UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE
CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

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

MANUAL

on
methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests

Part I

Mandate of ICP Forests and Programme Implementation

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Contents

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1. Introduction

In response to widespread concern that air pollution could affect forest condition, the International Co-operative Programme on the Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) was established under the UN/ECE Convention on Long-range Transboundary Air Pollution (CLRTAP) in 1985. One year later the European Union (EU) adopted the scheme on the protection of forests against atmospheric pollution and with Regulation (EEC) No. 3528/86 the legal basis for co-financing of relevant assessments was provided. This was replaced by a new Regulation (EC) No 2152/2003 (Forest Focus) adopted by the European Parliament and the Council in 2003. The monitoring activities pursue the objectives of Resolution S1 of the Strasbourg, Resolution H1 of the Helsinki and Resolution L2 of the Lisbon Ministerial Conference on the protection of Forests in Europe. The results of ICP Forests also contribute to the discussion on global forest policy, such as the Intergovernmental Forum on Forests leading to the United Nations Forest Forum and other important discussion forums such as the World Forestry Congress.

Since 1986 the monitoring of forest condition and its development has been carried out under both programmes in close co-operation. At present, 38 European countries as well as the United States of America and Canada are participating in the programmes, which include assessments according to harmonised methods following this ICP Forests Manual and which have developed as an important platform for the exchange of expert knowledge. Results of ICP Forests provide the scientific basis for political decisions on air pollution control and thus contribute to the elaboration and review of protocols of the Geneva Convention on Long-Range Transboundary Air Pollution (CLRTAP). Moreover, the wealth of the ICP Forests data for other environment related policies has only recently been investigated. In particular, ICP Forests monitoring activities can be expected to contribute to other aspects of relevance for forest policy, such as effects of climate change on forests, sustainable forest management and biodiversity in forests.

In 1997, at its 13th Task Force meeting ICP Forests decided to carry out an internal review of its programme. It was agreed that the results of this review should be presented to the 16th Task Force meeting in 2000 for discussion and adoption. As a consequence the ICP Forests programme has been updated as described in the following chapter. The update is based on discussions with DG AGRI of the European Commission (EC). Substantial contributions were received from all Expert Panels, the Programme Coordinating Group and the Programme Task Force of ICP Forests. The contributions and assistance received are gratefully acknowledged.

In 2004 the 20th Task Force meeting of ICP Forests adopted the new submanual on litterfall and agreed on updates in several existing parts of the ICP Forests manual. The Task Force also agreed that this version should remaine unchanged till 2006. It is foreseen that the European Commission will built on this version of the ICP Forests manual when elaborating the guidelines for the Forest Focus scheme.

The Manual has a modular design, comprising separate sub-manuals for all surveys carried out by ICP Forests and EC with exception of remote sensing, the methods of which are documented in a separate Manual of EC. The sub-manuals are updated under the auspices of the responsible Expert Panels and are adopted by the Programme Task Force.

Methodological details are provided in annexes. Each annex also contains forms for data submission which were provided by the European Commission and the Expert Panels.

2. Mandate and objectives of ICP Forests

Launched by the Executive Body of the CLRTAP as a reaction to widespread forest damage which was supposed to be a possible effect of long-range transboundary air pollution, ICP Forests was mandated to monitor air pollution effects on forests and to contribute to a better understanding of cause-effect relationships.

Within the complex of anthropogenic and natural stresses, air pollution continues to be regarded as an important stress factor. However the importance of atmospheric pollution varies, its impact depends on the region and its effects on site and stand conditions. Air pollution and its effects on forest ecosystems are complex and difficult to isolate and quantify. A large number of other stress factors also have an influence on forest condition and must therefore be taken into consideration.

Therefore, the ICP Forests **mandate** is:

- to monitor effects of anthropogenic factors (in particular air pollution) and natural stress factors on the condition and development of forest ecosystems in Europe and
- to contribute to a better understanding of cause-effect relationships in forest ecosystem functioning in various parts of Europe.

Based on its mandate, ICP Forests pursues the following **objectives**:

(a) to provide a periodic overview on the spatial and temporal variation in forest condition in relation to anthropogenic (in particular air pollution) as well as natural stress factors on an European and national large-scale systematic network (Level I),

(b) to contribute to a better understanding of the relationships between the condition of forest ecosystems and anthropogenic (in particular air pollution) as well as natural stress factors through intensive monitoring on a number of selected permanent observation plots spread over Europe (Level II) and to study the development of important forest ecosystems in Europe,

(c) to provide a deeper insight into the interactions between the various components of forest ecosystems by compiling available information from related studies,

(d) to contribute in close co-operation with the ICP on Modelling and Mapping to the calculation of critical levels/loads and their exceedances in forests and to improve collaboration with other environmental monitoring programmes inside and outside the CLRTAP,

(e) to contribute by means of the monitoring activities to other aspects of relevance for forest policy at national, pan-European and global level, such as effects of climate changes on forests, sustainable forest management and biodiversity in forests,

(f) to provide policy-makers and the general public with relevant information.

The proper implementation of this mandate and these objectives implies a continuation of the monitoring activities by the participating countries and the careful evaluation and reporting of the data.

3. Programme Implementation

3.1 Structure of ICP Forests

ICP Forests was established in 1985 under the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP) and operates under the Working Group on Effects (WGE). The subsidiary bodies of the Convention are shown in Figure 3.1-1.

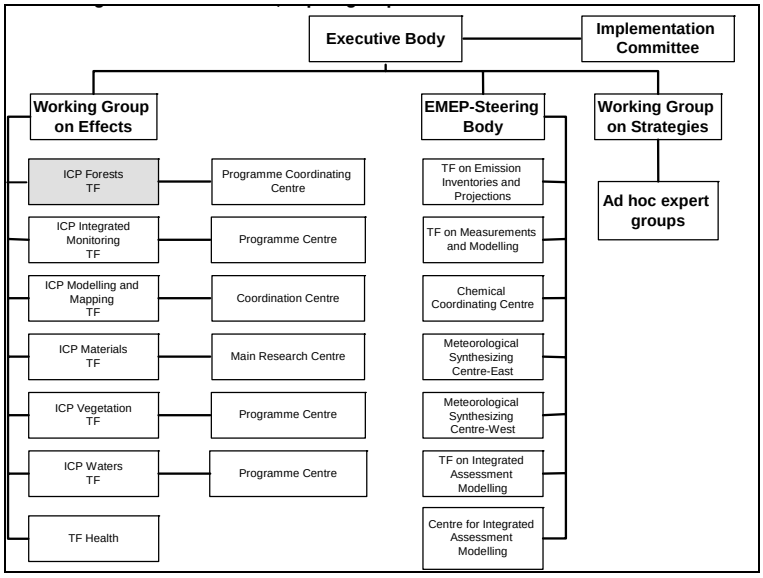


Figure 3.1-1: Bodies under the Convention on Long-range Transboundary Air Pollution
TF: Task Force, ICP: International Co-operative Programme

The structure of ICP Forests is shown in Figure 3.1-2. Germany was appointed as Lead Country.

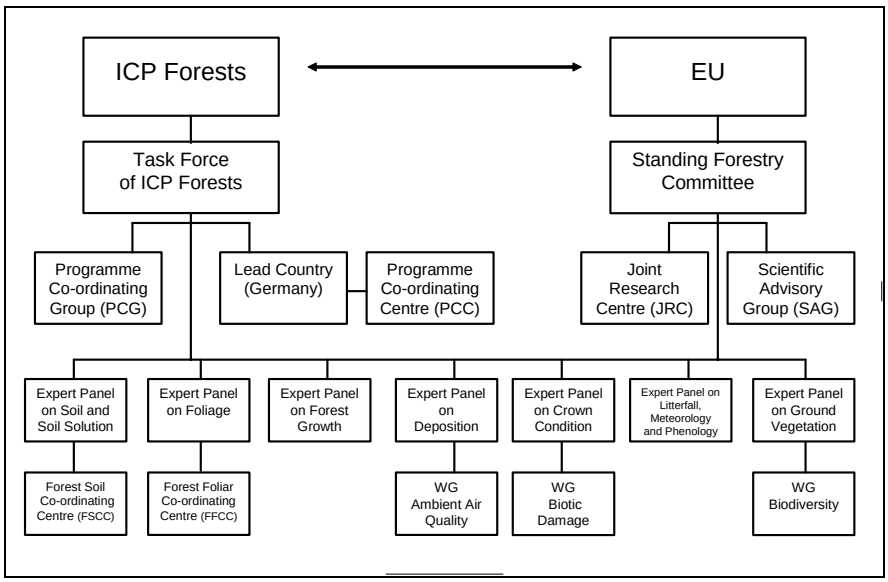


Figure 3.1-2: Bodies of ICP Forests and cooperating institutions of the EU

The programme is steered by its Task Force, in which 40 participating countries and the European Commission (EC) are represented and which is chaired by Germany as Lead

Country. Each participating country maintains a National Focal Centre (NFC). A Programme Co-ordinating Group (PCG) cares for the full programme implementation. Programme co-ordination, storage of relevant parts of the data as well as evaluations and reports are entrusted to the Programme Co-ordinating Centre (PCC). The Forest Soil Coordinating Centre (FSCC) is entrusted with the collection and evaluation of the soil data while the foliar data are managed by the Forest Foliar Coordinating Centre (FFCC).

In response to the demand for harmonised monitoring at both levels Expert Panels were established which were mandated to develop and maintain suitable and up to date methods and to support proper data evaluation at the European level. These are the Expert Panel (EP) on Soil and Soil Solution, the EP on Foliage, the EP on Forest Growth, the EP on Deposition with its Working Group on Ambient Air Quality, the EP on Crown Condition with its Working Group on Biotic Damage, the EP on Ground Vegetation with its Working Group on Biodiversity and the EP on Litterfall, Meteorology and Phenology.

3.1.1 Task Force of ICP Forests

The programme is steered by its Task Force, in which 40 participating countries and the European Commission (EC) are represented. The Task Force is the highest body of ICP Forests. All relevant programme issues have to be presented to the Task Force. The Chairman supported by the Lead Country prepares, convenes and chairs these annual meetings.

3.1.2 Task of the Lead Country

The Lead Country represents ICP Forests in the Working Group on Effects, maintains a close co-operation with the European Commission and is the contact point with other monitoring programmes within and outside the Convention.
The task of the Lead Country is in addition to support the Chairman to prepare, convene and chair the annual meetings of the Task Force. The Lead Country also convenes and chairs meetings of the Programme Co-ordinating Group.

3.1.3 Task of the Programme Co-ordinating Group (PCG)

The Programme Co-ordinating Group has the task to promote and supervise a continuous review of the programme and to support the Chairman in all issues of relevance for the future scheme of the programme. Recommendations of the PCG are directed to the Task Force of ICP Forests. To meet these tasks the PCG needs to convene regularly. Members of the PCG are the Chairman of ICP Forests, the Lead Country, PCC, EC and the Expert Panel chairpersons. At these meetings the European Commission may be accompanied by the Chairman of the Scientific Advisory Group and JRC whenever appropriate. A participation of representatives of NFCs can also be considered.

3.1.4 Task of the Programme Co-ordinating Centre (PCC)

The PCC in Hamburg is entrusted with a broad range of tasks in the fields of programme management, data processing, evaluations and reporting.

The co-ordinating activities consist of assistance to the Lead Country in the administration and further development of the programme, the discussion of methods and evaluation strategies with experts as well as the organisation of intercalibration courses in close co-operation with the Expert Panel on Crown Condition and the EC.
PCC keeps copies of all relevant parts of the data of ICP Forests and the EU scheme in order to make them available under the specific rules of the Executive Body and the EU.
In accordance with the programme objectives, PCC in co-operation with other relevant institutions concentrates on the following points:

- Execution of integrated evaluations of Level I crown, soil and foliar data and relevant external data from other large-scale survey,
- Extrapolation of relationships identified for Level II with available data at Level I plots,
- Further improvement of the understanding of cause-effect relationship by means of in-depth studies including literature reviews,
- Stimulation of common activities with other ICPs under the Working Group on Effects (e.g. common intercalibration course, common ringtests, common workshops),
- Improved co-operation with other international programmes for common evaluation projects.

3.1.5 Task of the Expert Panels (EP)

The Expert Panels of ICP Forests have the task to further develop the harmonised methods as laid down in the Manual. The Panels cooperate closely with PCC and with the Joint Research Centre (JRC) of EC in order to contribute to the data evaluation and quality assurance.
A main task of the Expert Panels is to further support an integrated monitoring and data evaluation approach. For such a specific purpose and for a limited period of time only, ad hoc working groups may be established consisting of representatives from different Expert Panels. Also combined Expert Panel meetings may help supporting this aim.

3.1.6 Task of the National Focal Centres (NFC)

The NFCs are nominated and financed by the participating countries. They are responsible for the collection, validation, evaluation and storage of their monitoring data and aggregation of national data in accordance with the ICP Forests Manual. The NFCs and their responsible agencies have to ensure that the data is collected according to the methods described in the Manual and that the quality assurance programme has been applied. The NFCs evaluate and interpret their national data. In the last years an enormous potential for evaluation and advancement of knowledge of forest ecosystems has been gained at national level. Increasing attention also at national level is paid to integrated data evaluations.

The NFCs have the task to submit the Level I and Level II data and accompanying information to PCC and JRC, respectively, in accordance with the deadlines agreed and the format laid down in this manual. The NFCs are invited to participate in the evaluation and interpretation of the data at European level.

3.2 Monitoring activities

General considerations

In 1985 the participating countries agreed that ICP Forests should fulfil its objectives and mandate by means of assessments on a large-scale 16x16 km grid (Level I) and intensive monitoring on Level II plots.

From 1989 onwards most of the Level I plots have been included in the European survey summing up to 6000 plots nowadays. Since then annual crown condition assessments have been carried out and on most of the plots soil condition and the chemical contents of needle and leaves have been assessed. In 1994, after having agreed on harmonised methods, the selection and installation of the Level II plots commenced. In the meantime most of the Level II plots (870) have been selected and installed and continuous monitoring of site and stress factors as well as on the biological and chemical ecosystem condition is underway. A broad monitoring approach has been chosen by ICP Forests in order to be able to analyse the wide range of factors influencing forest condition.

Based on the results of the monitoring activities, ICP Forests was and will be in the position to inform the public on forest condition in Europe and relevant trends. In addition, important cause-effect relationships were described, however further efforts are needed in this field.

Whilst the evaluation of the Level II monitoring results is directed towards the identification of cause-effect relationships at the ecosystem level, the survey of crown condition and of soil and foliar chemistry at Level I remains indispensable for obtaining trends and for further integrated evaluations of large-scale data of ICP Forests and other programmes. In addition, by means of large-scale data, processes identified at the ecosystem level may be upscaled to the regional and European level. This requires a careful evaluation of the parameters needed at both monitoring levels in order to ensure a statistically sound upscaling.

For holistic views of the complex interrelationships between the manifold causes and effects characterising forest condition on both the small and the large scale, the evaluations must not remain confined to the data of ICP Forests and EU, but should make use of all further data and information sources available from other programmes.

The proper assessment of high quality data and their careful evaluation and interpretation at national and European level will remain of high importance. However, a continuation of these activities will ask for sufficient budget resources at national and European level.

3.2.1 Monitoring activities at Level I

For monitoring forest condition and its spatial and temporal changes on a large scale and over a necessary period of time, the Level I network has been established. The Level I system covers the main forests in Europe adequately. The Level I network consists of approximately 6000 monitoring plots, which are systematically arranged in a nominal 16x16km grid throughout Europe (see Fig. 3.2.1-1). In addition, several countries are executing surveys at a denser national gridnet in order to obtain reliable estimates at national and regional level.

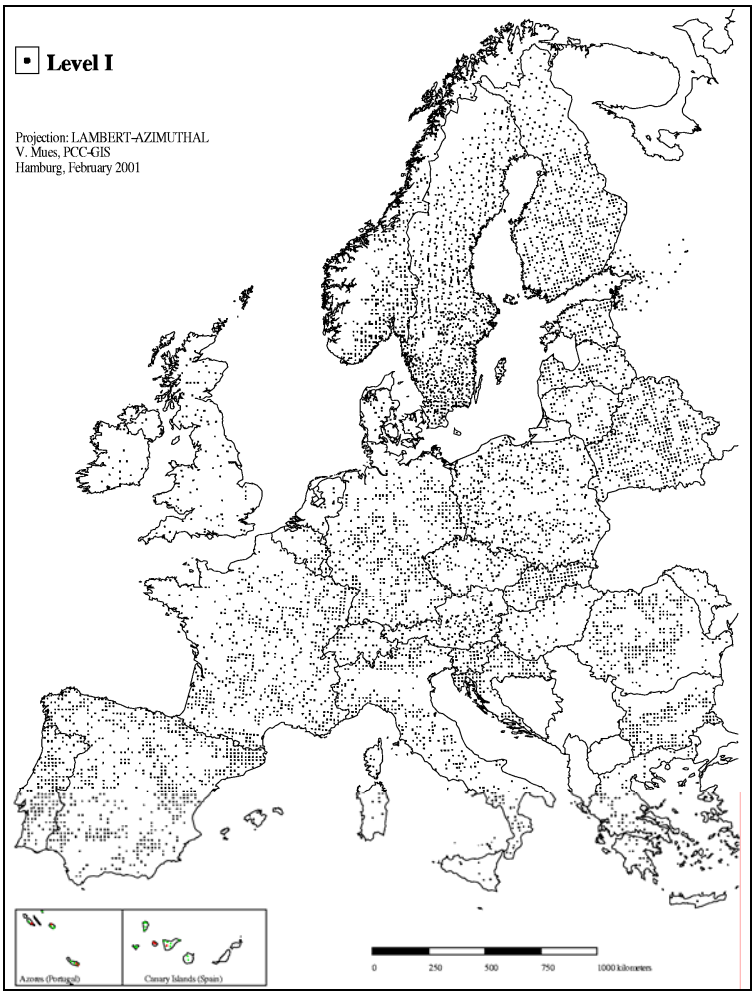


Figure 3.2.1-1: Transnational Level I plots in Europe

The latitude and longitude of the sampling points were obtained by means of a reprojection of the 16x16 km grid points to geographical coordinates. These coordinates were calculated and provided to the participating countries by the European Commission (CORINE project). If a country had already established plots with coordinates deviating from the calculated ones, the existing plots were accepted, provided that the mean point density resembled that of a 16x16 km grid, and that the assessment methods corresponded to those of the ICP Forests Manual and the relevant EU Regulations. Only in boreal areas and in maquis area, wider grids are applied (16x32 or 32x32 km).
The selection of sample points is described in Annex I.

Crown condition assessment
Crown condition at Level I has proven to be a valuable tool for detecting status and trends of tree condition in Europe. Therefore it is essential to continue these assessments in the future.

Crown condition is assessed at European level annually at all of the 16x16km Level I points. The main parameters to be assessed are:

- defoliation/crown transparency
- discolouration
- stand and site characteristics which support the interpretability of the crown condition results and serve as a basis for upscaling Level II results.

Quality assurance has been a matter of particular concern in this part of the programme. In order to detect, discuss and manage differences in methods applied by the countries cross-calibration courses are being offered annually. However to ensure time consistency of national data, differences between countries are accepted. As a result of the internal review and in order to further improve quality assurance, different activities are being developed. Examples are the development of new concepts and methods for International Crosscalibration Courses and the use of digital image processing.

Further details on assessment methods, analysis methods, quality control and data submission are described in Part II of the Manual.

Assessment of the occurrence of identifiable damage causes

Biotic factors can have both a positive or negative effect on forest condition. Occasionally however, crown condition may be seriously affected by damage types caused by e.g. insect pests or fungal diseases.

The presence of these damaging factors is included in the crown condition assessments. A recently improved method will contribute to a better understanding of their influence on tree vitality and is in line with the recommendations from the internal review.

Forest Soil Condition survey

There are clear correlations between forest soil chemistry and the deposition of acidity and heavy metals. Therefore the soil condition assessment at Level I provides information on soil related stress factors for forest condition with respect to nutrient imbalances and soil condition.

A first forest soil survey was executed by 23 countries in the years 1994/95.

The main objectives of a second soil survey are

- to provide information on changes in soil chemistry,
- to complete soil information at the European level
- to assess relevant soil parameters, soil layers and plots not considered in the first survey.

A repetition of the soil survey is presently under discussion, also taking into account the European Soil Strategy. Prior to a repetition the following questions need to be clarified:

- Completion of clearly defined and recommended sampling and analytical methods,
- Control of the quality of the analytical methods applied by means of an interlaboratory comparison including practical measures to improve quality assurance,
- In principle all Level I plots will be taken into consideration. However as several countries are recommending to sample only on a selection of plots, the selection criteria for those areas with reduced sampling coverage need to be specified.
- Verification of the relevance of soil data for the Convention on Climate Change.

FSCC and the Expert Panel on Soil are invited to take the necessary steps for clarification.

Details on assessment methods, analysis methods, quality control and data submission are described in Part III of the Manual.

Forest Foliar Survey
The monitoring of tree nutrition is essential for assessing forest condition, as changes in forest condition may manifest themselves in foliar nutrient concentrations. The main objective of the foliar survey is to monitor the nutritional status of forest trees.

Few countries (16) have analysed the chemical composition of the foliage of Level I sample trees in the years 1994/95. The data base on tree nutrition at European level is therefore incomplete and needs to be amended.

Data submission at Level I
The results of the defoliation and discolouration assessments have to be submitted along with written reports to PCC every year for evaluation. For the annual reporting of the results the following deadlines for submission must be observed: the 15th of December for the data, and for the written reports the 31st of December.
The results of the soil and foliage surveys were reported in 1995 and 1996, respectively. Any further data resulting from a completion or a possible repetition of the surveys should be sent to FSCC and FFCC, respectively, as soon as possible.

3.2.2 Monitoring activities at Level II

For the intensive monitoring programme (Level II) more than 860 permanent observation plots have been established by the countries with the aim of investigating key factors and processes on the ecosystem scale. Plots have been selected on a preferential basis taking into account ecological and logistic issues (see below) and in such a way that major forest ecosystems are represented following general recommendations by ICP Forests and the EU.
The location and the surveys carried out on Level II plots are given in Figure 3.2.2-1 and Table 3.2.2-1.

One important selection criterion is that the Level II plots in a country should be located in such way that the most important forest species and most widespread growing conditions in the respective country are represented. Within the plot, the situation shall be as homogeneous as possible (regarding e.g. tree species, stand type and site conditions). Whenever possible, plots should be selected which have been monitored during the last years. The great advantage of existing data on air quality and meteorological parameters from nearby stations should be taken into consideration whenever establishing Level II plots.

The plot has a minimum size of 0.25 ha. Each plot is surrounded by a buffer zone with a minimum width of 10 m, if possible. There should be no differences in the management of the plot, its buffer zone and surrounding forest (e.g. management operations should be comparable and fencing should be limited to a minimum). However, the disturbance of the monitoring activities should be minimized. Trees felled in the plot or in the buffer zone should be registered and if possible used for increment analysis. Annex 2 visualizes the standard Level II-plot design.

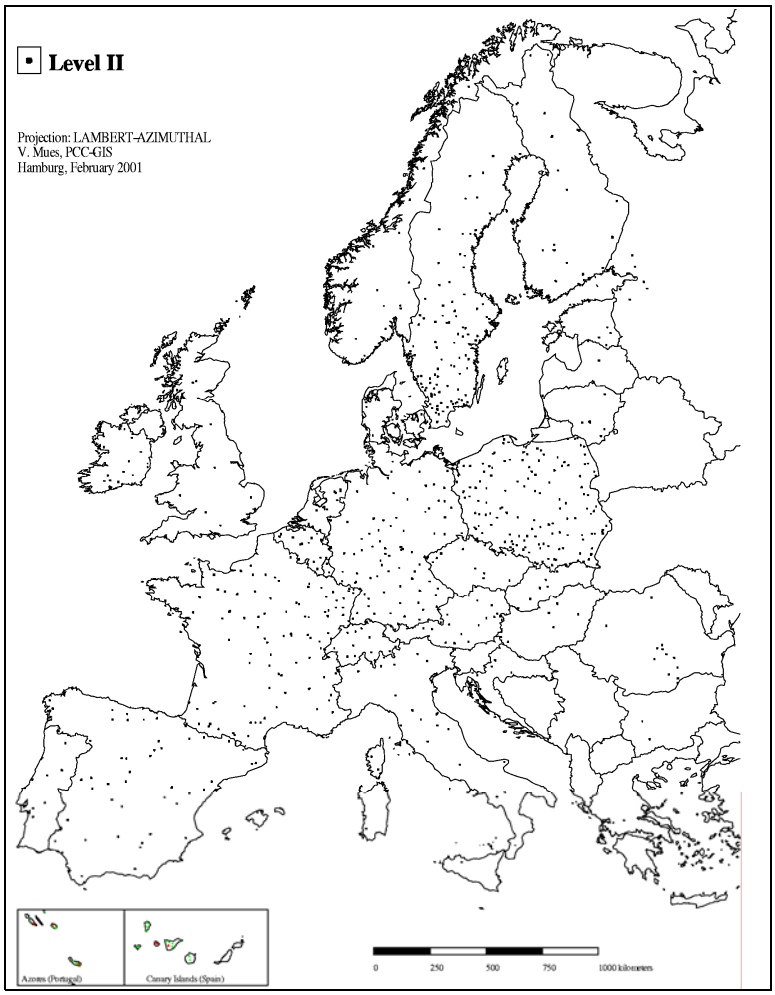


Figure 3.2.2-1: Level II plots in Europe

In principle, all trees in the total plot are to be included in the sample for the tree assessment (e.g. crown inventory, increment assessment). In the case that the plot has many trees (i.e. dense stands), a sub-plot may be defined to be used for these surveys. The size of the sub-plot at the time of the installation of the plots should be large enough to give reliable estimates for theses surveys for a minimum of 20 years, preferably throughout the life of the stand. A minimum of at least 20 trees in the sub-plot should be available in this period.

The installation of a plot comprises its detailed description, including stand and site characteristics and other available information on the history of the plot, or other nearby monitoring stations. The relevant forms for data submission of plot related information are provided in Part II.

Table 3.2.2-1: Surveys carried out on Level II plots:

Survey	Frequency	Intensity
a. Crown condition	at least annually	all plots
b. Soil (solid phase)	every 10 years	all plots
c. Soil solution	continuously	part of the plots
d. Foliage	every 2 years	all plots
e. Deposition	continuously	part of the plots
f. Ambient air quality	continuously	part of the plots
g. Meteorology	continuously	part of the plots
h. Forest growth	every 5 years	all plots
i. Ground Vegetation	every 5 years	all plots
j. Phenology	several times per year	optional
k. Litterfall	continuously	part of the plots
l. Remote Sensing	preferably at plot installation	optional

For integrative evaluations (see 3.4.2), efforts to complete the set of data on as many plots as possible are important. The best option is to carry out all the surveys on as many plots as possible. If it is not possible to equip all plots in a country, it is strongly recommended to concentrate the continuous measurements on soil solution, meteorological parameters, deposition and ambient air quality at a smaller number of plots. These plots are best selected taking into account the need of statistical analysis.

If all measurements mentioned under points a – k are carried out at the same plot, this plot is then called a key plot. All countries are invited to establish at least 10% of their Level II plots as key plots. While all Level II plots contribute at a certain degree to improve the understanding of the cause-effect relationship (objective b) the key plots will provide the supplementary information necessary to fulfil objective c (to provide a deeper insight into the interactions between the various components of forest ecosystems by compiling available information from related studies).

Data submission at Level II

The Level II data are to be submitted to the Joint Research Centre of the European Commission (JRC) in Ispra (Italy) which is responsible for the data validation and storage. A copy of the data is to be sent to the Programme Coordinating Centre of ICP Forests.

Data collected by the end of each year should be submitted annually at the end of the subsequent year. Submitted data should be accompanied by a Data Accompanying Report (DAR-Q) stating deviations from the methods described in the manual.

Details on assessment methods, analysis methods, quality control and data submission are described in Part II - XI of the Manual.

3.2.3 Integrative evaluations

Given their nature, the Level I and in particular the Level II approach ask for an integration of the data from various monitoring surveys. Actually, the possibility for integrating data from different investigation into a cohesive evaluation system is the most important aspect related to the Level II plots and this feature will be strenghtened as the time series increase. The

integration can be achieved at different levels according to data availability in space and time. Forest health in terms of growth, tree condition, plant diversity and soil condition can be impacted by biotic (pests and diseases) and abiotic (e.g. climate, air pollution) factors, the effects and importance of which depends on inherent site properties (e.g. site history and management, topography, soil condition) according to complex and often mutual relationships. These relationships can be fully investigated only if data from all investigations are available. However, a full integration of data is only possible on those plots where all investigations are carried out (Table 3.2.2-1). A second option can be to consider modelled data from available and suited models, provided model ouputs can be applied with confidence to the situation of the plot being considered. In this respect, the wealth of data collected on Level II sites can be used to establish deterministic relationships that can be useful for deriving estimates of unmeasured variables at given sites.

Integrated approaches include multivariate statistical evaluations applied to collected or modelled data within different fields of forest and related ecosystem research. They aim to clarify relations between tree condition features as response parameters and anthropogenic as well as natural stress factors as predictors. It also includes modelling approaches related to:

- the fate of elements in the forest ecosystem (e.g. the occurence of N saturation or Al release), allowing the calculation of critical loads,
- the long-term impact of atmospheric input on nutrient cycling in soil and soil solution chemistry
- the impact of meteorological and soil factors and deposition on tree growth and species diversity of the ground vegetation.

The integrated evaluation of the existing data as well as of newly generated ones will however require an intensive co-operation of the responsible bodies.
The integrated evaluations will also in the future require the necessary funding for specialised statisticians in the evaluating data centres. The complex results will have to be interpreted with caution and in such a way that they provide understandable information for the public as well as for policy makers.

3.3 Reporting system

The ICP Forests reporting system comprises annual Executive Reports which provide a general overview on the monitoring results and their interpretation with respect to relevant results of forest damage research as well as on special topics. The target group for the Executive Report is a broad one, ranging from politicians across NGOs and environmentalists to forest owners and the general public.
The scientific and technical basis for the Executive Reports are provided by Technical Reports and data evaluations as carried out by the Expert Panels, the NFCs or PCC. The Technical Reports may vary between a yearly and biannually publication. The target group for these reports are scientists and other experts involved in the work.
PCC is responsible for elaborating and compiling of the annual reports.

In comparison to printed media, the Internet will gain increasing importance for the dissemination of results to all target groups. Besides continuously updated basic information on the programme, PCC will regularly provide the latest findings of all surveys on its website www.icp-forests.org.

4. Policy implications

Approximately one third of Europe is covered with forest. Forests have high economic, ecological and social values which have to be preserved. In rural areas forest and forest industries create a source of valuable income. Sustainable forest management supplies the demand for the renewable material wood and other forest products. Forests also ensure water reserves, protect against soil erosion and avalanches and provide habitat for flora and fauna. Forests are increasingly accepted as recreational areas by the public. For all these functions forests in Europe have to be stable and healthy.

For the ICPs under the Working Group on Effects as well as for the scientific community the Level I and Level II plots of ICP Forests provide an excellent basis for evaluations of the effects of air pollution on forest ecosystems. ICP Forests and its NFCs are looking forward to a close co-operation at regional, national and European level. In addition, special reports and contributions are targeted for the scientific community. ICP Forests monitoring activities will contribute to other relevant forest issues such as carbon sequestration, climate change, sustainable forest management and changes in biodiversity.

With its approximately 6000 Level I and 860 Level II plots the pan-European monitoring system of ICP Forests and EU offers a unique source of information on the condition of forest ecosystems. The data gathered in this programme and their evaluation are of great interest for policy making processes not only in the field of environmental protection but also for different kinds of forest policy items, such as sustainable forest management, biodiversity in forest or the effects of climate change on forest ecosystems. Thus, the monitoring system of ICP Forests provides a cost-effective multifunctional monitoring approach.
ICP Forests offer its various results in print media (e.g. annual Executive Reports) and via Internet (www.icp-forests.org).

Annexes

Annex1: Selection of sample points: random number grid for shifting plot centres

Annex2: Standard Level II plot design (example)

Annex 3: List of selected relevant publications of ICP Forests and EU

Annex 4: Forms

Annex 1: Selection of sample points: random number grid for shifting plot centres

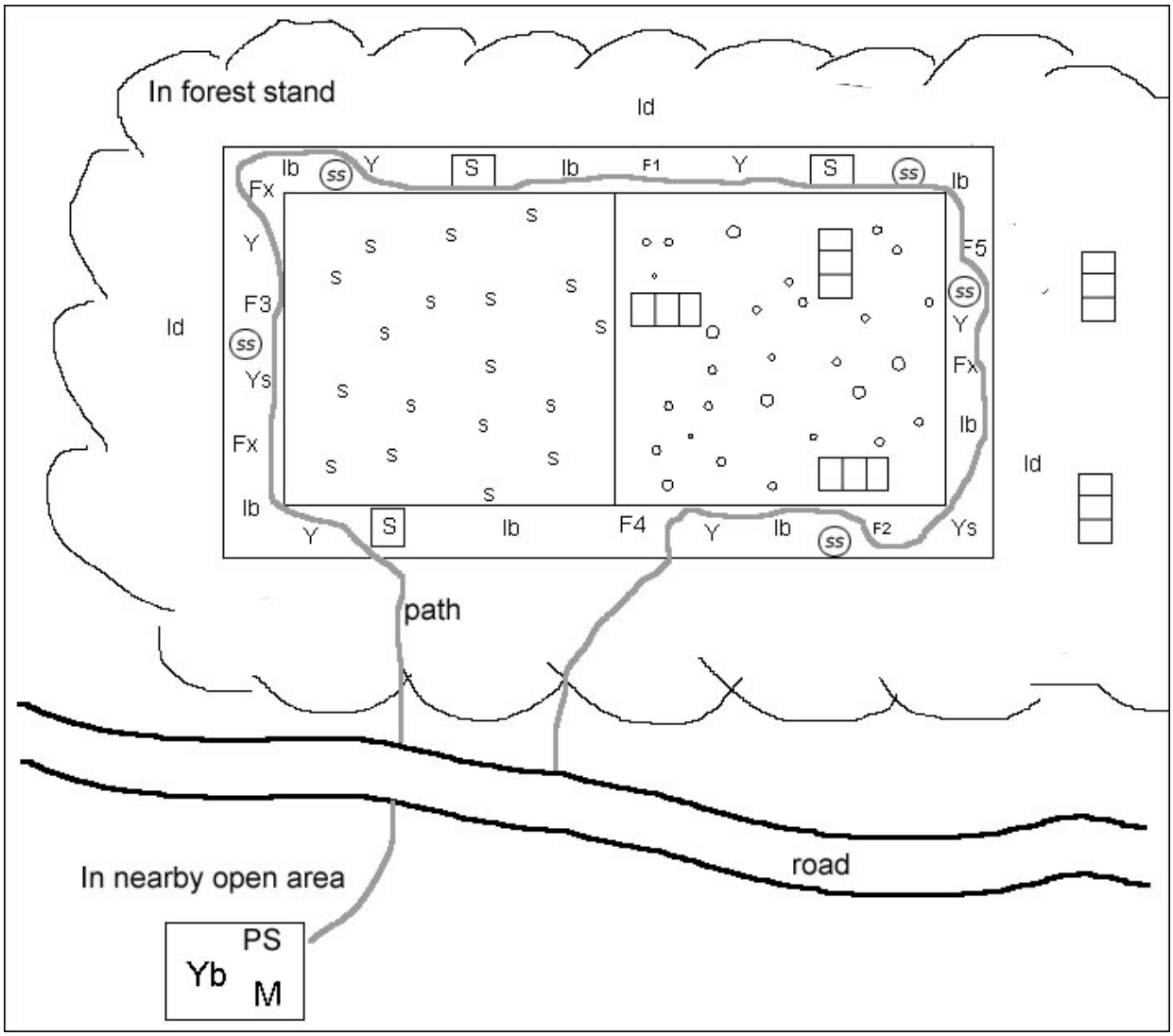
If the stand at the sample point, as established by the coordinate intersection point, does not contain the required minimum of 10 sample trees the point has to be shifted by using the random number grid (see figure below). This grid is available in the common map scales and covers an area of nearly 16 ha. Grid intersection points are approximately 70 m apart. In the field, the centre of the transparent grid overlay is placed on the coordinate points, the top pointing north. Use of the overlay guarantees an objective selection of alternative sample points.

The criteria for selecting Level I plots have been described in Chapter 3.2.1. If the sample point does not fulfil the requirements, the point is shifted to the nearest point with the next higher number and so on. If no suitable point can be found in the initial stand one proceeds to the next stand within the area of the overlay using the point with the lowest random number. This point is the centre of the sample unless it is unsuitable, when one proceeds to the point with the next higher random number using the above procedure, and so on. If no suitable point can be found this grid point is abandoned and recorded as not being a sample point.

+ 102	+ 14	+ 57	+ 91	+ 114	+ 89	+ 81	+ 105	+ 119	+ 5	+ 54
+ 58	+ 79	+ 76	+ 34	+ 58	+ 48	+ 38	+ 21	+ 118	+ 22	+ 62
+ 82	+ 111	+ 84	+ 47	+ 40	+ 23	+ 80	+ 120	+ 4	+ 115	+ 50
+ 54	+ 12	+ 39	+ 1	+ 103	+ 53	+ 115	+ 108	+ 15	+ 33	+ 17
+ 44	+ 73	+ 87	+ 92	+ 66	+ 59	+ 98	+ 32	+ 99	+ 72	+ 19
+ 117	+ 51	+ 46	+ 51	+ 67	+ **0**	+ 112	+ 50	+ 88	+ 85	+ 37
+ 41	+ 95	+ 35	+ 93	+ 104	+ 45	+ 70	+ 28	+ 74	+ 30	+ 8
+ 113	+ 3	+ 29	+ 75	+ 55	+ 7	+ 59	+ 63	+ 31	+ 12	+ 10
+ 58	+ 20	+ 49	+ 26	+ 96	+ 83	+ 2	+ 24	+ 43	+ 65	+ 6
+ 90	+ 13	+ 100	+ 110	+ 36	+ 75	+ 105	+ 9	+ 11	+ 25	+ 96
+ 94	+ 101	+ 27	+ 71	+ 109	+ 15	+ 77	+ 97	+ 42	+ 52	+ 107

↑north

Annex 2: Standard Level II plot design (example)



Crown assessment
- ° Tree for crown assessment (yearly)

Soil (every 10 years)
- s Location for soil sampling (minimal disturbance)
- S Location for soil pit
- SS Soil solution samplers

Deposition and ambient air quality
- Y Throughfall collector
- Ys Stemflow collector (in beech mandatory)
- Yb Bulk or wet-only collector
- PS Passive Samplers

Foliar
- Fx Tree x for foliar sampling (2-yearly)

Increment
- ° Trees for increment measurement DBH (5-yearly)
- Ib Trees for increment measurement bores (once)
- Id Trees for increment measurement disks (once)

Meteorology
- M Meteorological equipment

Ground vegetation
- ☐☐☐ Ground vegetation sampling areas (always located outside fence)

Annex 3: List of selected relevant publications of ICP Forests and EU

Annual Executive Report on Forest Condition in Europe

Annual Technical Report on Forest Condition in Europe

Others:

Augustin, S. and H. Andreae (Eds.). 1998. **Cause-effect-interrelations in forest condition** – State of current knowledge. UN/ECE and EC. Geneva, Brussels, 52 p.

De Vries, W., Forsius, M., Lorenz, M., Lundin, L., Haussmann, T., Augustin, S., Ferretti, M., Kleemola, S., Vel, E. 2002. **Cause-effect Relationships of Forest Ecosystems**. ICP Forests and ICP Integrated Monitoring, 46 p.

Müller-Edzards, J.W. Erisman & W. De Vries. 1997. **10 Years Forest Condition Monitoring in Europe**: Studies on Temporal Development, Spatial Distribution and Impacts of Natural and Anthropogenic Stress Factors. Technical Background Report. EC and UN/ECE, Brussels, Geneva. 350 p.

Rademacher, P. 2001: **Atmospheric Heavy Metals and Forest Ecosystems**. Current implementation of ICP monitoring systems and contribution to risk assessment. UN/ECE, Geneva.

Schall, P. and Seidling, W. 2004: **Upscaling results form forest ecosystem monitoring to the large scale**. UNECE, Geneva, 114 p.

Seidling, W., 2001: **Integrative studies on forest ecosystem conditions**: Multivariate evaluations on tree crown condition for two area with distinct deposition gradients. UN/ECE, EC, Flemish Community, Geneva, Brussels, Gent, 88 p.

Seidling, W., 2000: **Multivariate Statistics within Integrated Studies on Tree Crown Condition in Europe** – an Overview. UN/ECE and EC, Geneva, Brussels, 101 p.

Stefan, K., Fürst, A., Hacker, R., Bartels, U. 1997. **Forest Foliar Condition in Europe**. Technical Report. Austrian Federal Forest Research Centre, EC, UN/ECE, Vienna, Brussels, Geneva. 184 p.

Vanmechelen, L., Groenemans, R., Van Ranst, E. 1997. **Forest Soil Condition in Europe**. Technical Report. Ministry of the Flemish Community, EC and UN/ECE, Brussels, Geneva. 257 p.

Internet: **www.icp-forests.org**

Annex 4: Form: General Plotfile

The parameters which have to be submitted with the particular forms may change over time. Therefore, with the update from June 2006 the NFCs are asked to start each data file (A3.2) with a header line. This line is starting with an exclamation mark followed by the names of the parameters, each separated by a comma. For each data file a proposal is given at the top of the form.

Example for first (comment) line submitted within the file XXGENER.PLT:
!Sequence, country_code, plot_number, latitude, longitude, altitude, orientation, installation date, plot_size, number_of_trees, sub_plot_size, mean_age, tree_species, yield_abs, yield_total, other_observation

Form 1a
XXGENER.PLT
Contents of file with the information on Plot level
to be completed during installation

1 - - 4	6 - 7	9 - - 12	14 - - - - - - 20	22 - - - - - - 28	30 31	33	35 - - - 40	42 - - - - 47	49 - - 52	54 - - - - 59	61 62	64 - 66	68 70	72 - - - - 82
Sequence	Country	Observation plot number	Latitude Coordinate (+ D D M M S S)	Longitude coordinate (+ D D M M S S)	Altitude	Orien-tation	Installation date (D D M M Y Y)	Total plot size (ha)	Number of trees in plot	Size of sub-plot (ha)	Mean Age	Main tree species	Yield abs rel	Observations
1								.		.				
2								.		.				
3								.		.				
4								.		.				
5								.		.				
6								.		.				
7								.		.				
8								.		.				
9								.		.				
1 0								.		.				

Column		See explanation item #
1 - 4	Sequence number of plots (1 to 9999)	
6 - 7	Country Code (France = 01, Belgium = 02, etc.)	*(1)*
9 - 12	Observation plotnumber (max. 9999)	*(2)*
14 - 20	Latitude in +DDMMSS (e.g.+505852)	*(4)*
22 - 28	Longitude in (+ or -)DDMMSS (e.g. +035531)	*(4)*
30 - 31	Altitude (in 50 metre classes from 1 to 51)	*(7)*
33	Orientation (N =1, NE = 2, etc.)	*(8)*
35 - 40	Installation date in DD-MM-YY	*(3)*
42 - 47	Total plot size (in 0.0001 ha)	*(11)*
49 - 52	Number of trees in total plot	*(12)*
54 - 59	Size of sub-plot (in 0.0001 ha)	*(11)*
61 - 62	Mean age of dominant storey (in 20 year classes from 1 to 8)	*(9)*
64 - 66	Main tree species	*(15)*
68	Yield estimate - absolute	*(13)*
70	Yield estimate - relative	*(13)*

In the last column a remark on the plot can be included:

72 - 111	Other observations (word)	*(99)*

New form to be used from 2007 onwards

updated 06/2006

Explanatory items

(1) Country

1 France	13 Sweden	59 Estonia
2 Belgium	14 Austria	60 Slovenia
3 Netherlands	15 Finland	61 Republic of Moldova
4 Germany	50 Switzerland	62 Russia
5 Italy	51 Hungary	63 Bulgaria
6 United Kingdom	52 Romania	64 Latvia
7 Ireland	53 Poland	65 Belarus
8 Denmark	54 Slovak Republic	66 Cyprus
9 Greece	55 Norway	67 Serbia
10 Portugal	56 Lithuania	68 Andorra
11 Spain	57 Croatia	95 Canaries (Spain)
12 Luxembourg	58 Czech Republic	96 Azores (Portugal)

(2) Observation plot number

The observation plot number corresponds to a unique number given to the permanent plot during the selection or installation.

(3) Date of plot installation

Dates shall be completes in the following order day, month and year:

Day	Month	Year
08	09	94

(4) Latitude-/ longitude coordinates

Fill in the full six figure latitude and longitude coordinates of the centre of the observation plot, e.g:

	+/-	Degress		Minutes		Seconds	
— latitude	+	5	0	2	0	2	7
— longitude	-	0	1	1	5	3	2

the first box is used to indicate a + or - coordinate

(7) Altitude

1:	≤ 50 m	**14:**	651— 700 m	**27:**	1301— 1350 m	**40:**	1951— 2000 m
2:	51— 100 m	**15:**	701— 750 m	**28:**	1351— 1400 m	**41:**	2001— 2050 m
3:	101— 150 m	**16:**	751— 800 m	**29:**	1401— 1450 m	**42:**	2051— 2100 m
4:	151— 200 m	**17:**	801— 850 m	**30:**	1451— 1500 m	**43:**	2101— 2150 m
5:	201— 250 m	**18:**	851— 900 m	**31:**	1501— 1550 m	**44:**	2151— 2200 m
6:	251— 300 m	**19:**	901— 950 m	**32:**	1551— 1600 m	**45:**	2201— 2250 m
7:	301— 350 m	**20:**	951— 1000 m	**33:**	1601— 1650 m	**46:**	2251— 2300 m
8:	351— 400 m	**21:**	1001— 1050 m	**34:**	1651— 1700 m	**47:**	2301— 2350 m
9:	401— 450 m	**22:**	1051— 1100 m	**35:**	1701— 1750 m	**48:**	2351— 2400 m
10:	451— 500 m	**23:**	1101— 1150 m	**36:**	1751— 1800 m	**49:**	2401— 2450 m
11:	501— 550 m	**24:**	1151— 1200 m	**37:**	1801— 1850 m	**50:**	2451— 2500 m
12:	551— 600 m	**25:**	1201— 1250 m	**38:**	1851— 1900 m	**51:**	> 2500 m
13:	601— 650 m	**26:**	1251— 1300 m	**39:**	1901— 1950 m		

(8) Orientation

1: N	4: SE	7: W
2: NE	5: S	8: NW
3: E	6: SW	9: flat

(9 Mean age of dominant storey (years)

1: ≤ 20	4: 61-80	7: > 120
2: 21-40	5: 81-100	8: Irregular stands
3: 41-60	6: 101-120	

(11) Total plot size in hectares

The size of the total plot, or sub-plot shall be stated in 0.0001 ha.

(12) Number of trees in total plot

The total number of trees (*shoots* in coppice forests) in the total plot. All trees (*shoots*) from 5 (*3*) cm (DBH) and more are counted.

(13) Yield estimates

The yield estimates consist of an absolute and a relative yield estimate. The absolute estimate will bet he estimated average yield over the total life period of the stand. The relative yield will indicate whether the absolute yield estimate is considered to be low, normal or high fort he stand. The following codes will be used:

Absolute: yield code	
0	0.0 – 2.5 m^3 per hectare per year
1	2.5 – 7.5 m^3 per hectare per year
2	7.5 – 12.5 m^3 per hectare per year
3	12.5 – 17.5 m^3 per hectare per year
4	17.5 – 22.5 m^3 per hectare per year
5	>22.5 m^3 per hectare per year

Relative: yield code	
1	Low
2	Medium
3	High

(15) main tree species (Reference Flora Europaea)

Broadleaves (= species to be used for the foliage inventory)*

001: Acer campestre*
002: Acer monspessulanum*
003: Acer opalus
004: Acer platanoides
005: Acer pseudoplatanus*
006: Alnus cordata*
007: Alnus glutinosa*
008: Alnus incana
009: Alnus viridis
010: Betula pendula*
011: Betula pubescens*
012: Buxus sempervirens
013: Carpinus betulus*
014: Carpinus orientalis
015: Castanea sativa (C. vesca)*
016: Corylus avellana*
017: Eucalyptus sp.*
018: Fagus moesiaca*
019: Fagus orientalis
020: Fagus sylvatica*
021: Fraxinus angustifolia spp. oxycarpa (F. oxyphylla)*
022: Fraxinus excelsior*
023: Fraxinus ornus*
024: Ilex aquifolium
025: Juglans nigra
026: Juglans regia
027: Malus domestica
028: Olea europaea*
029: Ostrya carpinifolia*
030: Platanus orientalis
031: Populus alba
032: Populus canescens
033: Populus hybrides*
034: Populus nigra*
035: Populus tremula*
036: Prunus avium*
037: Prunus dulcis (Amygdalus communis)
038: Prunus padus
039: Prunus serotina
040: Pyrus coomunis
041: Quercus cerris*
042: Quercus coccifera (Q. calliprinos)*
043: Quercus faginea*
044: Quercus frainetto (Q. conferta)*
045: Quercus fruticosa (Q. lusitanica)
046: Quercus ilex*
047: Quercus macrolepis (Q. aegilops)
048: Quercus petraea*
049: Quercus pubescens*
050: Quercus pyrenaica (Q. toza)*
051: Quercus robur (Q. pedunculata)*
052: Quercus rotundifolia*
053: Quercus rubra*
054: Quercus suber*
055: Quercus trojana
056: Robinia pseudoacacia*
057: Salix alba
058: Salix caprea
059: Salix cinerea
060: Salix eleagnos
061: Salix fragilis
062: Salix sp.
063: Sorbus aria
064: Sorbus aucuparia
065: Sorbus domestica
066: Sorbus torminalis
067: Tamarix africana
068: Tilia cordata
069: Tilia platyphyllos
070: Ulmus glabra (U. scabra, U. scaba, U. montana)
071: Ulmus laevis (U. effusa)
072: Ulmus minor (U. campestris, U. carpinifolia)
073: Arbutus unedo)
074: Arbutus andrachne
075: Ceratonia siliqua
076: Cercis siliquastrum
077: Erica arborea
078: Erica scoparia
079: Erica manipuliflora
080: Laurus nobilis
081: Myrtus communis
082: Phillyrea latifolia
083: Phyllyrea angustifolia
084: Pistacia lentiscus
085: Pistacia terebinthus
086: Rhamnus oleoides
087: Rhamnus alaternus
088: Betula tortuosa
089: Ceratonia siliqua (same as 75)
090: Crataegus monogyna
091: Ilex canariensis
092: Laurus azorica
093: Myrica faya
098: Quercus petrea_or_robur
099: Other broadleaves

Conifers (= species to be used for the foliage inventory)*

100: Abies alba*
101: Abies borisii-regis*
102: Abies cephalonica*
103: Abies grandis
104: Abies nordmanniana
105: Abies pinsapo
106: Abies procera
107: Cedrus atlantica
108: Cedrus deodara
109: Cupressus lusitanica
110: Cupressus sempervirens
111: Juniperus communis
112: Juniperus oxycedrus*
113: Juniperus phoenicea
114: Juniperus sabina
115: Juniperus thurifera*
116: Larix decidua*
117: Larix kaempferi (L.leptolepis)
118: Picea abies (P. excelsa)*
119: Picea omorika
120: Picea sichensis*
121: Pinus brutia*
122: Pinus canariensis
123: Pinus cembra
124: Pinus contorta*
125: Pinus halepensis*
126: Pinus heldreichii
127: Pinus leucodermis
128: Pinus mugo (P. montana)
129: Pinus nigra*
130: Pinus pinaster*
131: Pinus pinea*
132: Pinus radiata (P.insignis)*
133: Pinus strobus
134: Pinus sylvestris*
135: Pinus uncinata*
136: Pseudotsuga menziesii*
137: Taxus baccata
138: Thuya sp.
139: Tsuga sp.
140: Chamaecyparis lawsonia
141: Cedrus brevifolia
199: Other conifers