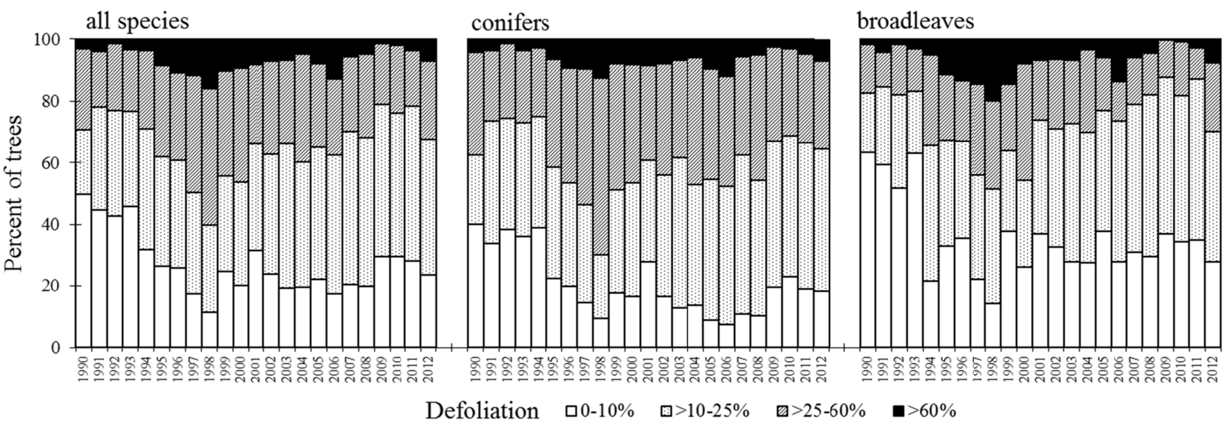
## Belarus



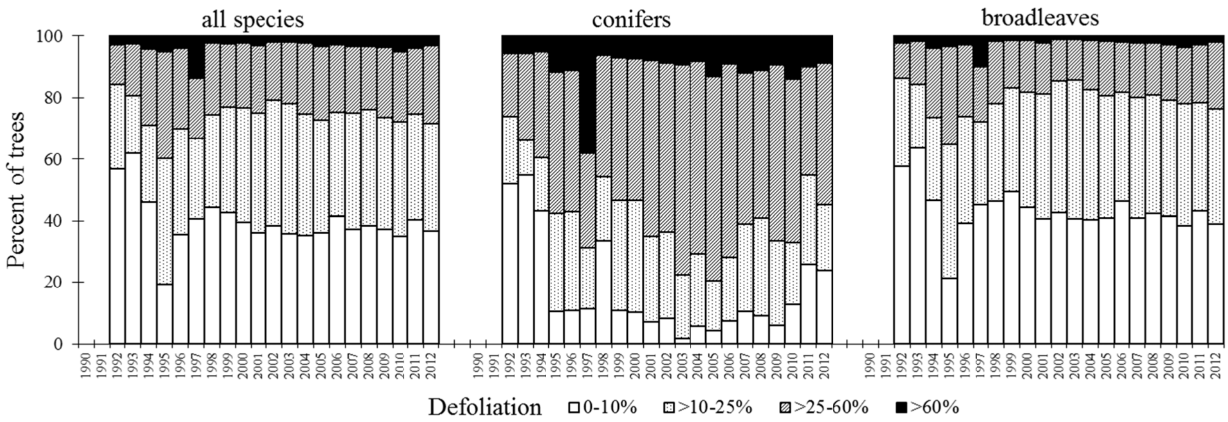

## Belgium



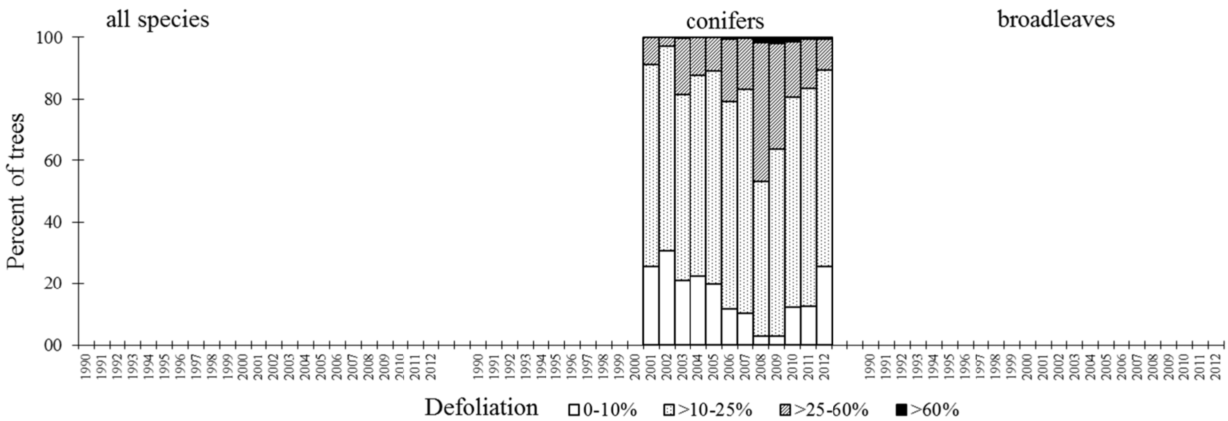

## Bulgaria



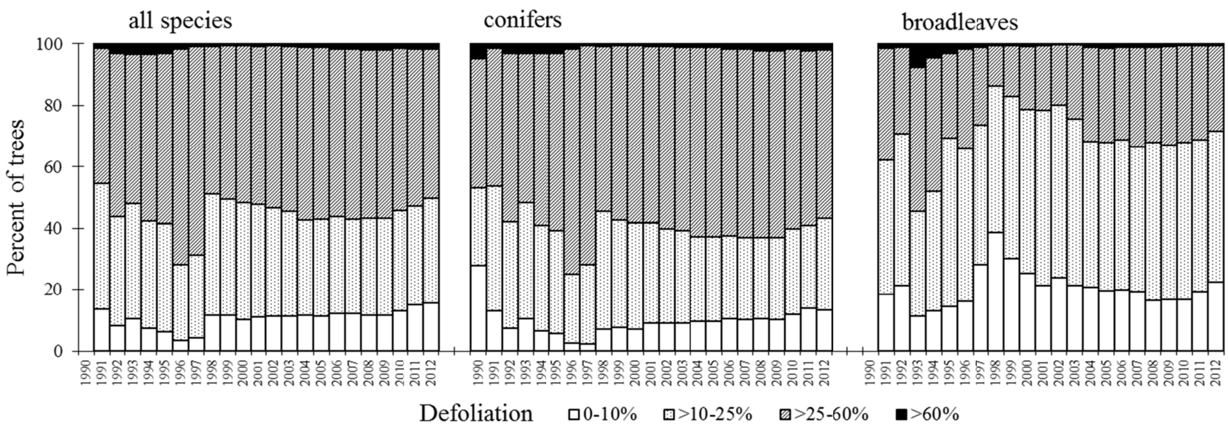
## Croatia



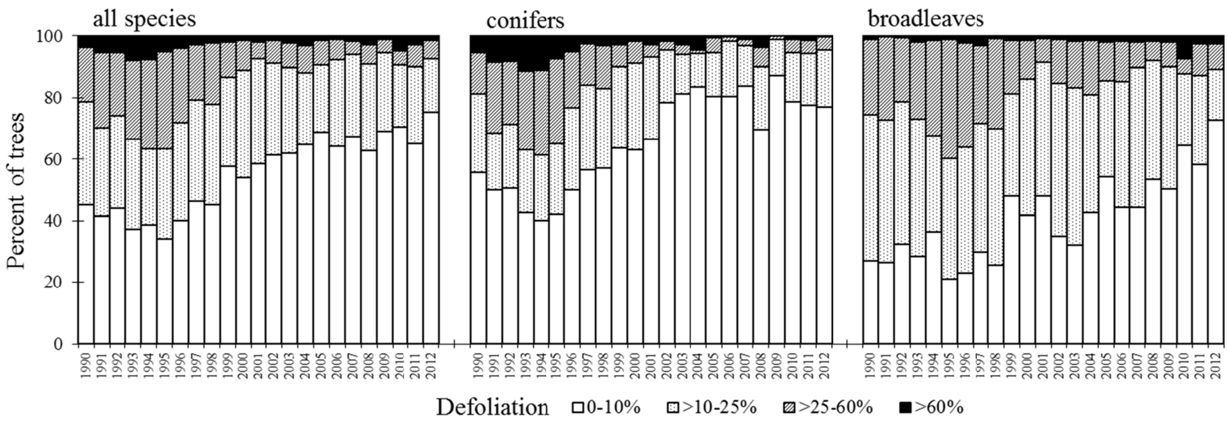

## Cyprus



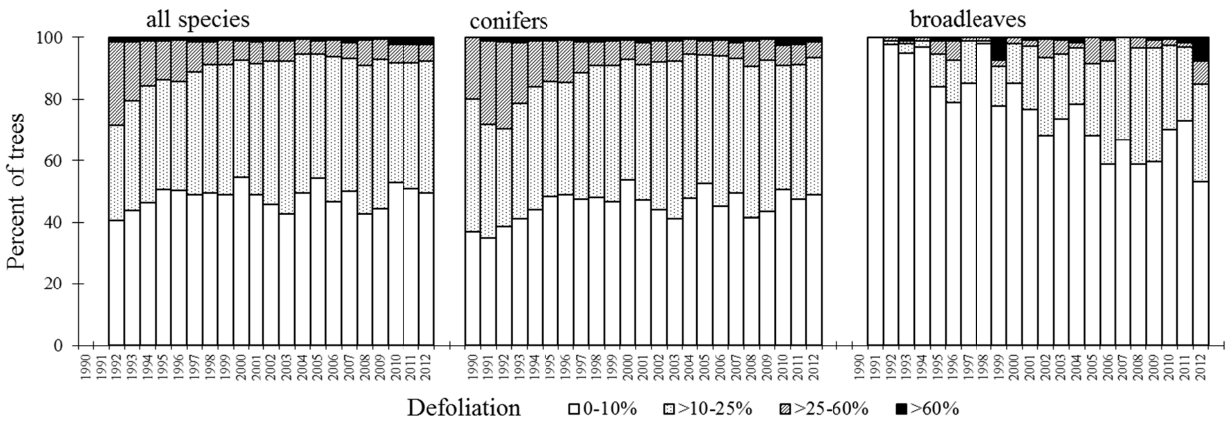

## Czech Republic



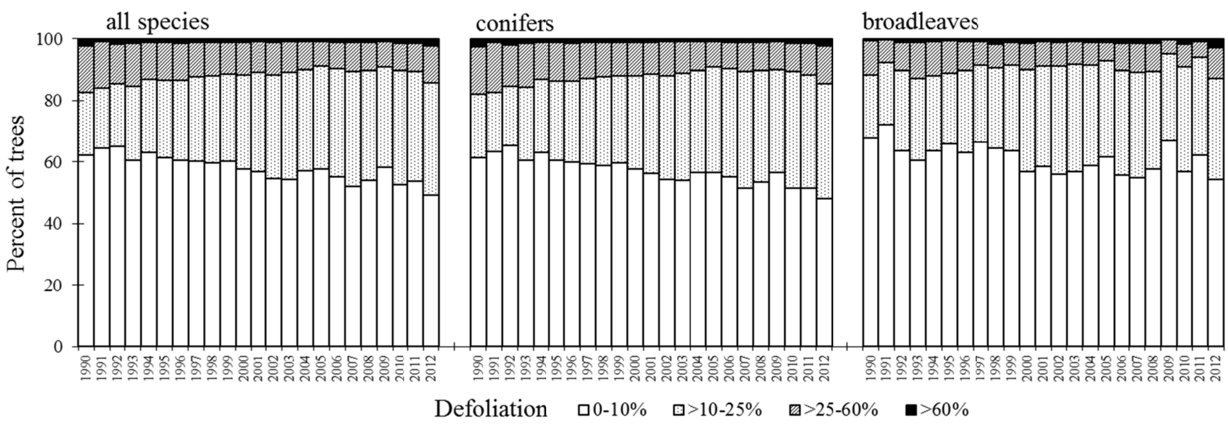
## Denmark



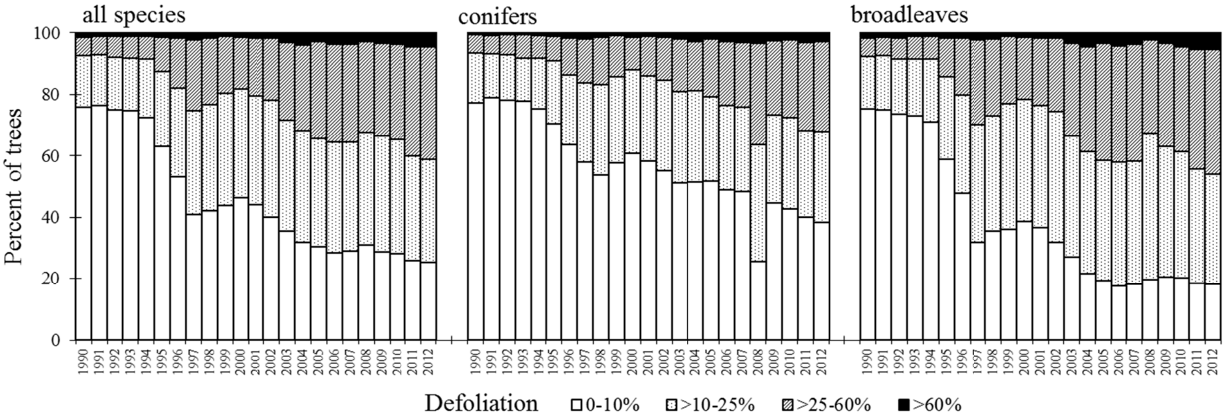

## Estonia



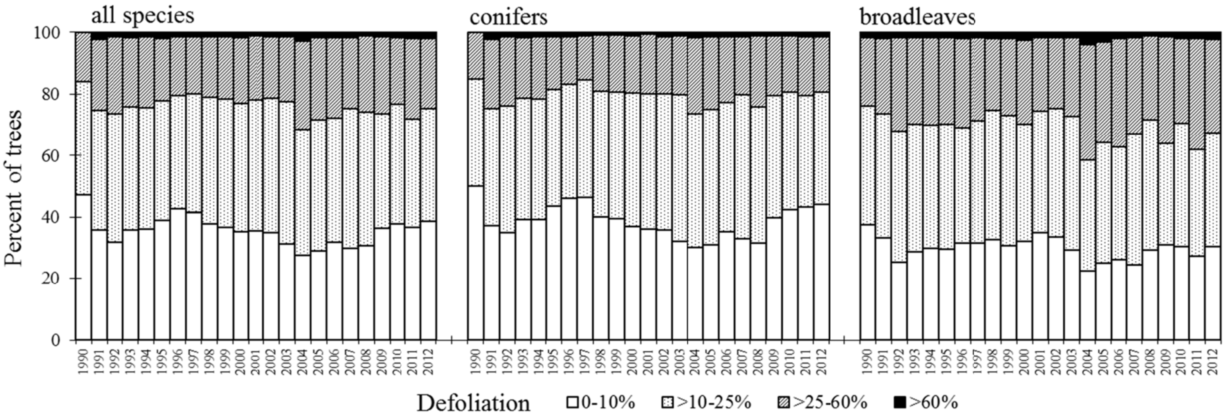

## Finland



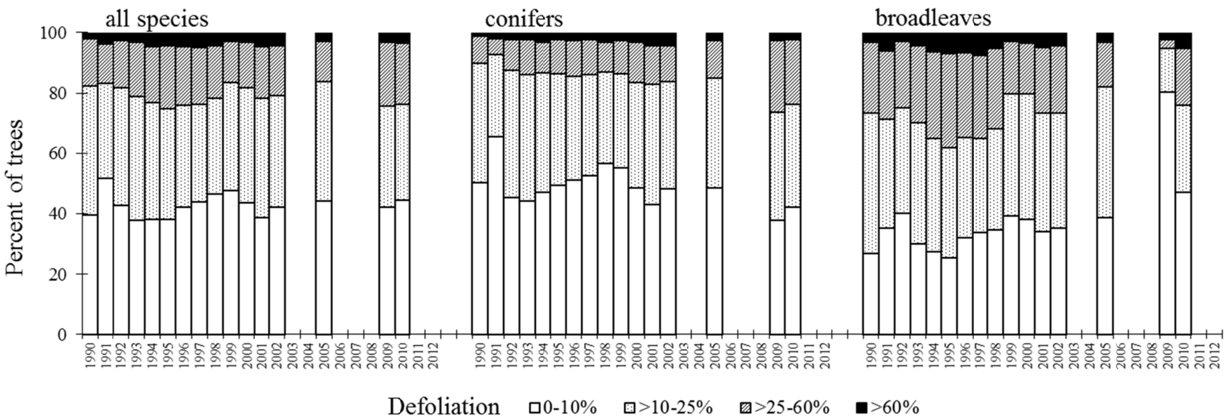
## France



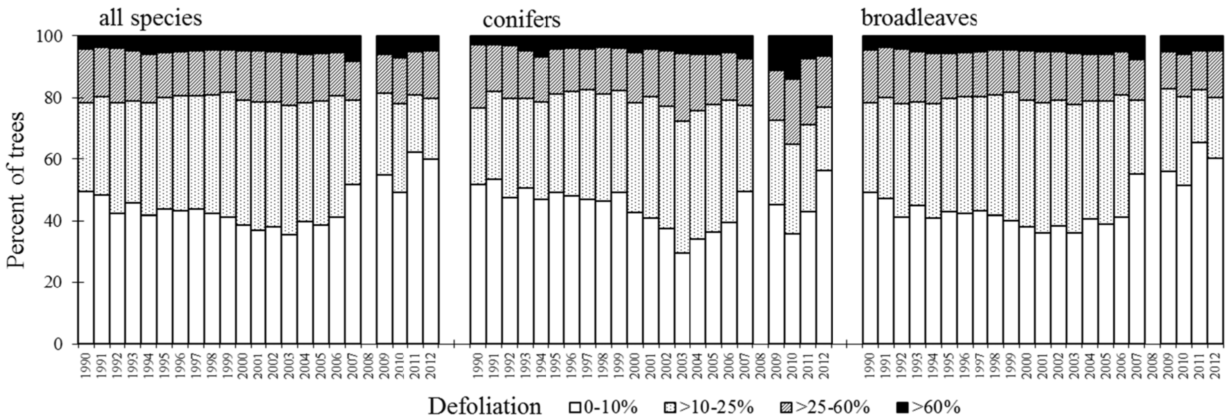

## Germany



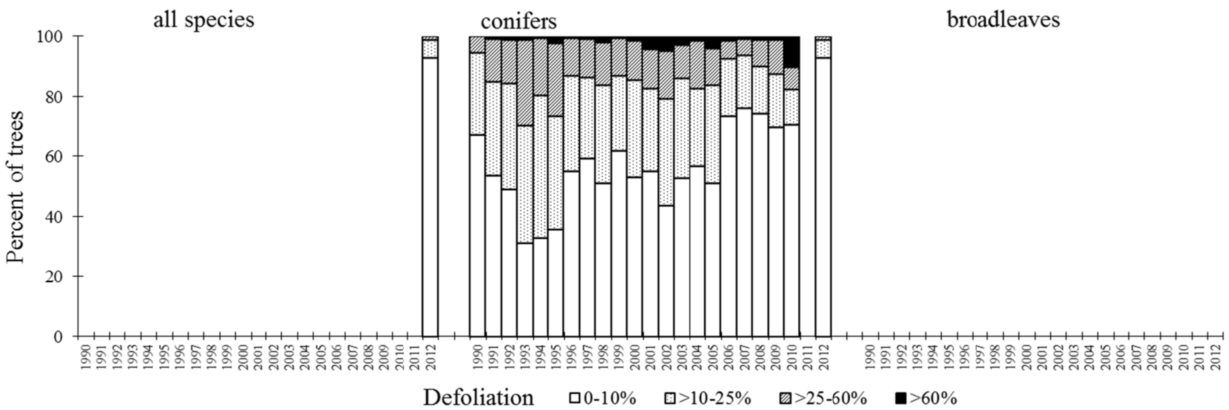

## Greece



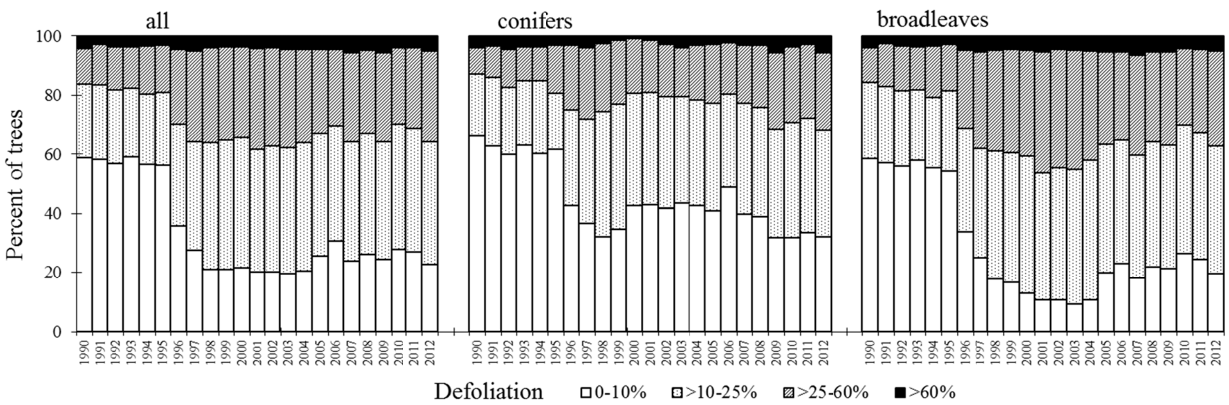
## Hungary



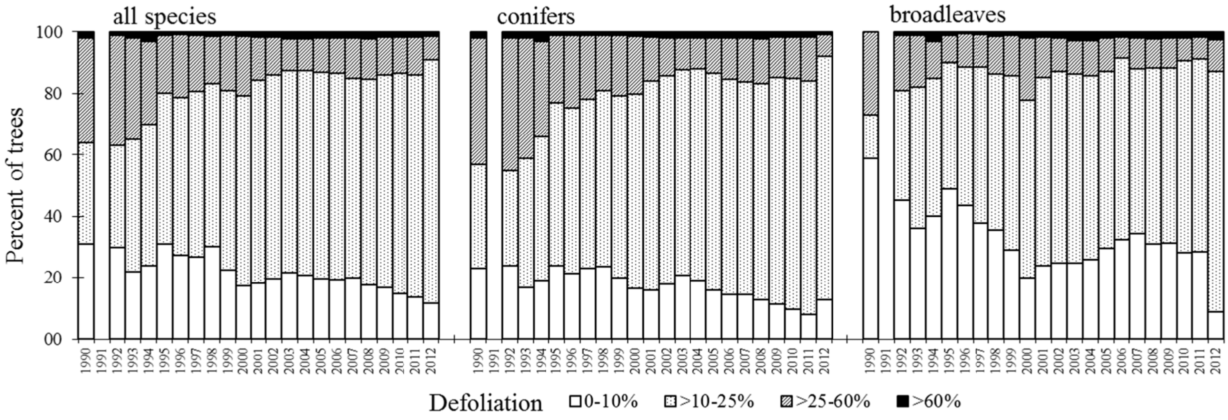

## Ireland



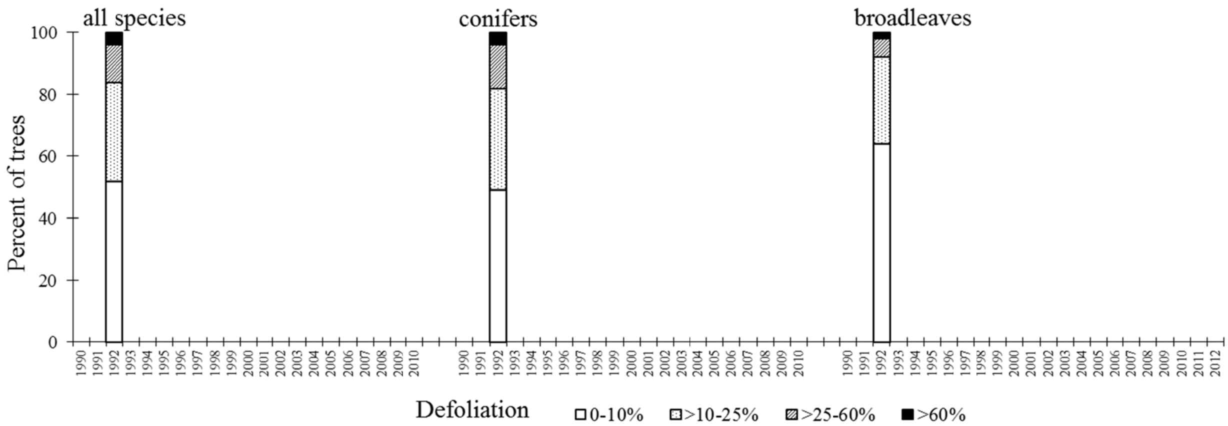

## Italy



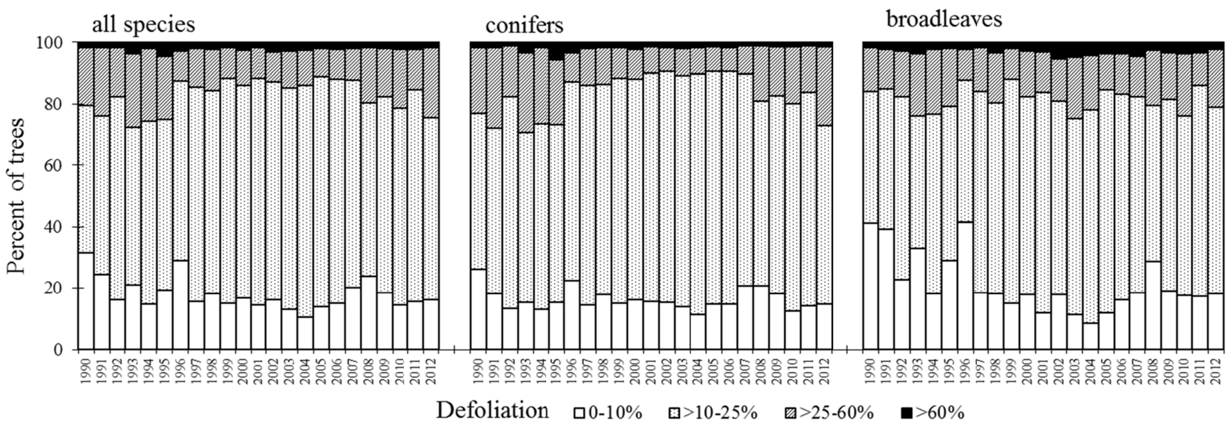
## Latvia



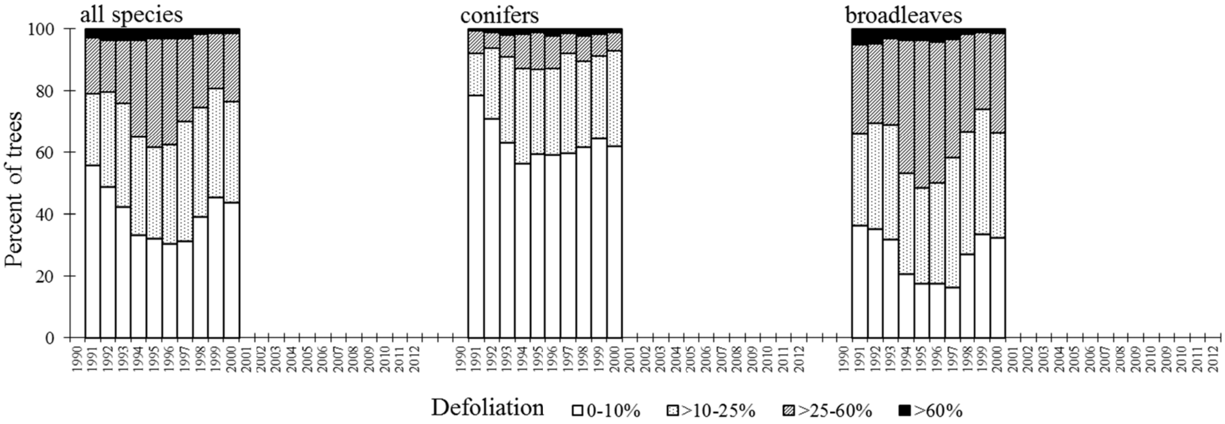

## Liechtenstein



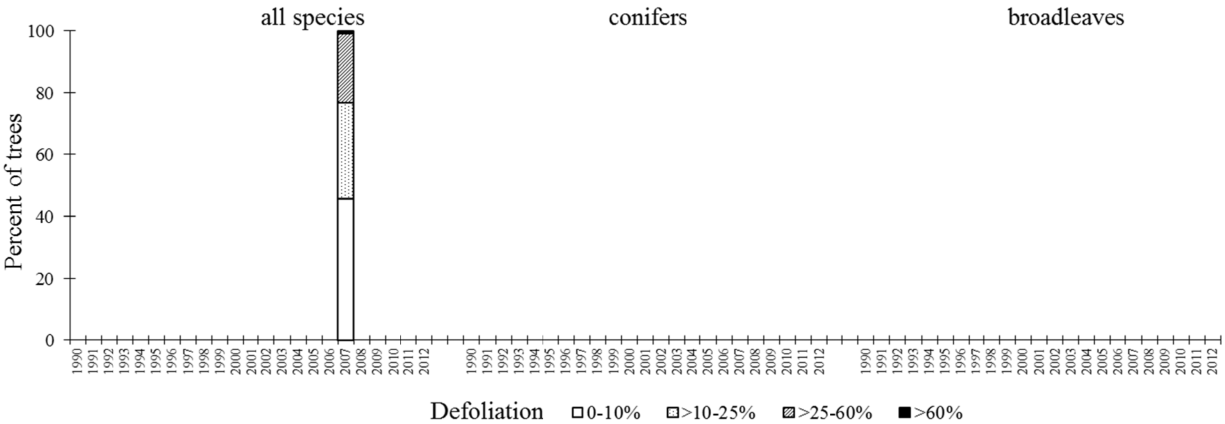

## Lithuania



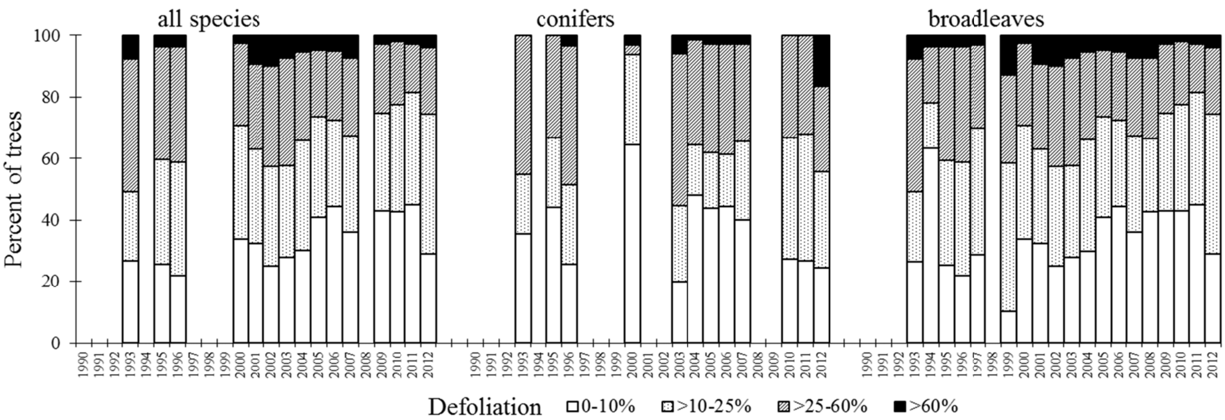
## Luxembourg



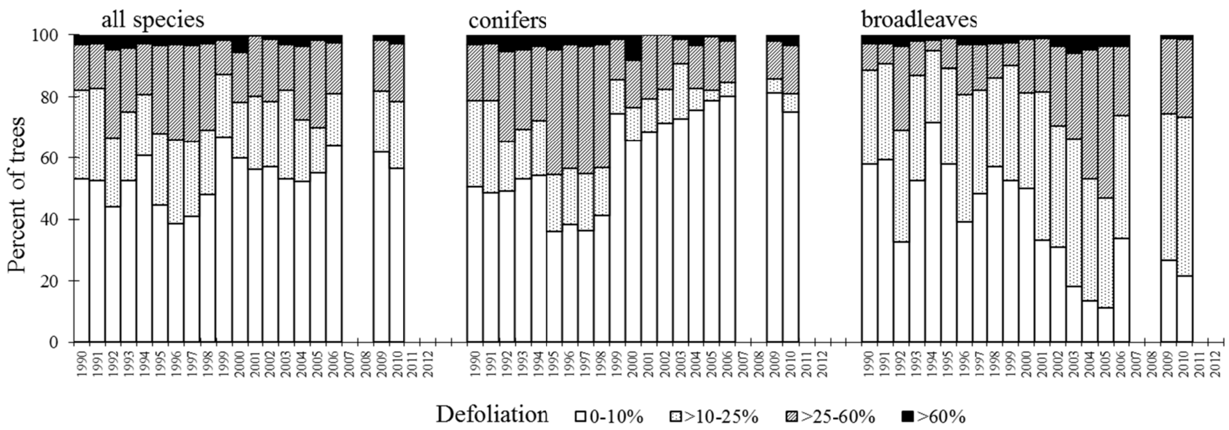

## FYR of Macedonia



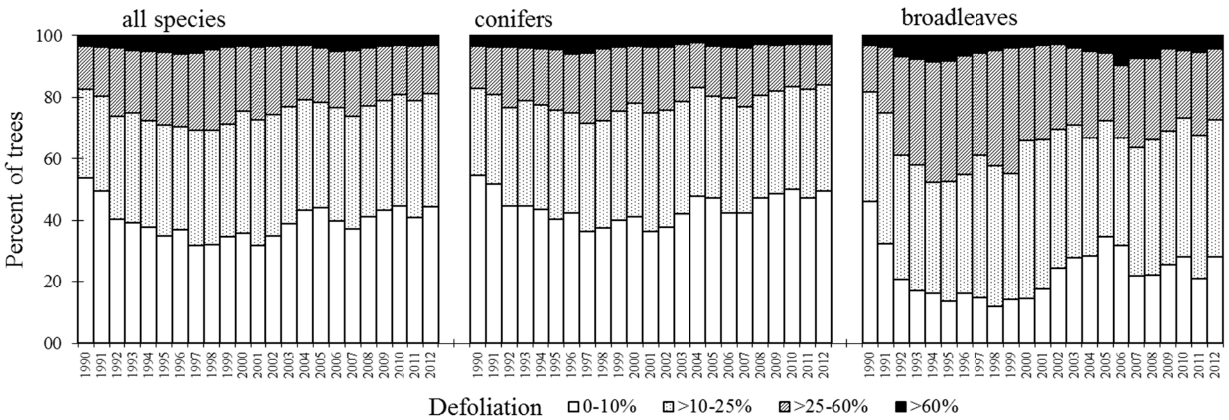

## Republic of Moldova



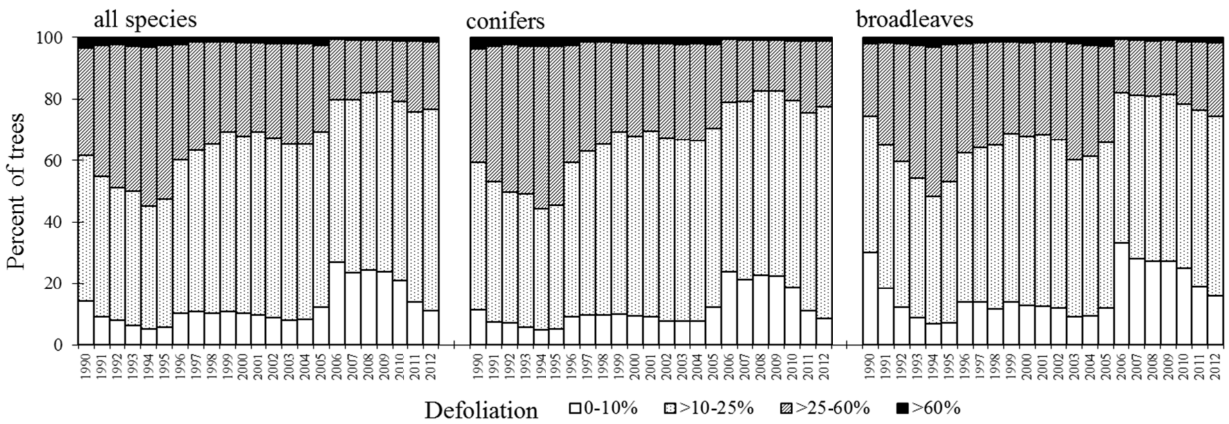
## Netherlands



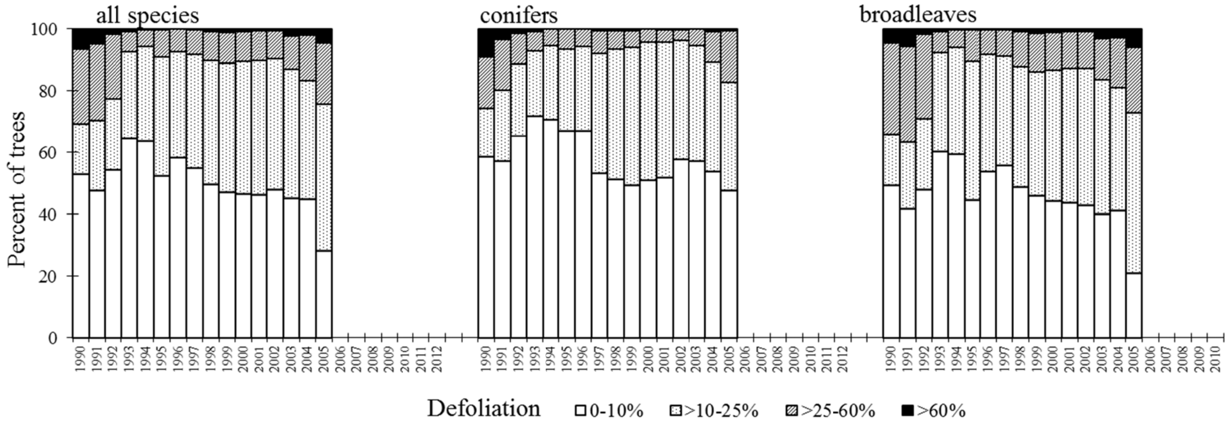

## Norway



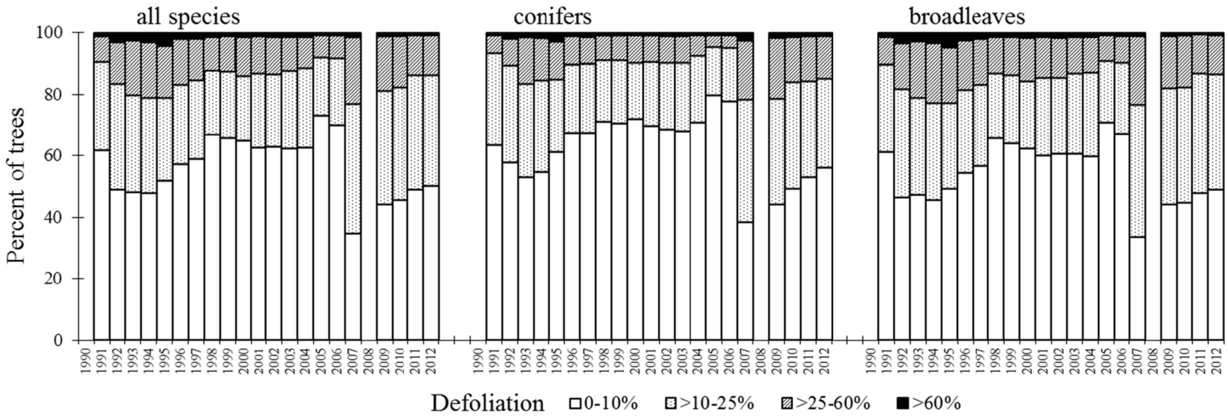

## Poland



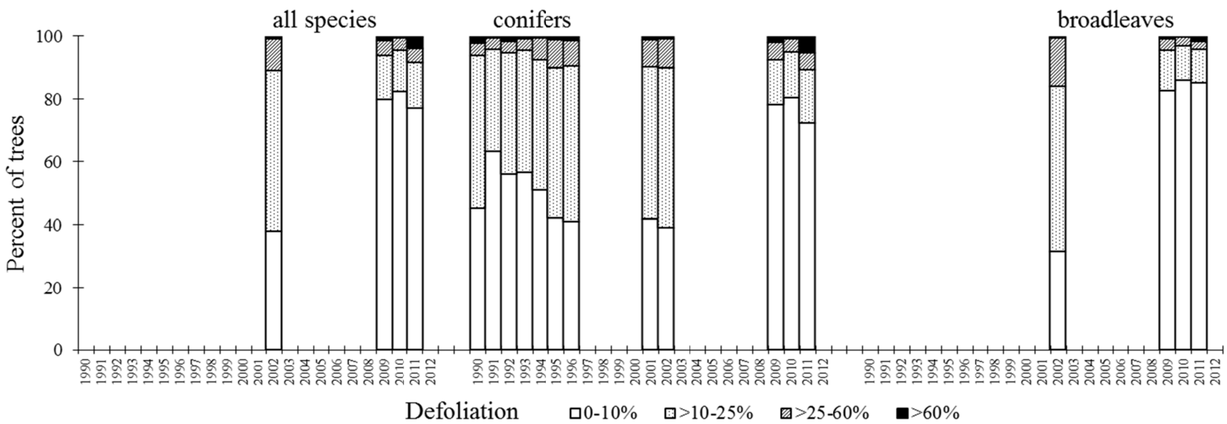
## Portugal



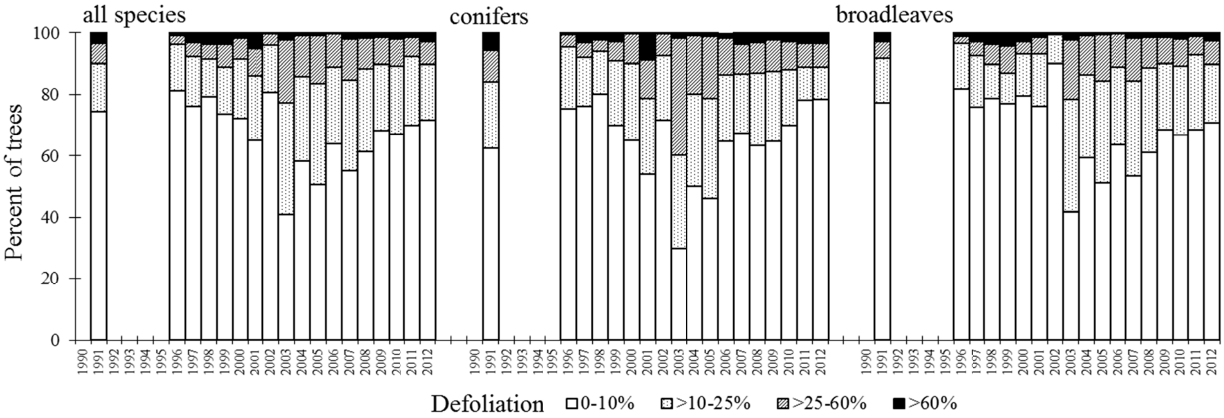

## Romania



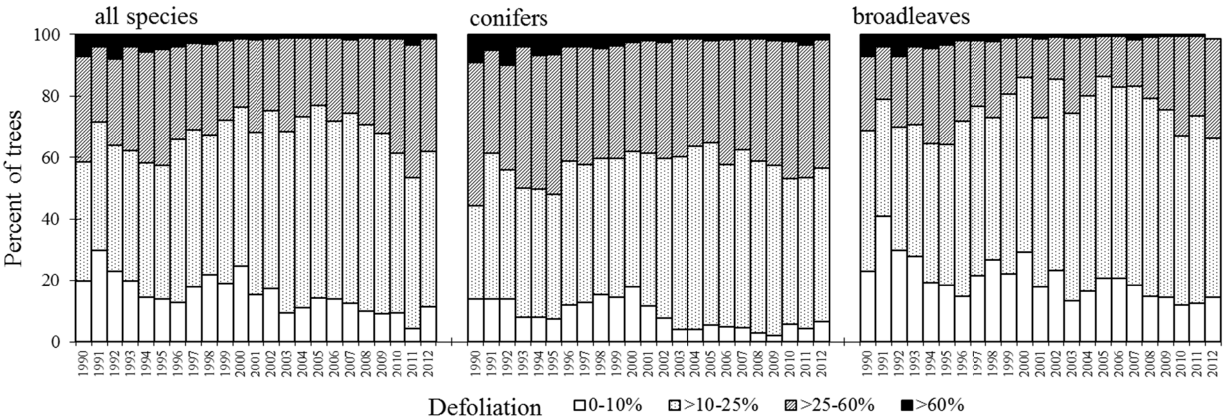

## Russian Federation



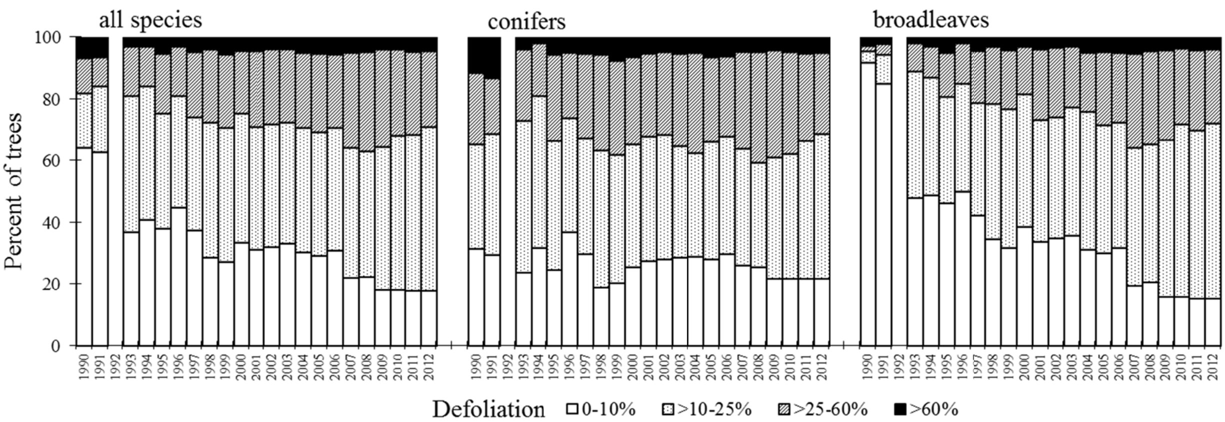
## Serbia



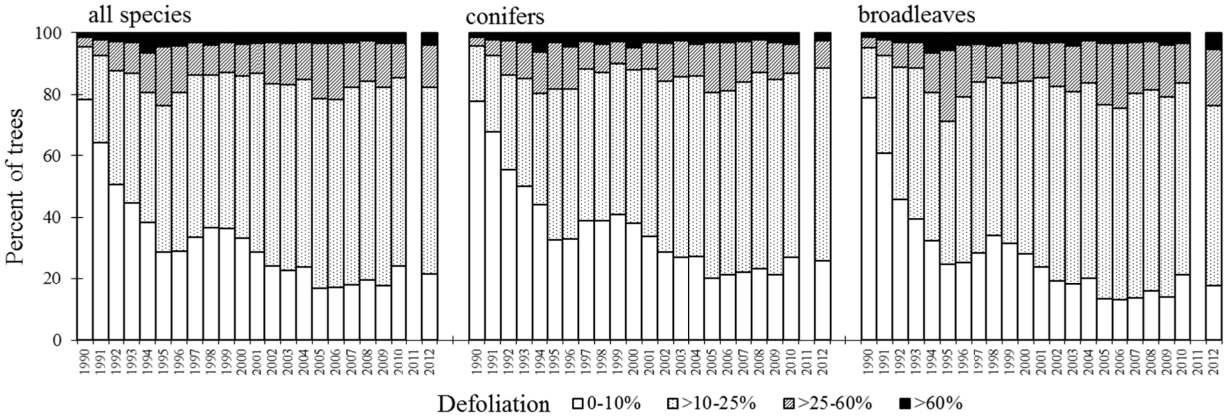

## Slovak Republic



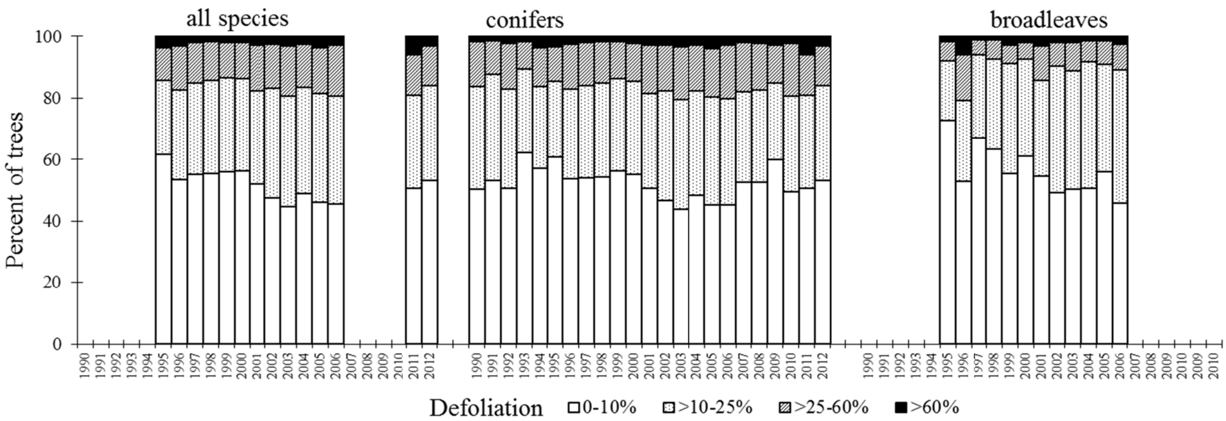

## Slovenia



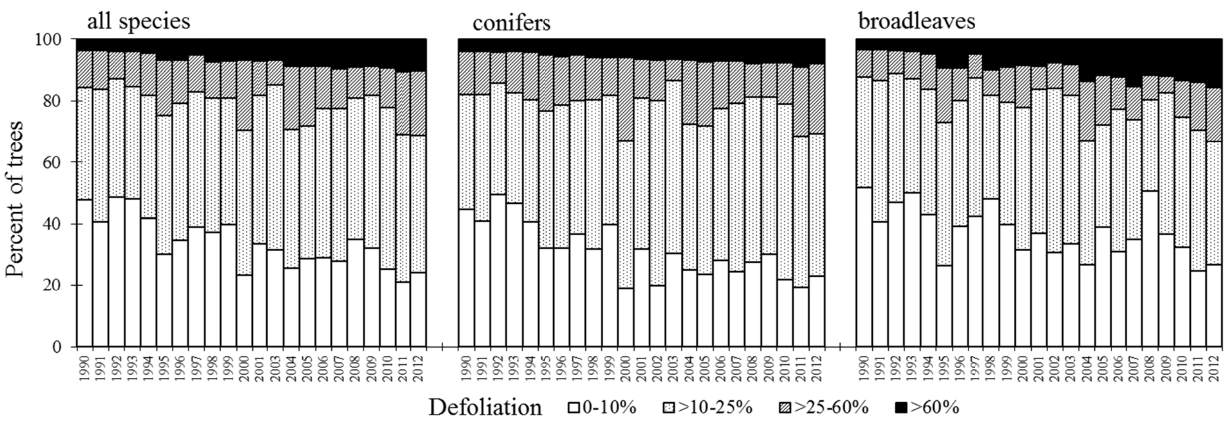
## Spain



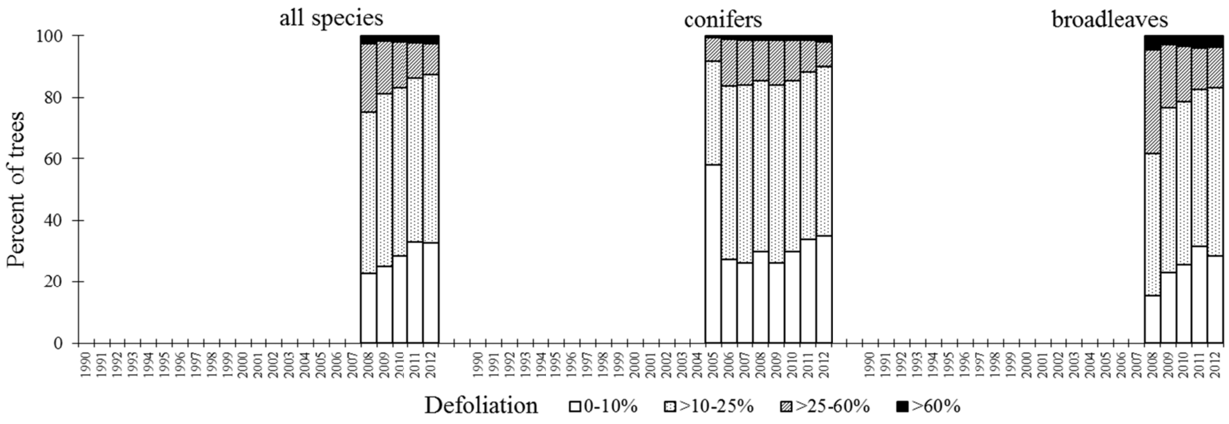

## Sweden



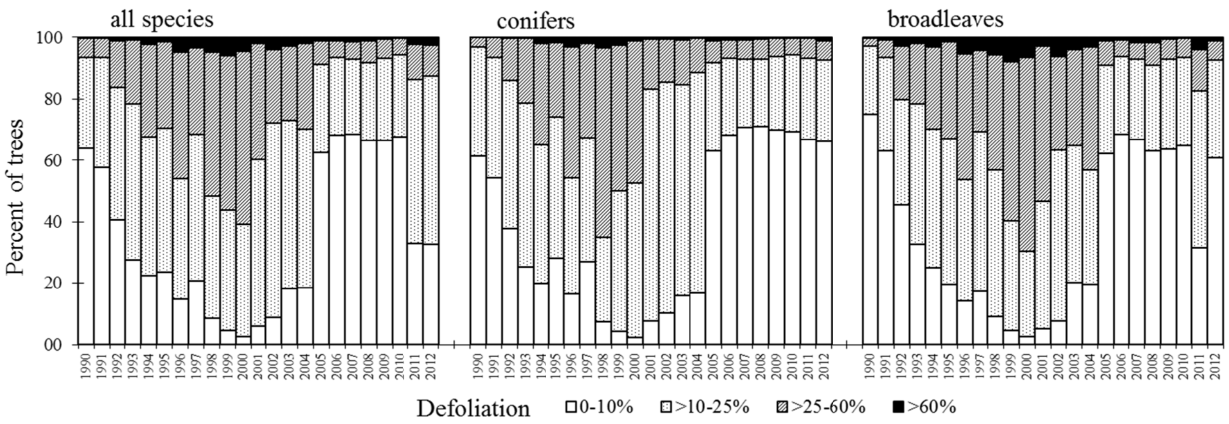

## Switzerland



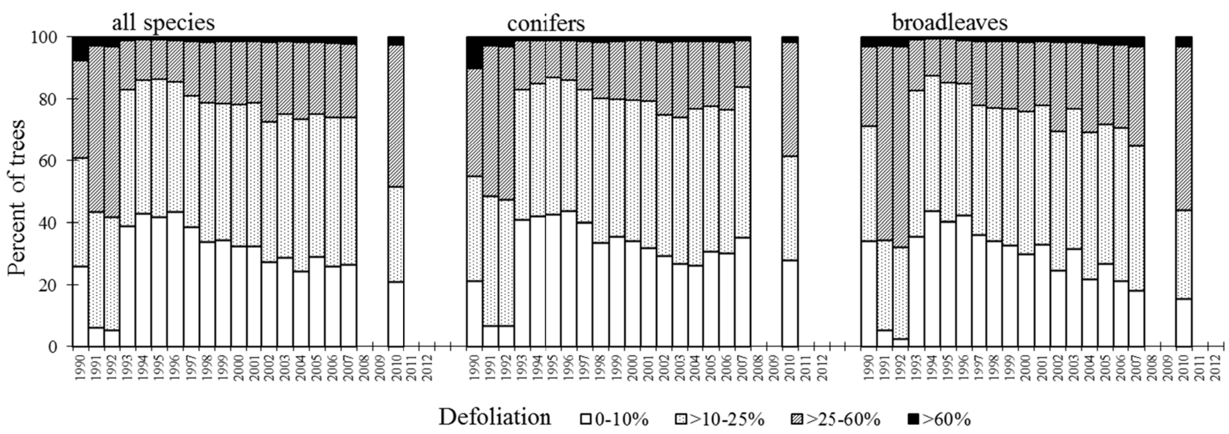
## Turkey




## Ukraine




## United Kingdom



# ANNEX III: CONTACTS

## Annex III-1: UNECE and ICP Forests

| | |
|---|---|
| **UNECE** | United Nations Economic Commission for Europe<br>LRTAP Convention Secretariat<br>Palais des Nations, 8-14, avenue de la Paix<br>1211 GENEVA 10, SWITZERLAND<br>Phone: +41 (22) 917 23 58/Fax: +41 (22) 917 06 21<br>Email: krzysztof.olendrzynski@unece.org<br>Mr Krzysztof Olendrzynski |
| **ICP Forests Lead Country** | Federal Ministry of Food and Agriculture – Ref. 535<br>Postfach 14 02 70<br>53107 BONN, GERMANY<br>Phone: +49 228 99 529-41 30/Fax: +49 228-99 529 42 62<br>Email: sigrid.strich@bmel.bund.de<br>Ms Sigrid Strich |
| **ICP Forests Chair** | Universität Hamburg, Zentrum Holzwirtschaft<br>Leuschnerstr. 91<br>21031 Hamburg, GERMANY<br>Phone: +49 40 739 62 101/Fax: +49 40 739 62 199<br>Email: michael.koehl@uni-hamburg.de<br>Mr Michael Köhl, Chairman of ICP Forests |
| **ICP Forests Programme Coordinating Centre (PCC)** | Thünen Institute of Forest Ecosystems<br>Alfred-Möller-Str. 1<br>16225 Eberswalde, GERMANY<br>Phone: +49 3334 3820-338 /Fax: +49 3334 3820-354<br>Email: walter.seidling@ti.bund.de<br>Internet: http://www.icp-forests.org<br>Mr Walter Seidling |

## Annex III-2: Expert panels, WG and other coordinating institutions

**Expert Panel on Soil and Soil Solution**

Research Institute for Nature and Forest Environment
& Climate Unit
Gaverstraat 4
9500 GERAARDSBERGEN, BELGIUM
Mr Bruno De Vos, Chair
Phone: +32 54 43 71 20/Fax: +32 54 43 61 60
Email: bruno.devos@inbo.be

Finnish Forest Research Institute Metla
PL 18
01301 VANTAA, FINLAND
Ms Tiina Nieminen, Co-chair
Phone: +358 10 211 5457/Fax: +358 10 211 2103
Email: tiina.nieminen@metla.fi

**Expert Panel on Foliar Analysis and Litterfall**

Finnish Forest Research Institute
Northern Unit
Eteläranta 55
96300, ROVANIEMI, FINLAND
Mr Pasi Rautio, Chair
Phone: +358 50 391 4045/Fax: +358 10 211 4401
Email: pasi.rautio@metla.fi

Finnish Forest Research Institute Metla
PL 18
01301 VANTAA, FINLAND
Ms Liisa Ukonmaanaho, Co-chair Litterfall
Phone: +358 10 211 5115/Fax: +358 10 211 2103
Email: liisa.Ukonmaanaho@metla.fi

**Expert Panel on Forest Growth**

Bundesforschungs- und Ausbildungszentrum für
Wald, Naturgefahren und Landschaft (BFW)
Seckendorff-Gudent-Weg 8
1131 WIEN, AUSTRIA
Mr Markus Neumann, Chair
Phone: +43 1 878 38 13 27/Fax: +43 1 878 38 12 50
Email: markus.neumann@bfw.gv.at

**Expert Panel on Deposition Measurements**

IVL Swedish Environmental Research Institute
Natural Resources & Environmental Research Effects
Box 210 60
100 31 STOCKHOLM, SWEDEN
Ms Karin Hansen, Chair Expert Panel Depostion
Phone: +46 859 85 64 25(direct) and +46 859 85 63 00
Fax: +46 859 85 63 90
Email: Karin.hansen@ivl.se

Slovenian Forestry Institute
Gozdarski Inštitut Slovenije GIS
Večna pot 2
1000 LJUBLJANA, SLOVENIA
Mr Daniel Zlindra, Co-chair
Phone: +38 6 12 00 78 00/Fax: +38 6 12 57 35 89
Email: daniel.zlindra@gozdis.si

| | |
|---|---|
| **Expert Panel on Ambient Air Quality** | Eidgenössische Forschungsanstalt für Wald,<br>Schnee und Landschaft (WSL)<br>Zürcherstr. 111<br>8903 BIRMENSDORF, SWITZERLAND<br>Mr Marcus Schaub, Chair<br>Phone: +41 44 73 92 564/Fax: +41 44 73 92 215<br>Email: marcus.schaub@wsl.ch |
| | Fundación Centro de Estudios Ambientales<br>del Mediterráneo - CEAM<br>Parque Tecnológico<br>C/ Charles R. Darwin, 14<br>46980 PATERNA – VALENCIA, SPAIN<br>Mr Vicent Calatayud, Co-chair<br>Phone: +34 961 31 82 27/Fax: +34 961 31 81 90<br>Email: vicent@ceam.es |
| **Expert Panel on Crown Condition Assessment and Damage Types** | Research Institute for Nature and Forest<br>Gaverstraat 4<br>9500 GERAARDSBERGEN, BELGIUM<br>Mr Peter Roskams, Chair<br>Tel. +32 54 43 71 15/Fax: +32 54 43 61 60<br>Email: peter.roskams@inbo.be |
| **Expert Panel on Biodiversity and Ground Vegetation Assessment** | Camerino University<br>Dept. of Environmental Sciences<br>Via Pontoni, 5<br>I - 62032 Camerino (MC), ITALY<br>Mr Roberto Canullo, Chair<br>Phone: +39 0737404503/5/Fax: +39 0737404508<br>Email: roberto.canullo@unicam.it |
| | Coillte Teoranta<br>Research and Development<br>Dublin Road<br>Newtown Mt. Kennedy<br>CO. WICKLOW, IRELAND<br>Mr Pat Neville, Chair<br>Phone: +353 120 11 162/Fax: +353 120 11 199<br>Email: Pat.Neville@coillte.ie |
| **Committee on Quality Assurance** | TerraData Environmetrics srl<br>Via L. Bardelloni 19<br>58025 Monterotondo Marittimo (GR), ITALY<br>Mr Marco Ferretti, Chair<br>Phone: +39 056 691 66 81<br>Email: ferretti@terradata.it |
| | Nordwestdeutsche Forstliche Versuchsanstalt<br>Grätzelstraße 2<br>37079 Göttingen, GERMANY<br>Mr Nils König, Co-chair<br>Phone: +49 551 69 40 11 41/Fax. +49 551 69 40 11 60<br>Email: Nils.Koenig@NW-FVA.de |

| | |
|---|---|
| **WG on Quality Assurance and Quality Control in Laboratories** | Nordwestdeutsche Forstliche Versuchsanstalt<br>Grätzelstraße 2<br>37079 Göttingen, GERMANY<br>Mr Nils König, Chair<br>Phone: +49 551 69 40 11 41/Fax. +49 551 69 40 11 60<br>Email: Nils.Koenig@NW-FVA.de |
| | Forest Research Institute<br>Sękocin Stary, 3 Braci Leśnej Street<br>05-090 RASZYN, POLAND<br>Ms Anna Kowalska, Co-chair<br>Phone: +48 22 71 50 300/Fax: +48 22 72 00 397<br>Email: a.kowalska@ibles.waw.pl |
| **Expert Panel on Meteorology and Phenology** | Bayerische Landesanstalt für Wald und Forstwirtschaft (LWF)<br>Hans-Carl-von-Carlowitz-Platz 1<br>85354 Freising, GERMANY<br>Mr Stephan Raspe, Chair<br>Phone: +49 (81 61) 71 49 21 / Fax: +49 (81 61) 71 49 71<br>Email: Stephan.Raspe@lwf.bayern.de |
| | Slovenian Forestry Institute<br>Večna pot 2<br>SI-1000 LJUBLJANA, SLOVENIA<br>Ms Urša Vilhar, Co-chair Phenology<br>Phone: +386 (1) 200 78 46 149 / Fax: +386 (1) 257 35 89<br>Email: ursa.vilhar@gozdis.si |
| **Forest Foliar Coordinating Center (FFCC)** | Bundesforschungs- und Ausbildungszentrum für<br>Wald, Naturgefahren und Landschaft (BFW)<br>Seckendorff-Gudent-Weg 8<br>1131 WIEN, AUSTRIA<br>Mr Alfred Fürst<br>Phone: +43 1 878 38 11 14/Fax: +43 1 878 38 12 50<br>Email: alfred.fuerst@bfw.gv.at |
| **Forest Soil Coordinating Centre** | Research Institute for Nature and Forest (INBO)<br>Gaverstraat 4<br>9500 GERAARDSBERGEN, BELGIUM<br>Ms Nathalie Cools<br>Phone: +32 54 43 61 75/Fax: +32 54 43 61 89<br>Email: nathalie.cools@inbo.be |

## Annex III-3: Ministries (Min) and National Focal Centres (NFC)

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|---|---|
| **Albania**<br>(Min) | Ministry of the Environment, Forests and Water Administration<br>Dep. of Biodiversity and Natural Resources Management<br>Rruga e Durrësit, Nr. 27<br>TIRANA, ALBANIA<br>Phone: +355 42 70 621, +355 42 70 6390<br>Fax: +355 42  70 627<br>Email: info@moe.gov.al |
| (NFC) | Forest and Pasture Research Institute<br>Halil Bego Str, L. 23<br>TIRANA, ALBANIA<br>Phone: +355 437 12 42/Fax +355 437 12 37<br>Email: ikpk@albaniaonline.net |
| **Andorra**<br>(Min)<br>(NFC) | Ministeri de Medi Ambient, Agricultura i Patrimoni<br>Natural Govern d'Andorra, Departament de Medi Ambient<br>Tècnica de l'Àrea d'Impacte Ambiental<br>C. Prat de la Creu, 62-64<br>500 ANDORRA LA VELLA, PRINCIPAT D'ANDORRA<br>Phone: +376 87 57 07/Fax: +376 86 98 33<br>Email: Silvia_Ferrer_Lopez@govern.ad, Anna_Moles@govern.ad<br>Ms Silvia Ferrer, Ms Anna Moles |
| **Austria**<br>(NFC) | Bundesforschungs- und Ausbildungszentrum für Wald,<br>Naturgefahren und Landschaft (BFW)<br>Seckendorff-Gudent-Weg 8<br>1131 WIEN, AUSTRIA<br>Phone: +43 1 878 38 13 30/Fax: +43 1 878 38 12 50<br>Email: ferdinand.kristoefel@bfw.gv.at<br>Mr Ferdinand Kristöfel |
| (Min) | Bundesministerium für Land- und Forstwirtschaft,<br>Umwelt und Wasserwirtschaft, Abt. IV/2<br>Stubenring 1<br>1010 WIEN, AUSTRIA<br>Phone: +43 1 71 100 72 14/Fax: +43 1 71 10 0 0<br>Email: vladimir.camba@lebensministerium.at<br>Mr Vladimir Camba |
| **Belarus**<br>(NFC) | Forest inventory republican unitary company<br>"Belgosles"<br>Zheleznodorozhnaja st. 27<br>220089 MINSK, BELARUS<br>Phone: +375 17 22 63 053/Fax: +375 17 226 30 92<br>Email: belgosles@open.minsk.by, olkm@tut.by<br>Mr Valentin Krasouski |
| (Min) | Committee of Forestry<br>Myasnikova st. 39<br>220048 MINSK, BELARUS<br>Phone/Fax: +375 172 00 45 82<br>Email: mlh@mlh.by<br>Mr Petr Semashko |

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|---|---|
| **Belgium**<br>*Wallonia*<br>(Min)<br>(NFC) | Service public de Wallonie (SPW)<br>Direction générale opérationnelle Agriculture,<br>Ressources naturelles et Environnement (DGARNE)<br>Département de la Nature et des Forêts - Direction des Ressources Forestières<br>Avenue Prince de Liège 15<br>5100 JAMBES, BELGIUM<br>Phone: +32 (81) 33 58 42 and +32 (81) 33 58 34<br>Fax: +32 (81) 33 58 11<br>Email: Christian.Laurent@spw.wallonie.be, etienne.gerard@spw.wallonie.be<br>Mr Christian Laurent, Mr Etienne Gérard, Mr. Mathieu Jonard |
| (NFC) | Earth and Life Institute, Environmental Sciences<br>Université catholique de Louvain<br>Croix du Sud, 2 - L7.05.09<br>1348 LOUVAIN-LA-NEUVE, BELGIUM<br>Phone: +32 10 47 37 02 and +32 10 47 25 48<br>Fax: +32 10 47 36 97<br>Email: isabelle.caignet@uclouvain.be, mathieu.jonard@uclouvain.be<br>Ms Isabelle Caignet, Mr Mathieu Jonard |
| *Flanders*<br>(Min) | Ministry of the Flemish Region (AMINAL)<br>Flemish Forest Service<br>Koning Albert II-laan 20 bus 22<br>1000 BRUSSELS, BELGIUM<br>Phone: +32 2 553 81 02/Fax: +32 2 553 81 05<br>Email: carl.deschepper@lne.vlaanderen.be<br>Mr Carl De Schepper |
| *Flanders*<br>(NFC) | Research Institute for Nature and Forest<br>Gaverstraat 4<br>9500 GERAARDSBERGEN, BELGIUM<br>Phone: +32 54 43 71 15/Fax: +32 54 43 61 60<br>Email: peter.roskams@inbo.be<br>Mr Peter Roskams |
| **Bulgaria**<br>(NFC) | Executive Environment Agency<br>Monitoring of Lands, Biodiversity and Protected Areas Department<br>136 "Tzar Boris III" Blvd., P.O. Box 251<br>1618 SOFIA, BULGARIA<br>Phone: +359 2 940 64 86/Fax:+359 2 955 90 15<br>Email: forest@eea.government.bg<br>Ms. Genoveva Popova |
| (Min) | Ministry of Environment and Water<br>National Nature Protection Service<br>22, Maria Luiza Blvd.<br>1000 SOFIA, BULGARIA<br>Phone: + 359 2 940 61 12/Fax: +359 2 940 61 27<br>Email: p.stoichknova@moew.government.bg<br>Ms. Penka Stoichkova |

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| **Canada**<br>(Min)<br>(NFC) | Natural Resources Canada<br>580 Booth Str., 12th Floor<br>OTTAWA, ONTARIO K1A 0E4, CANADA<br>Phone: +1 (613) 947 90 60/Fax: +1 (613) 947 90 35<br>Email: Pal.Bhogal@nrcan.gc.ca<br>Mr Pal Bhogal |
| Québec<br>(Min)<br>(NFC) | Ministère des Ressources naturelles<br>Direction de la recherche forestière<br>2700, rue Einstein, bureau RC. 102<br>STE. FOY (QUEBEC) G1P 3W8, CANADA<br>Phone: +1 418 643 79 94 Ext. 65 33/Fax: +1 418 643 21 65<br>Email: rock.ouimet@mrnf.gouv.qc.ca<br>Mr Rock Ouimet |
| **Croatia**<br>(Min)<br>(NFC) | Hrvatski šumarski institut<br>Croatian Forest Research Institute<br>Cvjetno naselje 41<br>10450 JASTREBARSKO, CROATIA<br>Phone: +385 1 62 73 027/Fax: + 385 1 62 73 035<br>Email: nenadp@sumins.hr<br>Mr Nenad Potocic |
| **Cyprus**<br>(Min)<br>(NFC) | Ministry of Agriculture,<br>Natural Resources and Environment<br>Research Section - Department of Forests<br>Louki Akrita 26<br>1414-NICOSIA, CYPRUS<br>Phone: +357 22 81 94 90/Fax: +357 22 30 39 35<br>Email: achristou@fd.moa.gov.cy<br>Mr Andreas Christou |
| **Czech Republic**<br>(NFC) | Forestry and Game Management<br>Research Institute (VULHM)<br>Jíloviště-Strnady 136<br>PRAGUE 5 – Zbraslav<br>PSČ 156 04, CZECH REPUBLIC<br>Phone: +420 257 89 22 21/Fax: +420 257 92 14 44<br>Email: lomsky@vulhm.cz<br>Mr Bohumír Lomský |
| (Min) | Ministry of Agriculture of the Czech Republic<br>Forest Management<br>Tešnov 17<br>117 05 PRAGUE 1, CZECH REPUBLIC<br>Phone: +420 221 81 11 11/Fax: +420 221 81 29 88<br>Email: info@mze.cz, posta@mze.cz<br>Mr Tomáš Krejzar |
| **Denmark**<br>(NFC) | Forest & Landscape Frederiksberg<br>University of Copenhagen<br>Rolighedsvej 23<br>1958 Frederiksberg C, DENMARK<br>Phone: +45 35 33 18 97/Fax: +45 35 33 15 08<br>Email: moi@life.ku.dk<br>Mr Morten Ingerslev |

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Ministère de l'alimentation, de l'agriculture et de la pêche
Direction générale de l'alimentation
Sous-Direction de la qualité et de la protection des végétaux
Département de la santé des forêts
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fabien.caroulle@agriculture.gouv.fr
Mr Jean-Luc Flot, Mr Fabien Caroulle

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|---|---|
| **Germany**<br>(Min)<br>(NFC) | Bundesministerium für Ernährung,<br>Landwirtschaft und Verbraucherschutz – Ref. 535<br>Rochusstr. 1, 53123 BONN, GERMANY<br>Phone: +49 228 99 529-41 30/Fax: +49 228 99 529-42 62<br>Email: sigrid.strich@bmelv.bund.de<br>Ms Sigrid Strich |
| **Greece**<br>(NFC) | Forest Research Institute of Athens<br>National Agricultural Research Foundation<br>Terma Alkmanos str.<br>11528 ILISSIA<br>ATHENS, GREECE<br>Phone: +30 210 77 84 850, +30 210 77 84 240<br>Fax: +30 210 77 84 602<br>Email: oika@fria.gr, mipa@fria.gr<br>Mr George Baloutsos, Mr. Anastasios Economou,<br>Mr Panagiotis Michopoulos |
| (Min) | Ministry of Rural Development and Foods<br>Gen. Secretariat for Forests and the Natural Environment<br>Dir. of Forest Resources Development<br>Halkokondili 31<br>101 64 ATHENS, GREECE<br>Phone: +30 210 52 42 349/Fax: +30 210 52 44 135<br>Email: pbalatsos@yahoo.com, skollarou@yahoo.gr<br>Mr Panagiotis Balatsos, Mrs Sofia Kollarou |
| **Hungary**<br>(NFC) | State Forest Service<br>National Food Safety Office, Forestry Directorate<br>Frankel Leó út 42-44, 1023 BUDAPEST, HUNGARY<br>Phone: +36 1 37 43 220/Fax: +36 1 37 43 206<br>Email: kolozs.laszlo@aesz.hu<br>Mr László Kolozs |
| (Min) | Ministry of Agriculture and Rural Development<br>Department of Natural Resources<br>Kossuth Lajos tér 11<br>1055 BUDAPEST, HUNGARY<br>Phone: +36 1 301 40 25/Fax: +36 1 301 46 78<br>Email: andras.szepesi@fvm.gov.hu<br>Mr András Szepesi |
| **Ireland**<br>(NFC) | Coillte Teoranta<br>Research & Environment<br>Dublin Road<br>Newtown Mt. Kennedy, CO. WICKLOW, IRELAND<br>Phone: + 353 1 20 111 62/Fax: +353 1 20 111 99<br>Email: pat.neville@coillte.ie<br>Mr Pat Neville |
| (Min) | Forest Service<br>Department of Agriculture, Fisheries and Food<br>Mayo West<br>Michael Davitt House, CASTLEBAR, CO. MAYO, IRELAND<br>Phone: +353 94 904 29 25/Fax: +353 94 902 36 33<br>Email: Orla.Fahy@agriculture.gov.ie<br>Ms Orla Fahy |

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|---|---|
| **Italy**<br>(Min)<br>(NFC) | Ministry for Agriculture and Forestry Policies<br>Corpo Forestale dello Stato<br>National Forest Service, Headquarter, Division 6^ (NFI, CONECOFOR Service and forest monitoring)<br>via G. Carducci 5<br>00187 ROMA, ITALY<br>Phone: +39 06  466 570 43/Fax: +39 06 481 89 72<br>Email: e.pompei@corpoforestale.it<br>Mr Enrico Pompei |
| **Latvia**<br>(Min) | Ministry of Agriculture<br>Forest Department<br>Republikas laukums 2<br>RIGA LV-1981, LATVIA<br>Phone: +371 670 27 285/Fax: +371 670 27 094<br>Email: lasma.abolina@zm.gov.lv<br>Ms Lasma Abolina |
| (NFC) | Latvian State Forest Research Institute„Silava<br>Rigas Street 111, Salaspils<br>LV-2169, LATVIA<br>Phone: +371 67 94 25 55/Fax: +371 67 90 13 59<br>Email: zane.libiete@silava.lv<br>Mrs Zane Libiete-Zalite |
| **Liechtenstein**<br>(Min)<br>(NFC) | Amt für Wald, Natur und Landschaft<br>Dr. Grass-Str. 10<br>9490 VADUZ, FÜRSTENTUM LIECHTENSTEIN<br>Phone: +423 236 64 02/Fax: +423 236 64 11<br>Email: norman.nigsch@awnl.llv.li<br>Mr Norman Nigsch |
| **Lithuania**<br>(NFC) | State Forest Survey Service<br>Pramones ave. 11a<br>51327 KAUNAS, LITHUANIA<br>Phone: +370 37 49 02 90/Fax: +370 37 49 02 51<br>Email: a.kasparavicius@amvmt.lt<br>Mr Albertas Kasperavicius |
| (Min) | Ministry of Environment<br>Dep. of Forests and Protected Areas<br>A. Juozapaviciaus g. 9<br>2600 VILNIUS, LITHUANIA<br>Phone: +370 2 72 36 48/Fax: +370 2 72 20 29<br>Email: v.vaiciunas@am.lt<br>Mr Valdas Vaiciunas |
| **Luxembourg**<br>(Min)<br>(NFC) | Administration de la nature et des forêts<br>Service des forêts<br>16, rue Eugène Ruppert<br>2453 LUXEMBOURG, LUXEMBOURG<br>Phone: +352 402 20 12 09/Fax: +352 402 20 12 50<br>Email: elisabeth.freymann@anf.etat.lu<br>Ms Elisabeth Freymann |

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**Republic of Moldova**
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**Montenegro**
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(Min)
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| **Poland**<br>(NFC) | Forest Research Institute<br>Instytut Badawczy Lesnictwa<br>Sękocin Stary<br>ul. Braci Leśnej nr 3<br>05-090 RASZYN, POLAND<br>Phone: +48 22 715 06 57/Fax: +48 22 720 03 97<br>Email: j.wawrzoniak@ibles.waw.pl<br>Mr Jerzy Wawrzoniak |
| (Min) | Ministry of the Environment<br>Department of Forestry<br>Wawelska Str. 52/54<br>00 922 WARSAW, POLAND<br>Phone: +48 22 579 25 50/Fax: +48 22 579 22 90<br>Email: Department.Lesnictwa@mos.gov.pl<br>Mr Edward Lenart |
| **Portugal**<br>(Min)<br>(NFC) | Autoridade Florestal Nacional / National Forest Authority<br>Ministério da Agricultura, do Desenvolvimento Rural e das Pescas<br>Divisão de Protecção e Conservação Florestal<br>Av. João Crisóstomo, 26-28<br>1069-040 LISBOA, PORTUGAL<br>Phone: +351 21 312 49 58/Fax: +351 21 312 49 87<br>Email: mbarros@afn.min-agricultura.pt<br>Ms Maria Barros |
| **Romania**<br>(Min)<br>(NFC) | Forest Research and Management Institute (ICAS)<br>Bd. Eroilor 128<br>077190 Voluntari, Judetul Ilfov, ROMANIA<br>Phone: +40 21 350 32 38/Fax: +40 21 350 32 45<br>Email: biometrie@icas.ro, obadea@icas.ro<br>Mr Ovidiu Badea, Mr Romica Tomescu |
| **Russian Fed.**<br>(Min) | Ministry of Natural Resources of the Russian Federation<br>4/6, B. Gruzinskaya Str.<br>MOSCOW D-242, GSP-5, 123995, RUSSIAN FEDERATION<br>Phone: +7 495 254 48 00/Fax: +7 495 254 43 10 and<br>+7 495 254 66 10<br>Email: korolev@mnr.gov.ru<br>Mr Igor A. Korolev |
| (NFC) | Centre for Forest Ecology and Productivity<br>of the Russian Academy of Sciences<br>Profsouznaya str., 84/32<br>117 997 MOSCOW, RUSSIAN FEDERATION<br>Phone: +7 495 332 29 17/Fax: +7 495 332 26 17<br>Email: lukina@cepl.rssi.ru<br>Ms Natalia Lukina |
| **Republic of Serbia**<br>(Min) | Ministry of Agriculture, Forestry and Water Management<br>Directorate of Forests<br>Omladinskih brigada 1<br>11070 BELGRADE, REPUBLIC OF SERBIA<br>Phone: +381 11 311 75 66/Fax: +381 11 313 15 69<br>Email: sasao@uns.ac.rs<br>Mr Sasa Orlovic |

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**Spain**
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|---|---|
| **Sweden**<br>(Min)<br>(NFC) | Swedish Forest Agency<br>Vallgatan 6<br>551 83 JÖNKÖPING, SWEDEN<br>Phone: +46 36 35 93 85/Fax: +46 36 16 61 70<br>Email: sture.wijk@skogsstyrelsen.se<br>Mr Sture Wijk |
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| **Turkey**<br>(NFC) | General Directorate of Forestry<br>(NFC) Orman Genel Müdürlüğü<br>Orman İdaresi ve Planlama Dairesi Başkanlığı<br>Söğütözü Cad. No: 14/E Kat: 17<br>A ANKARA, TURKEY<br>Phone: +90 312 296 41 94/95, Fax: +90 312 296 41 96<br>Email: uomturkiye@ogm.gov.tr,<br>Sitki Öztürk |
| (Min) | Ministry of Environment and Forestry<br>Çevre ve Orman Bakanlığı<br>Dumlupınar Bulvarı (Eskişehir Yolu 9. Km.) No:252<br>TOBB İkiz Kuleleri D Kule Kat: 21<br>BALGAT /ANKARA, TURKEY<br>Phone: +90 312 248 17 89 Fax: +90 312 248 18 02<br>Email: ahmetkarakasadana@ogm.gov.tr<br>Mr Ahmet Karakas |
| **Ukraine**<br>(NFC) | Ukrainian Research Institute<br>of Forestry and Forest Melioration (URIFFM)<br>Laboratory of Forest Monitoring and Certification<br>Pushkinska Str. 86,<br>61024 KHARKIV, UKRAINE<br>Phone: +380 57 707 80 57/Fax: +380 57 707 80<br>Email: buksha@uriffm.org.ua<br>Mr Igor F. Buksha |
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