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

MANUAL

on

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

Part IV

Visual Assessment of Crown Condition and Damaging Agents

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Prepared by:

ICP Forests Expert Panel on Crown Condition Assessment

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CONTENTS

1. Introduction

The 2nd Ministerial Conference on the Protection of Forests in Europe held in Helsinki in 1993 agreed on General Guidelines for the Sustainable Management of Forests in Europe (Resolution H1). The guidelines underline that forest ecosystem health and vitality has to be maintained. Defoliation is an essential indicator in the concept of Pan-European forest ecosystem health and vitality.

The assessment of crown condition is central to the ICP Forests operated under the UNECE since 1985. The assessment methods developed in the mid-1980s for Level I formed the basis of the assessments for the Level II plots. Within Europe, the combination of almost 6000 plots on a systematic 16x16 km grid (Level I) and almost 900 intensive monitoring plots (Level II) provides a unique data set of long time series. However, at the beginning of the year 2000 a harmonization process between the existing Level I system and the National Forest Inventory (NFI) was initiated in several countries. Some national Level I concepts changed the pattern of samples.

This manual is a synthesis of earlier Expert Panel meetings, manuals, assessment recommendations, pilot studies, and results of a questionnaire reflecting the use of parameters in the FutMon project in 2009/2010.

In a previous version of this manual the guidelines for the assessment of damage causes were part of a separate submanual. These guidelines are now integrated in the manual on crown condition assessment.

2. Scope and application

This Part IV of the Manual aims at providing a consistent methodology to collect high quality, harmonized and comparable tree condition data at the large-scale Level I plots and at the intensive Level II plots of the UNECE monitoring network. Harmonization of procedures of assessment is essential to ensure comparability of the tree condition data across Europe, which is in turn necessary to permit trans-national studies on status and trends of tree condition and its relationships with environmental factors. In order to have their data used in the international database and evaluations, National Focal Centers (NFC) and their scientific partners participating in the UNECE ICP Forests programme should follow the methods described here and achieve the reported data quality requirements.

Table IV-1 gives an overview of variables and application. Levels of monitoring are the systematic large scale Level I grid, modified in some countries by varying National Forest Inventory systems, intensive monitoring plots and core plots. The last two belong to the existing so-called Level II network and cover selected relevant ecosystems in Europe. Intensive core monitoring plots contain the best monitoring information on key indicators of causes and effects.

Tab. IV-1: Parameter list of mandatory and optional variables of tree condition

Variable	see	Level I	Level II	Level II core	Reporting units
Tree visibility	5.2.1	O	M	M	code
Social class	5.2.2	O	M	M	code
Relative crown distance	5.2.3	O	O	M (only deciduous stands)	Relative measure
Crown shading	5.2.4	O	O	O	code
Defoliation	5.2.5	M	M	M	5 % classes
Foliage transparency	5.2.6	O	O	O	5 % classes
Flowering (only Pinus spec.)	5.2.7	O	O	O	code
Fruiting	5.2.8	O	O	M (only beech + spruce)	code
Apical shoot architecture (Fagus sylvatica)	5.2.9	O	O	M	code
Crown form / morphology (Picea ssp., Pinus sylvestris)	5.2.10	O	O	O	code
Tree removals and mortality	5.2.11	M	M	M	code
Stand age	5.2.12	M	M	M	classes
Tree age	5.2.12	O	O	M	classes
Secundary shoots/epicormics	5.2.13	O	O	O	code
Specification of affected part	5.3.1.1	M	M	M	code
Specification of symptoms	5.3.1.2	O	M	M	code
Location in crown	5.3.1.1	O	M	M	code
Symptom	5.3.1.2	M	M	M	code
Age of the damage	5.3.1.3	O	M	M	code
Causel agents or factors	5.3.2	M	M	M	code
Scientific name of cause	5.3.2.1	M	M	M	code
Extent and quantification	5.3.3	M	M	M	% (classes)

O – optional, M - mandatory

3. Objectives

The main objectives of tree vitality monitoring (as described in section 5.2, Part A) are:

(i) Tree condition assessment on large-scale Level I plots: Collect data to provide a periodic information on the spatial and temporal variation of tree vitality in relation to stress factors in a European and national large-scale systematic network. Level I contributes to a Europe-wide early warning system for developments and diseases in forest ecosystems.

(ii) Tree condition assessment on selected intensive monitoring Level II plots: collect data to contribute to a better understanding of the vitality of trees and forest ecosystems and causes and effects of stress factors.

(iii) Approved data quality: Field checks guarantee estimates on key tree condition indicators that permit high quality statistical analyses of spatial and temporal variation in European forest condition.

(iv) Within the tree vitality assessment, the main objective of assessing damage causes (as described in section 5.3) is to provide information about their impact on crown condition. Therefore this assessment should focus on the main damage factors influencing crown condition.

Information on the causes of damage to a tree and their influence on crown condition is essential for the study of cause-effect mechanisms. Without this information, data on defoliation and other crown parameters are extremely difficult to interpret. Data on leafloss and discoloration caused by the actions of defoliating insects or other factors will also provide valuable information for interpreting e.g. litterfall measurements and phenological observations. Long-term monitoring may also provide baseline data on the distribution, occurrence and harmfulness of biotic agents or damage factors in Europe. These data may also contribute to other aspects relevant for forest policy like sustainable forest management.

4. Location of measurements and sampling

4.1 Selection of plots and sample trees

The selection of plots is described basically in Part II of the Manual.

The national selection procedure for plots has to be described and reported by the NFCs to the Programme Coordinating Centre (PCC) (see Part II). Emphasis is put on the list of parameters that are suitable to indicate a holistic view on tree vitality. The assessments are linked to the statistically based sampling design (see Part II), including connections with NFI. It is strongly advisable to map the layout of the plot. Plot coordinates are submitted to the data centre with the respective forms for Level I and Level II, facilitating the use of GIS in the analytical stage. If the stand is clear-cut or wind thrown, no crown condition data will be submitted until a new stand has been established. A periodic revision of the Level I grid for adaptation to changes of forest area has to be conducted and reported to PCC by the submission of data on respective new or revised plots.

The sample trees have a minimum height of 60 cm. On Level I plots, preferably, all trees of Kraft classes 1-3 in the plot area should be sampled. On intensive monitoring plots assessments of crown condition and damaging agents can be conducted on a selected sub-plot (see Part II). The foliage of suppressed trees in high forest stands is mainly influenced by the overstorey. The inclusion of these trees in assessments is therefore optional and will depend on the aims of the national programme and the nature of the forest ecosystem.

Trees with >50% crown break (mechanical damage) are included in the crown condition sample, but in general no crown assessment is carried out if the assessable crown is severely affected. If countries decide to have a different procedure this has to be reported to PCC by using the code for parameter <removal and mortality> and if needed in addition by the submission of respective data accompanying reports in text format.

In coppice stands, macchia and other forest types where individual stools have many stems, the tree is considered as a single unit consisting of multiple stems.

In case of a Level I plot design with a fixed number of trees (e.g. four point cross cluster), trees that are excluded from assessment of crown condition and damaging agents by removal or mortality should be replaced according to the procedure described in section 5.2.11.

The parameters described in this manual are assessed by ground survey. For the assessment of parameters on tree parts that are five or more meters above ground, the use of binoculars is mandatory. The use of photo guides with typical photos of trees with different defoliation is strongly recommended. Some parameters may require closer observation (e.g. some forms of needle discoloration and foliage deformation). Closer (in-hand) examination is also usually required for full diagnostic assessments. Usually, a closer investigation becomes possible only every two years when the leaves for foliar analysis are sampled.

If a field check by an expert phytopathologist in order to assess the causes of an observed damage is not possible, photographs of the affected tree and/or samples of affected foliage, branches, fungal fruitbodies etc. may be of help for diagnosis. Nevertheless, damaging trees in the plots by destructive sampling is not allowed. Sampling of nearby trees outside the plot showing the same damage symptoms may be considered. However one should remember that similar damage symptoms may result from different causes.

5. Measurements

5.1 Methods of assessment

5.1.1 Frequency of assessment

Crown condition assessments are mandatory for all levels at least once a year. However, on coexisting Level I and NFI plots a different procedure may be used. In this case, the respective NFC has to document the method and inform PCC. The time of the assessment should be between the end of the first flush of foliage (when the leaves and needles are fully developed) and the beginning of autumnal senescence. For most species, the most suitable time for the assessment is mid- to late summer. The assessments should be done during the same period each year and within this time frame if possible under similar conditions. In regions with regular damage caused by summer drought, monitoring may be shifted to early summer.

For the assessment of damage causes the observations in Level I plots should be carried out during regular crown condition assessment in summer.

In the Level II plots it is recommended and in core plots it is strongly recommended to do an additional visit for damage assessment, if important damage is observed outside the period of crown condition assessment. The observations of the staff responsible for deposition sampling or phenological observations may act as an early warning system. This additional visit should be made at the time when the main damage cause is supposed to be at its maximum (e.g. spring for defoliators).

5.1.2 Assessable crown

The estimation of crown condition strongly depends on the definition of the assessable crown. The crown present at the moment of the assessment is to be considered, regardless of the potential or theoretical crown which may have existed in previous years. The influence of any present or absent trees on the crown of the sample tree must be taken into account when determining its condition. In cases where the sample tree crown is influenced by competition, the assessable crown includes only those parts that are not influenced by other crowns i.e. shading. Parts of the crown directly influenced by interactions between crowns or competition are excluded (see Fig. IV-1). The assessable crown of a freely developed tree is defined as the whole living crown from the lowest substantial living branch upwards. The following parts of such a crown must be excluded from the assessment:

- Epicormic shoots below the crown
- Gaps in the crown where it is assumed, that no branches ever existed

The assessable crown includes recently died branches, but excludes snags that have been dead for many years (i.e. which have already lost their side-shoots). Snags represent the historic mortality of parts of the crown and have no influence on the current condition of the tree. They are therefore excluded from the assessment. Dieback of shoots and branches represents an active process in the crown and is therefore included.

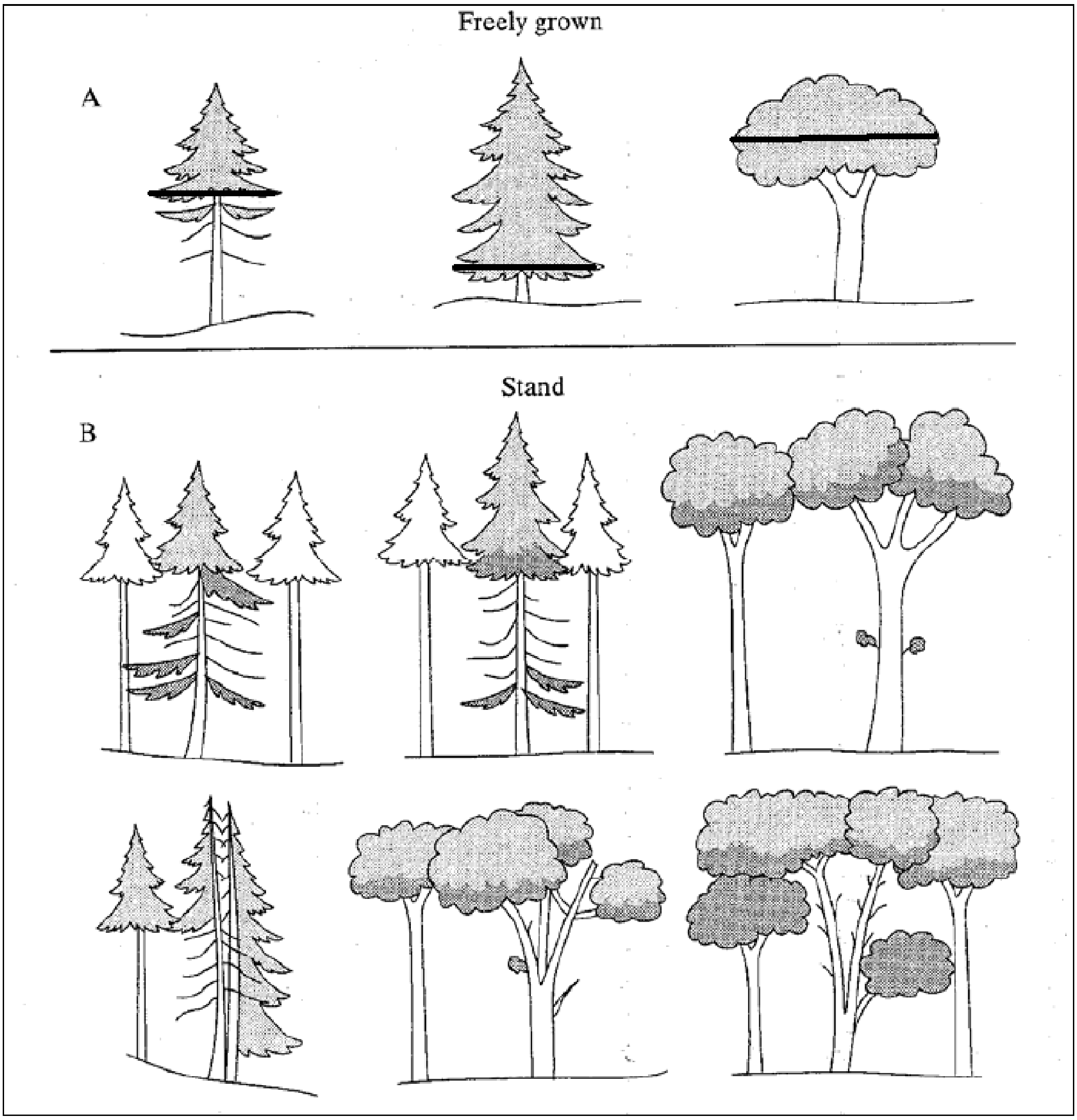

Fig. IV-1: Illustration of definition a): Assessment of the tree crown ranges from the tip of the tree to the widest horizontal span of the crown (stand: the lighter colour indicates assessable crown; freely grown trees: black line)

The definition of the assessable crown varies between countries. It is therefore essential that for each country, region and tree species the definition of assessable crown is documented. Data have to be sent to the ICP Forests data base unit with form TRE (Level I) and TRC (Level II), respectively.

In coppice (and macchia) stands it may be necessary to consider the assessable crown as a single unit consisting of crown parts from different stems.

5.1.3 Definitions

Damage is defined as an alteration or a disturbance to a part of the tree which may have an adverse effect on the ability to fulfill its functions.

Symptom: Any condition of a tree resulting from the action of a damaging agent that indicates its occurrence (e.g. defoliation, discoloration, necrosis)

Sign: Evidence of a damaging factor other than that expressed by the tree (e.g. fungal fruiting bodies, nests of caterpillars)

Discoloration: any deviation from the usual colour of the living foliage for the assessed tree species.

Dieback: branch mortality which begins at the terminal portion of a branch and proceeds towards the trunk and/or the base of the live crown.

Definitions of crown condition assessments are assigned to the related crown condition parameters.

5.2 Variables for Crown Condition Assessment

5.2.1 Visibility

Definition

The visibility of a crown is the degree to which different parts of the assessable crown can be viewed from the ground.

Crowns with poor visibility are not removed from the sample, but information about the visibility of individual tree crowns is useful to help with the interpretation of the data from those trees. Such trees remain in the sample as the use of an objective sampling design means that their exclusion could lead to bias in the results. Some parameters, e.g. stem and branch damage may be assessable on such trees.

Method

The following five classes for the visibility of assessable crown are used. Respective codes are listed in the explanatory items of the forms document available under www.icp-forests.org/Manual.htm.

- Whole crown is visible
- Crown only partially visible
- Crown only visible with backlighting (i.e. in outline). Note that some parameters can still be assessed when only back-lighting is present.
- Crown not visible

5.2.2 Social class

Definition

Social status is a measure of the height of a tree relative to the surrounding trees. Information on social status is useful as an aid to interpreting crown condition and increment data for the individual trees.

Method

Five classes are recognized. Respective codes are listed in the explanatory items of the forms document available under www.icp-forests.org/Manual.htm.

- dominant (including free-standing): Trees with upper crown standing above the general level of the canopy
- codominant: Trees with crowns forming the general level of the canopy
- subdominant: Trees extending into the canopy and receiving some light from above, but shorter than 1 or 2
- suppressed: Trees with crowns below the general level of the canopy, receiving no direct light from above
- Dying

Note: The assessment of the social class of a tree is in some cases difficult. Suppressed trees should not be equated with dying trees as, in a mixed-age stand, they represent future generations of trees. Classification on steep slopes presents a problem as even relatively short trees may receive direct light from above. In such cases, classification should be based on the relative height of the trees.

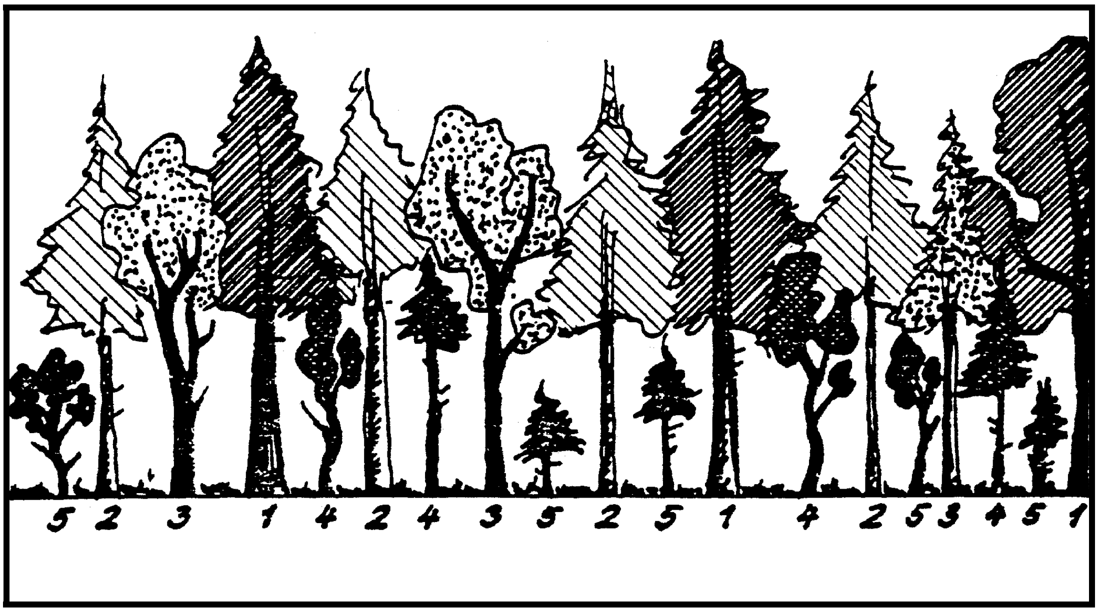

Fig IV-2: Illustration of social status classes (crown canopy classes) after Kraft (1 = dominant, 2 = codominant, 3 = subdominant, 4 = suppressed, 5 = dying)

Hint: The concept of social classes (KRAFT) supports the selection of crown condition sample trees.

5.2.3 Relative crown distance

Definition

Crown diameter related distance to surrounding trees in main directions (CDRD_N).

The relative distance between trees explains to a high degree the variability of characteristic defoliation data of deciduous trees.

Method

Scores are given for each perpendicular direction. Respective codes are listed in the explanatory items of the forms document available under www.icp-forests.org/Manual.htm.

- cramped, canopies overlap
- closed, crowns touch one another
- loose spread, gap between crowns up to one third of average crown diameter
- spread, gap between crowns up to two thirds of average crown diameter
- distant, gap between crowns from two thirds up to one whole of average crown diameter
- very distant. Gap between crowns > than 1/1 of average crown diameter

It is recommended, to start with the tree standing closest to the sample tree in a clockwise procedure. Dead trees are taken into account, as long as they are in the crown condition sample (see: 5.2.11).

Calculation

(Score1 + Score2 + Score3 + Score4) / 4 = CDRD_N

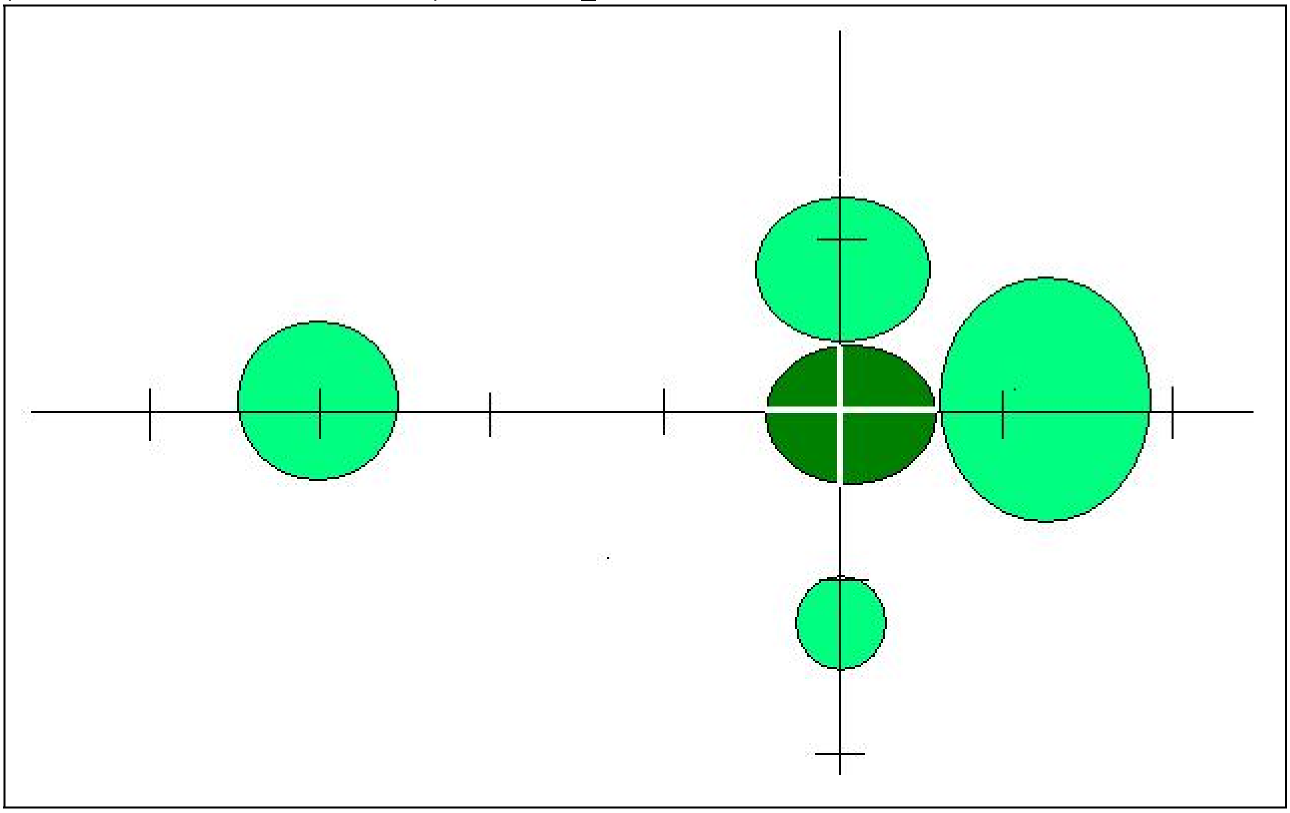

Fig. IV 3: Example: Crown diameter related distance to surrounding trees

Example:

[2+2+6+5]/4= 3.75

Crown diameter is a relative measure used to analyse crown stand structure in four perpendicular directions. Score values are to be averaged.

Note: If detailed stand structure information including crown projection maps of single trees is available, crown diameter related distance of sample trees can be calculated from this information. (see: Part V: Tree growth)

5.2.4 Crown shading

In order to allow for the continuation of existing time series the method of Crown shading is defined.

Definition

Crown shading is an estimate of the openness of the tree's situation.

Open-grown trees usually have much larger crowns than ones in closed canopies. In addition, the absence of any competition may change the susceptibility of a tree to particular stresses. A change in the degree of shading may have significant effects on crown condition. Consequently, this assessment should refer to the degree of shading at the time of assessment. This may change from one year to the next through, for example, thinning operations or storm damage. Consequently, it should be recorded annually.

Method

Crown shading is assessed on a six-point scale. Respective codes are listed in the explanatory items of the forms document available under www.icp-forests.org/Manual.htm.

- crown significantly affected (shading or physical interactions) on one side
- crown significantly affected (shading or physical interactions) on two sides
- crown significantly affected (shading or physical interactions) on three sides
- crown significantly affected (shading or physical interactions) on four sides
- crown open-grown or with no evidence of shading effects
- suppressed trees

5.2.5 Defoliation

Definition

Defoliation is defined as needle/leaf loss in the assessable crown as compared to a reference tree. Defoliation is observed regardless of the cause of foliage loss (i.e. for example it includes damage by insects).

Methods

Defoliation is assessed in 5% steps. These classes are 0, 5 (>0-5%), 10 (>5-10%) and so on. Trees should be reported in these 5% classes and not in aggregated groupings.

A tree with >95% and up to 100% defoliation, which is still alive, is coded as "99". The code "100" is reserved for dead trees.

Hint: If the above-ground parts of a tree die (e.g. after a forest fire), the tree is classified as dead. The above-ground parts of the tree are considered dead, if the phloem and xylem is dead. Note that dormant buds may continue to flush for one or more seasons on cut logs, indicating that the tissues may remain alive for some time after some people might consider them as dead. Regrowth from the roots is excluded until the shoots attain the requirements for inclusion in the assessments. Although biologically inappropriate, for practical reasons regrowth from the base of the trees should be classified as new stems with new crowns.

The reference tree can be either a healthy tree in the vicinity (of the same crown type), a photograph locally applicable, representing a tree with full foliage or a conceptual (imaginary) tree.

Note: The concept of the reference tree is one of the most controversial issues in the monitoring programme, yet it is crucial for to the assessments. Two different types of reference trees are recognised: local reference trees and absolute reference trees. Use of absolute reference trees may lead to higher defoliation estimates than the application of local reference trees, but the results are perhaps more amenable to temporal and spatial analyses. Most countries have adopted local reference trees as standards. This local reference takes into account the build-up and the development stage of the tree.

A local reference tree or a conceptual (imaginary) tree is defined here as the best tree with full foliage that could grow at a particular site, taking into account factors such as altitude, latitude, tree age, site conditions and social status. It has 0% defoliation. This tree should represent the typical crown morphology and age of trees in the plot. Absolute reference trees are the best possible trees of a genotype or species, regardless of site conditions, tree age, etc. A number of photo guides exist which provide guidelines on absolute reference trees in different parts of Europe.

5.2.6 Foliage transparency

Definition

Foliage transparency is defined as the additional amount of skylight visible through the crown compared to the amount of skylight visible through a fully foliated crown.

Method

Estimate foliage transparency in 5% classes based on the live, normally foliated portion of the crown and branches using the transparency diagram in Fig. IV 4. Dead branches, crown dieback and missing branches where foliage is expected to be missing are deleted from the estimate (Fig. IV 5).

Large uniform crowns are scored as if the whole crown should be foliated. When defoliation is severe, branches alone will screen the light, but the surveyors should exclude the branches from the foliage and rate the area as if light was penetrating. For example, an almost completely defoliated dense spruce may have less than 20% light coming through the crown, but it will be scored as highly transparent because of the missing foliage. Old trees, and some broad-leaved species, have crown characteristics with densely foliated branches which are spaced far apart in the crown. These spaces between branches should not be included in the foliage transparency score. When foliage transparency in one part of the crown differs from another part, the average foliage transparency is estimated and recorded.

Hint: The easiest way to assess foliage transparency is first to mentally draw a two-dimensional crown outline. Then block the foliated area into the crown outline. Lastly, estimate the transparency of this foliated area.

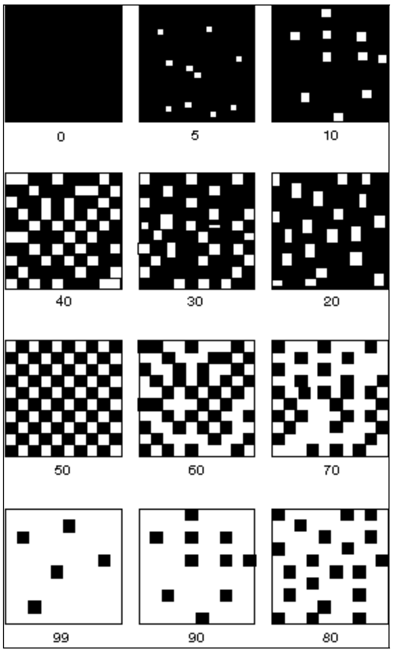

Fig. IV 4: Guide to estimating transparency (derived from Tallent-Halsell, 1994).

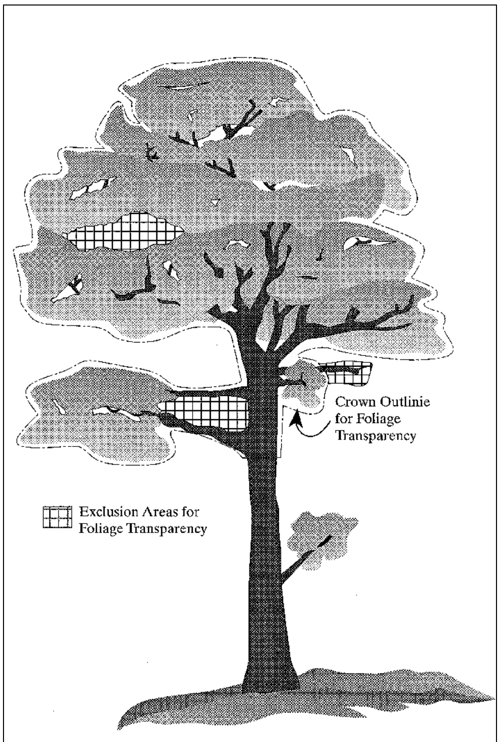

Fig. IV 5: Crown outline to be taken into account when estimating foliage transparency. Note the areas to be excluded from the estimates. This is a free standing tree, therefore the assessable crown covers a rather large area (derived from Tallent-Hassel 1994). Hint: Stem and dead branches have to be deleted from the estimate as well.

5.2.7 Flowering

Flowering is linked to phenology observations (see: Part VI Tree phenology).

Definition

This score is defined as the estimation of (current) flowering in the crown.
Flowering is a precondition for natural regeneration, may affect defoliation scores and is of interest because of it´s effects on the carbon balance of the tree.

Method

Two assessments are made: (i) in the assessable part of the crown and (ii) in the whole crown. Respective codes are listed in the explanatory items of the forms document available under www.icp-forests.org/Manual.htm.

- Absent or scarce. The flowers are not seen in a cursory examination.
- Common. Flowering effect is clearly visible.
- Abundant. Flowering dominates the appearance of the tree.

Hint: In some species, such as Pinus and Larix, the flowers will probably have been dropped by the time of assessment. Scoring is based on the gaps along the shoots where the flowers formerly were.

Hint: Some species produce large amounts of green tissues associated with the flowers (e.g. *Carpinus betulus* and *Fraxinus excelsior*). These tissues contain chlorophyll and contribute to the carbon budget of the tree. It is recommended that such tissues are included with the foliage mass when assessing defoliation. As fruiting in such species remains relatively constant from year to year, annual changes in fruiting will not significantly affect the defoliation estimates.

5.2.8 Fruiting

Definition

Fruiting is defined as annual seed production of trees in the assessable crown. Only the fruit of the respective assessment year is to be considered.
Spruce: cones greenish to magenta, at end of shoots, scales close to the cone.

Pine: only green cones

Annual seed production of trees with heavy seeds such as beech can cause considerable changes in internal cycles. Annual seed production may cause a significant change in allocation of carbon, nutrients and energy from leaves and stem growth to generative structures. This is an important criterion for tree vitality.

Respective codes are listed in the explanatory items of the forms document available under www.icp-forests.org/Manual.htm.

- absent: Fructification is absent or inconsiderable. Even reasonably lengthy observation of the crown with binoculars yields no signs of fruiting.
- scarce: Sporadic occurrence of fruiting, not noticeable at first sight. It must be looked for on purpose with binoculars.
- common: Fructification is such that it can be observed with the naked eye. The appearance of the tree is influenced but not dominated by fructification.
- abundant: Fructification is obvious and immediately meets the eye, determines the tree's appearance.

5.2.9 Apical shoot architecture (*Fagus sylvatica*)

Application and Definition

Apical shoot architecture is defined as assessment of growth patterns of the topmost twigs of crown of *Fagus sylvatica*.

The beech architecture model allows recognising vitality anomalies in time series. From a distance apical shoot architecture indicates typical growth patterns, which can be assessed using binoculars.

Methods

Only the topmost twigs of a beech's crown are suitable for assessment of the apical shoot architecture. If there is a good visibility on top of the sample trees, it can be assessed during summer assessment. It is recommended to derive a concluding estimation by using the weighted value of three observation values, e.g. using a clockwise pattern at 11 hrs, 12 hrs and 13 hrs in the very top part of beech crowns. If there is only a limited view on the top of trees for example in dense stands, it is recommended to carry out the assessment in the off-growing season.

The assessment is recommended (mandatory for *Fagus sylvatica* on core plots) once every 3 years, starting in 2010.

1 Exploratory phase: Apical shoots and upper side buds form long shoots. Flat, longitudinal, expansive shoot development.

Fig. IV 6: Exploratory phase (right: drawing by ROLOFF, 2001)

2 Intermediary form between 1 and 3: In crowns representing code 2 the assessment detects as well shoots in exploratory phase as shoots in degeneration phase.

3 Degeneration phase: Only apical bud forms a long shoot. Shoots of side buds are stunted. Spear-shaped development of main shoots with reduced side shoot formation "spear-shaped".

Fig. IV 7: Spear-shaped degeneration phase (right: drawing by ROLOFF, 2001)

4 Intermediary form between 3 and 5

Fig. IV 8: Intermediary form 3/5

5 Stagnation phase: Stunted long shoots, claw-like appearance because of pluriannual short shoot chains.

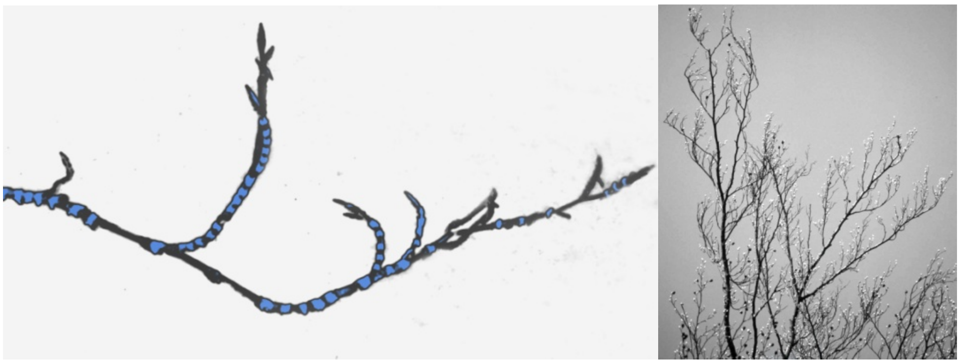

Fig. IV 9: Stagnation phase

6 Intermediary form between 5 and 7

Fig. IV 10: Intermediary form 5/7

7 Resignation phase: Dieback of twigs of the topmost part of the crown or even the whole crown itself.

8 Regeneration phase. Phase with obvious regeneration: From worse phase to a better form on the same branch.

Hint: The codes have a new definition here. The assessment must be clearly distinguished from the coding used in the previous ICP Forests manual. This is done by the use of the new Beech parameter <apical shoot architecture>, the old beech codes for parameter <crown form> (5.2.10) are not longer valid.

5.2.10 Crown form/morphology (*Picea spp., Pinus sylvestris*)

Definition

Crown form is defined as the appearance of the crown. It may be influenced by crown shape and/or by branch habit.

Crown form provides supplementary information about the condition of a tree. In many cases, crown form changes through time. The premature development of such changes often indicates the action of one or more types of stress. However, the separation of stress- and genetically-induced changes is often difficult.

Methods

For *Picea* species the following crown forms can be specified (Fig. IV-11). Respective codes are listed in the explanatory items of the forms document available under www.icp-forests.org/Manual.htm.

- comb
- brush
- plate
- mix

For *Pinus sylvestris* the following crown forms can be specified

- pine, vigorous apical dominance with tree growing strongly upwards
- pine, reduced or no apical dominance with crown showing signs of widening
- pine, as 32, but lower branches being lost through suppression
- platform developing, with dominant growth direction no longer upwards
- platform fully developed, no vertical growth
- other (specify)

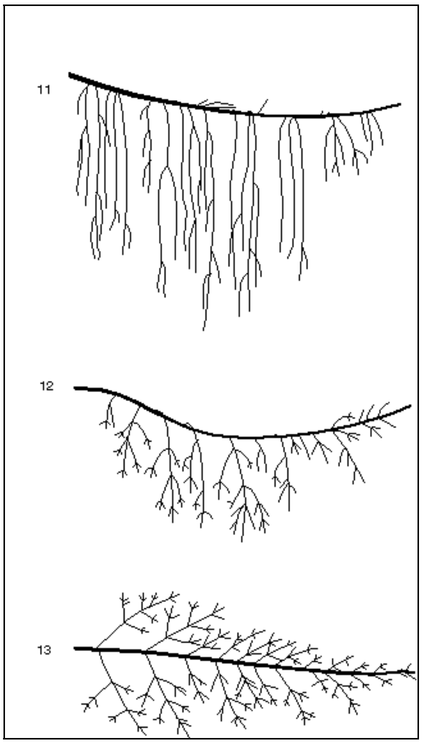

Fig. IV-11: Crown form in *Picea* spp.: 11 Comb; 12 Brush; 13 Plate.

5.2.11 Removals and mortality

Definition

Removals are trees that for some reason are not included in the sample of assessed trees. Mortality refers to sample trees which have died. A tree is defined as dead if all conductive tissues in the stem(s) have died.

Trees may have to be withdrawn or eliminated from sampling for several reasons. It is important to record this information so that the causes of changes in the numbers of assessment trees in each plot can be assessed and annual mortality rates can be derived.

If a tree has died, the cause must be determined (if possible). Standing dead trees (classes 31–39) of Kraft classes 1–3 should be assessed for defoliation and other parameters only during first assessment after their death. When they have fallen or have been removed the standing dead tree is replaced by a new sample tree in case of a sampling design which is not area related.

Method

The yearly state of removals and mortality covers the assessment or derivation of an annual mortality rate. The following classification has to be used. Respective codes are listed in the explanatory items of the forms document available under www.icp-forests.org/Manual.htm.

- tree alive, in current and previous inventory
- new alive tree (ingrowth)
- alive tree (present but not assessed in previous inventory)

Tree is not in sample or at least no data are available for this tree in the submitted year:

- alive tree but tree not longer in growth/crown sample due to heavy disturbances (e.g. heavy storm damage); may be assessed and data submitted
- no info on this tree with this submission (e.g. tree forgotten during field work)
- alive tree but due to alternating tree selection not in submitted sample

Tree has been cut and removed, only its stump has been left

- planned utilization, e.g. thinning
- utilization for biotic reasons, e.g. insect damage
- utilization for abiotic reasons, e.g. windthrow
- cut, reason unknown
- reason for disappearance unknown
- reason for disappearance not determined/observed

Tree is still standing and alive, but crown condition parameters are no longer assessed

- lop-sided or hanging tree
- heavy crown break (over 50% of the crown) or broken stem (only applicable in those countries that do not record trees with more than 50% crown damage).
- tree is no longer in Kraft classes 1, 2 or 3 (not applicable to the first inventory in a plot, only applicable to those countries that restrict sampling to Kraft classes 1, 2 and 3).
- other reasons (specify)

Standing dead tree

- biotic reasons, e.g. bark beetle attack
- abiotic reasons, e.g. drought, lightning
- unknown cause of death
- cause was not determined/observed

Trees that have fallen (living or dead)

- abiotic reasons (e.g. storm)
- biotic reasons (e.g. beavers)
- unknown cause
- cause was not determined/observed

This classification allows for reporting the reason why a tree has died or has been removed in broad categories only (e.g. biotic/abiotic reasons). If more details are available, e.g. the exact cause of mortality of a tree was determined, this shall be reported by using the codes of the guidelines on assessment of damage causes. This can be either a numeric code (e.g. 220 for Bark beetles) or even a letter code for the scientific name of the agent involved (e.g. HETEANN for *Heterobasidion annosum*).

Note: Mortality and the number of dead trees present in a plot are two different issues. Annual mortality can be calculated from the number of living trees that are dead the following year. The total number of dead trees in a plot at any one time provides no information on mortality rates, but provides information on the condition of a stand in the year of assessment.

Note: If trees in the plot have not been mapped, there may be some difficulty in identifying the fate of individual trees that have disappeared between surveys.

5.2.12 Stand age and tree age

Definition

Stand age is defined as the mean age of the dominant storey.

Definition

Tree age is defined as tree specific age of sample trees.

Different age of sample trees has been shown to be one of the main causes for differing results in defoliation estimations in various European countries. Studies show, that even rough age estimations help to explain a substantial amount of defoliation variability.

Even if assessment accuracy is expected to be low in most cases, the submission of tree specific age should help for a better understanding of stand structure during data evaluations.

Method

Stand age is reported in 20 year classes. Respective codes are listed in the explanatory items of the forms document available under www.icp-forests.org/Manual.htm.

Hint: The stand age information is needed in Manual Part IV to ensure the best possible link to crown condition sample trees and plots.

Tree age is reported in 20 year classes. Respective codes are listed in the explanatory items of the forms document available under www.icp-forests.org/Manual.htm.

For core plots, tree age must be specified for all sample trees of a plot. The best exact method should be used and described, indicating also the uncertainties of this method.

The method defines two new fields in a tree specific table:

Tree age is to be specified in quality codes of determination. Respective codes are listed in the explanatory items of the forms document available under www.icp-forests.org/Manual.htm.

- assured dates of stand establishment
- tree stumps
- age determination of the lowermost twigs (add estimated time it has taken to grow to that height)

- increment borer, stem discs (from similar sized trees/median sized trees) outside the plot
- assessment (impossible in most cases)
- estimation without any exact information

5.2.13 Secondary shoots and epicormics

Definition

Secondary shoots and epicormics are used synonymously and are defined as shoots that have developed from dormant buds on the stem or on branches. In some cases, old epicormics can be difficult to separate from branches.

In some species, the development of secondary shoots is the normal part of crown formation. For example, in Picea abies, secondary shoots develop along the main branches to replace older shoots that have lost their needles. In other species, particularly broadleaves, the development of epicormic shoots in the crown and on the stem may reflect increased levels of light penetration through the foliage of the outer crown.

Scoring of the presence of shoots reveals whether the tree is responding to loss of foliage and thus the regenerative capacity of the tree. For example, a heavily defoliated Picea abies that has no secondary shoots is indicative of a tree under extreme stress.

Methods

Separate assessments are made of the frequency (3 classes) of epicormics in the assessable crown and on the stem. The assessment must include all epicormics, not only the ones of the current year. Scoring is in three classes. Respective codes are listed in the explanatory items of the forms document available under www.icp-forests.org/Manual.htm.

- None or rare
- Medium: light development or only present in parts of the crown or stem
- Abundant: present throughout the majority of the crown or all over the stem

5.3 Variables for Damaging Agents

The assessment of damage causes consists of 3 major parts:

- symptom description
- determination of the cause
- quantification of symptoms (extent)

5.3.1 Symptom description

“Describe what you see” could be a summary of the aims of the symptom description: it indicates which part of the tree is affected and the type of symptom it shows. It is an essential step for diagnosis of the causal agent and for the study of cause-effect mechanisms. However this does not mean that every symptom observed has to be reported. The symptom description should focus on important factors which may influence the condition of the tree. See also National lists.

The symptom description specifies the presence of damage symptoms. It does not deal with the extent of the damage. For quantification see section 5.3.3.

In principle the symptom description is restricted to causal agents or factors which may influence crown condition (defoliation, discoloration). However this does not mean that the symptom description is restricted to symptoms observed on the foliage: damage to the branches or the stem (e.g. bark beetle attack) often results in defoliation but its contribution in the defoliation score may be very difficult to assess. Therefore the symptom description should cover all parts of the tree.

In the symptom description, the whole tree i.e. stem, collar and the total crown (which may be different from the assessable crown) should be taken into account. This is important because symptoms that may be recognized outside the assessable crown may indicate the start of a process which may affect the assessable crown at a later stage (e.g. Peridermium pini infection in Pinus).

5.3.1.1 Affected part of the tree and location in crown

Three main categories are distinguished for indicating the affected part of the tree: (a) leaves/needles; (b) branches, shoots & buds; (c) stem & collar. For each affected part further specification is required, which is important for diagnostic purposes. For this more detailed description, the categories used in other parts of the crown manual are applied. A separate code allows for reporting also the location in the crown. This may provide further valuable information for the diagnosis. Respective codes are listed in the explanatory items of the forms document available under www.icp-forests.org/Manual.htm.

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

Tab. IV-2: Affected parts of a tree and location in crown

Special cases:

The following codes for special cases shall be reported in the column for 'specification of affected part' of the tree:

- Dead trees:

Dead trees should be reported using code 04. Defoliation score of this tree is "100". The cause of death should be reported in the column for the causal agent / factor. The death is reported in the first year when it is observed. In general, no information is submitted in the succeeding years. Only in case that in the succeeding years the reason – i.e. a biotic damage – may be found to be the reason for the tree's dying, this damage should be submitted with the respective forms.

- No symptoms at all are observed on any part of the tree (no further damage parameters are assessed or submitted):

In order to avoid that the observers have to report that there are no symptoms on the foliage, nor at the branches and the stem, this case should be reported using code 00.

- No assessment of damage causes was made (no other damage parameters are assessed or submitted)

Report code 09 in the column for specification of affected part.

5.3.1.2 Symptoms and their specification

Symptoms are grouped into broad categories like wounds, deformations, necrosis etc. A separate code (specification of symptom) allows for a more detailed description. Nests of caterpillars, fungal fruit bodies etc. are not considered as symptoms but are defined as 'signs' of insects, fungi, etc. Their presence provides valuable information for diagnostic purposes and should be reported. If signs of insects or fungi are observed it is important to report also the observed damage symptoms.

An overview of symptoms, specifications and codes is given in Tab. IV-3. For the field teams this table provides a complete overview of the section on symptom description, including the codes for reporting. Each code for <symptom/sign specification> is used only for the specified combination of <affected part> and <symptom/sign> on the respective left part of the table. E.g. in case of bronzing leaves (symptom is bronzing, affected part is leaves/needles) only symptom specification 37 to 44 are used.

Affected part	Symptom / sign (mandatory Level I and Level II)	Code	Symptom/sign specification (optional Level I, mandatory Level II)	Code
Leaves/needles	Partly or totally devoured/missing	01	holes or partly devoured/missing notches (leaf/needle margins affected) totally devoured/missing skeletonised mined Premature falling	31 32 33 34 35 36
	Light green to yellow discolouration Red to brown discolouration (incl. necrosis) Bronzing Other colour	02 03 04 05	overall flecking, spots marginal banding interveinal tip, apical partial along veins	37 38 39 40 41 42 43 44
	microfilia (small leaves) other abnormal size	06 07		
	Deformations	08	curling bending rolling stalk twisting folding Galls wilting other deformations	45 46 47 48 49 50 51 52
	other symptom	09		
	Signs of insects	10	black coverage on leaves nest adults, larvae, nymph, pupae, egg masses	53 54 55
	Signs of fungi	11	white coverage on leaves fungal fruiting bodies	56 57
	Other signs	12		
Branches shoots& buds	devoured / missing Broken Dead / dying Abortion / abscission Necrosis (necrotic parts)	01 13 14 15 16		
	Wounds (debarking, cracks etc.)	17	debarking cracks other wounds	58 59 60
	Resin flow (conifers) Slime flux (broadleaves) Decay/rot	18 19 20		
	Deformations	08	wilting bending, drooping, curving cankers tumors whitches broom other deformations	51 61 62 63 64 52
	other symptom	09		
	Signs of insects	10	boring holes, boring dust nest white dots or covers adults, larvae, nymph, pupae, egg masses	65 54 66 55
	Signs of fungi	11	fungal fruiting bodies	57
	Other signs	12		
Stem / collar	Wounds (debarking, cracks etc.)	17	debarking cracks (frost cracks, …) other wounds	58 59 60
	Resin flow (conifers) Slime flux (broadleaves) Decay/rot	18 19 20		
	Deformations	08	cankers tumors Longitudinal ridges (frost ribs, …) other deformations	62 63 68 52
	tilted fallen (with roots) broken Necrosis (necrotic parts)	21 22 13 16		
	other symptom	09		
	Signs of insects	10	boring holes, boring dust white dots or covers adults, larvae, nymph, pupae, egg masses	65 66 55
	Signs of fungi	11	fungal fruiting bodies yellow to orange blisters	57 67
	Other signs	12		

Tab. IV-3: Symptoms/signs and specification of symptoms/signs

Important remarks:

- Table IV-3 aims at giving an overview of the more important symptoms that may occur in trees. The symptom description is mandatory for foliage, branches and stem, but countries are free to select for each affected part the more important symptoms at national level. If a selection is made this should be reported to the international data centre.

In order to reduce the time needed for the symptom description, countries may wish to compose a national standard list with a complete symptom description for well-known and frequently occurring damage factors for their field teams. In this way the surveyor will only have to fill in the name of the causal agent and the quantification of the damage. In the event of damage by a factor which is not on the standard list, the complete symptom description should be made.

Reporting to the international data centre, however, should always include the complete symptom description.

- The categories 'other' (symptom, sign, colour etc.) should be specified in the remarks (<other observations>) column.

- In the event of symptoms of ozone damage the guidelines and forms of the 'Submanual on Ozone injury on European Forest Ecosystems' shall be applied.

Specifications

a. Cause is unknown

If damage symptoms on a tree are observed and the cause is unknown, the symptoms and the extent should be reported nevertheless. However, in the field "cause" the code 999 should be entered. See also (b.) "Avoiding duplication of crown condition assessment".

b. Avoiding duplication of crown condition assessment:

Crown condition assessment in the ICP Forests monitoring programme mainly focuses on defoliation. This symptom is also very important for the assessment of damage causes. In this respect the following rules apply:

- If defoliation of a tree is observed and the cause is unknown, defoliation should only be reported in the crown condition assessment (TRC or TRE, respectively), and should not be reported as a symptom in the damage causes section and form (TRD or TRF, respectively). However, other relevant symptoms observed on the same tree (e.g. dead branches) should be reported.

- If defoliation can partly or totally be attributed to a certain, identified cause(s) (e.g. defoliators), defoliation should be reported in the damage causes section in addition.

c. Necrotic leaves

Necrosis of leaves/needles and its pattern is an important symptom for diagnostic purposes. According to the definition in this manual, discolouration is "any deviation of the usual colour of the living foliage of the considered tree species". Totally brown or necrotic leaves are considered to be dead, hence 'discolouration' does not apply here since this symptom is restricted to living foliage. Thus, totally brown leaves/needles should be considered as defoliation. However, leaves that are only partially necrotic should be reported under 'red to brown discolouration' (symptom code 03).

d. Multiple symptoms

In the event of several symptoms on a tree caused by the same, identified agent/factor, only the main symptom shall be reported.

e. Dead branches

Snags (dead branches which are dead for several years and without side shoots) and dead branches due to competition are excluded from the assessment of dead branches.

In some tree species (e.g. spruce), small dead branches may be a 'normal' phenomenon. This should not be reported except when an abnormal percentage of dead branches is observed.

5.3.1.3 Age of the damage

Recording this parameter helps in detecting new epidemics. Moreover, some injuries, like harvesting scars remain visible for many years.

The age of the damage shall be reported using three classes. Respective codes are listed in the explanatory items of the forms document available under www.icp-forests.org/Manual.htm.

Age of damage	description
fresh	damage that has begun after the last year's inventory
old	damage that has begun earlier
fresh and old	both, fresh and old damage is visible

5.3.2 Causal agents / factors

Determination of the causal agent that is responsible for the observed damage symptoms is crucial for the study of cause-effect mechanisms. The description of symptoms is an important step in the diagnostic process, but damage symptoms on their own do not always provide the explanation for the observed damage. In many cases further examination will be necessary to determine the causal agent.

In case that more than one damaging agents are found on the same tree they should be reported using additional lines in the submission forms (more than one line per tree possible).

In case that damage has to be reported that is caused by a damage factor for which no code is foreseen this should be reported to the PCC of ICP Forests. PCC will take care that a respective code will be defined by the EP and be provided to the NFCs.

Causal agents are grouped into the following categories. Respective codes are listed in the explanatory items of the forms document available under www.icp-forests.org/Manual.htm.

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

Tab. IV-4: Main categories of causal agents / factors

In each category a more detailed determination is possible according to a hierarchical coding system (see Tables 5 – 12). Report the damage cause as detailed as possible, if possible up to species level. E.g. a code 210 for insects is more helpful than a score 200, as in the first case it is specified that the causal agent is a defoliator.

Agent group	Code	Class	Code	Type	Code
Game and grazing	100	Cervidae	110	Roe deer	111
				Red deer	112
				Reindeer	113
				Elk/Moose (*Alces alces*)	114
				Other Cervidae	119
		Suidae	120	Wild boar	121
				Other Suidae	129
		Rodentia	130	Rabbit	131
				Hare	132
				Squirrel etc.	133
				Vole	134
				Beaver	135
				Other Rodentia	139
		Aves	140	Tetraonidae	141
				Corvidae	142
				Picidae	143
				Fringillidae	144
				Other Aves	149
		Domestic animals	150	Cattle	151
				Goats	152
				Sheeps	153
				Other domestic	159
		Other vertebrates	190	Bear	191
				Other vertebrate	199

Tab. IV-5: Codes for agent group 100 (game and grazing)

Agent group	Code	Class	Code	Main species	Code	Affected genus	Symptoms
				CONIFERS			
INSECTS	200	Defoliators	210	*Acantholyda sp.*		*Pinus*	Shelter made of silky threads and frass, on the needles,
				Brachonyx pineti		*Pinus*	Fine spots with a central hole in the needles and presence of small holes in the sheaths
				Brachyderes suturalis		*Pinus*	Devoured needles forming a thick saw edge
				Diprion pini		*Pinus*	Summer defoliations. False caterpillars, greenish with brown - orange head. Eggs in the needle margins and pupas in the soil
				Gelechia senticetella		*Juniperus, Cupressus*	Silky threads in dry twigs
				Lymantria dispar		*Larix, Picea, Pinus*	Devoured needles; caterpillars with long hairs, variable yellow to black coloured with characteristic double row of blue and red spots on the back
				Lymantria monacha		*Pinus*	Eggs disposed in cracks of the bark. Recently born caterpillars disposed in lines in the trunk. Summer defoliations.
				Bupalus piniarius		*Pinus*	
				Choristoneura murinana		*Abies*	
				Cephalcia abietis		*Picea*	
				Cephalcia lariciphila		*Larix*	
				Dendrolimus pini		*Pinus*	
		Stem, branch & twig borers (incl. shoot miners)	220	*Dioryctria sylvestrella*		*Pinus*	Boring hole with resin crumb on the trunk along with sawdust and reddish excrement rests
				Hylobius abietis		*Pinus*	Shallow bites in thin twigs and young pines
				Ips acuminatus		*Pinus*	Star - shaped system of galleries under the bark . Trees damaged situated in sparce close groups. Death of trees in summer.
				Ips sexdentatus		*Pinus*	Star - shaped system of galleries under the bark . Trees damaged situated in close groups. Death of trees in summer. Adult is bigger than the adult Ips sexdentatus
				Ips typographus		*Picea*	Bark beetle, borer, killing red spruce, dangerous for whole forest
				Magdalis sp.		*Pinus*	Punctures in buds and young twigs. Dry and hollow young shoots
				Orthotomicus sp.		*Pinus*	Long star - shaped system of galleries under the bark Adults of very small size.
				Phaenops cyanea		*Pinus*	damage of larvae in part of stem with thick bark, galleries of older larvae with 'cloudy' boring dust; beetle dark blue with green glow
				Pissodes castaneus		*Pinus*	Very small holes with resin drop resina in buds and shoots. Galleries under the bark and pupation chambers with thick wood chips.
				Pityogenes chalcographus		*Picea, Larix, Abies, Pseudotsuga*	
				Pityokteines curvidens		*Abies*	
				Retinia resinella		*Pinus*	Thick and big resin crumb, hollow inside, along with excrements, in small branches and/or buds
				Semanotus laurasi		*Juniperus*	Galleries and pupation chambers in branches and twigs. Reddish small areas disperse in the crown.
				Tomicus destruens		*Pinus*	Dry and hollow apical twigs. Resin crumb in trunk with a hole for entering. Under bark galleries with shape of fish thorns. Death of the trees in spring.
		Bud boring insects	230	*Rhyacionia buoliana*		*Pinus*	Hollow buds and young shoots (bayonet shaped shoots),
				Rhyacionia duplana		*Pinus*	Hollow buds and young shoots (bayonet shaped shoots), along without resin crumbs.
		Fruit boring insects	240	*Dioryctria mendacella*		*Pinus*	Irregular shaped boring holes filled with resin in the fruit (pine cones). Presence of galleries with excrements and silky threads.
				Pissodes validirostris		*Pinus*	Round and clean boring holes in the pine cones. Egg - layings are covered with a dark stopper and disposed in the pine cone scales
		Suking insects	250	*Haematoloma dorsatum*		*Pinus, Juniperus*	Eggs - laying in shape of a "spit" over grasses. Reddened needles.
				Leucaspis pini		*Pinus*	Adults with eliptic white bodies (like white scales stucked to the needles).
				Matsucoccus sp.		*Pinus*	Breakage and formation of scales in stems. Adults with eliptic sessile bodies under the bark.
		Mining insects	260	*Epinotia subsequana*		*Abies*	Brown and curved needle in part of its length, with a boring hole.
		Gallmakers	270				
		Other insects	290				

Tab. IV-6: Codes for agent group 200 (insects): Conifers

				BROADLEAVES			
Agent group	**Code**	**Class**	**Code**	**Main species**	**Code**	**Affected genus**	**Symptoms**
INSECTS	200	**Defoliators** (incl. skeletonizers, leaf rollers etc.)	210	*Abraxas pantaria*		*Fraxinus*	It attacks leaves during the summer. Caterpillars let themselves down from the crown by means of silky threads
				Agelastica alni		*Alnus*	Leaves are skeletonized and devoured irregularly. Eggs are yellow and the egg - laying is over the leaf.
				Altica quercetorum		*Quercus*	Leaves look brown due to the skeletonizing.
				Epirrita autumnata		*Betula*	leaves devoured
				Galerucela linneola		*Populus, Salix*	Leaves skeletonized with the veins intact and damages in buds. Eggs - layings in the back side of the leaf.
				Gonipterus scutellatus		*Eucalyptus*	Leaves devoured, with margins looking as narrow and deep saw teeth
				Leucoma salicis		*Populus, Salix, Betula*	White eggs - layings in trunks and branches.
				Lymantria dispar		*Quercus*	Attacks the current year leaves and in extreme cases also the older ones. Eggs - laying look like yellow mass and are
				Archips xylosteana		*Quercus*	Attacks the tip of the current year shoots. Shelter is made with young leaves tied toghether by means of silk threads.
				Lymantria monacha		*Quercus, Fagus, Betula u.a.*	
				Melolontha spec.		*Quercus u.a.*	
				Operophthera brumata		*Quercus*	
				Operophthera fagata		*Fagus*	
				Thaumetopoea processionea		*Quercus*	
				Melasoma populi = Chrysomela populi		*Populus, Salix*	Leaves devoured starting from the margins and /or in holes. Orange eggs - laying over the leaf. Very typical larvae (easy to recognise)
				Tortrix viridana		*Quercus*	Attacks the current year shoot tips. Makes a shelter with young leaves tied toghether by means of silky threads. Greenish caterpillar, they let themseves down by means of silky threads.
				Xanthogaleruca luteola		*Ulmus*	Leaves look brown due to skeletonizing.
		Stem, branch & twig borers (incl. shoot miners)	220	*Agrilus grandiceps*		*Quercus*	Death of thin twigs as it is a twig girdler - galleries . Circular exit holes
				Cerambyx sp.		*Quercus*	Big eliptic holes at the base of the trunk and thick branches through which sawdust flows. Big sized galleries
				Coroebus florentinus		*Quercus*	Death of small and median sized branches. Death of twigs due to twid girdling (galleries) Tha damage looks like red flashes distributed all along the crown
				Agrilus biguttatus		*Quercus*	
				Agrilus viridis		*Fagus*	
				Crematogaster scutellaris		*Quercus*	Great number of small holes in the cork. Ants.
				Cryptorrhynchus lapathi		*Populus, Salix*	Circular holes in the trunk trough which small wood chips flow. Superficial girdling damages.
				Melanophila picta		*Populus*	Debarking and eliptic holes with a compact dark brown coloured detritus at the base of the trunk.
				Paranthrene tabaniformis		*Populus, Salix*	Circular holes in the trunk through which flows round wood chips Rests of the chrysalis in the hole. Affects to young
				Phoracantha semipunctata		*Eucalyptus*	Eliptic holes in the trunk. Wide galleries under the bark.
				Platipus cylindrus		*Quercus*	Circular holes in the trunk through wich flows sawdust , which is acumulated at the base of the trunk.
				Sesia apiformis		*Populus, Salix*	Circular holes at the base of the trunk and chrysalid cocoons made of sawdust. Affects to trees of more than 10 - 15 centimetres of dbh
		Bud boring insects	230				
		Fruit boring insects	240	*Curculio glandium*		*Quercus*	Boring holes in the acorns
		Sucking insects	250	*Ctenaritaina eucalypti*		*Eucalyptus*	Small aphids over young shoots. Bent shoots and sap
				Kermes sp.		*Quercus*	Spherical bodies covered by a brilliant black reddish wax cover, situated in the stalks insertion areas of leaves, buds
		Mining insects	260	*Rhynchaenus fagi*		*Fagus*	Many small holes in the leaf, it mines the leaf starting from the central vein to the margins
		Gallmakers	270	*Cynips tozae*		*Quercus*	Big spherical greyish - brown galls with a crown of teeth on the top, in small branches or twigs.
				Dryomyia		*Quercus*	Hemispheric or irregular shaped swellings at the back side
				Eriophyes ilicis		*Quercus*	Areas with abundant reddish brown hair at the back side of the leaf
				Mikiola fagi		*Fagus*	Small pink galls with a shape like waters drops, on the leaf
		Other insects	290				

Tab. IV-7: Codes for agent group 200 (insects): Broadleaves

Agent	Code	Class	Code	Main species	Code	Affected genus	Symptoms
				CONIFERS			
FUNGI	300	Needle casts and needle-rust fungi	301	*Lophodermium pini = Leptostroma pinostri*		*Pinus*	Long brilliant black carpophores located on the upper needle surface
				Cyclaneusma minus = Naemacyclus minor		*Pinus (Sylvestris, radiata)*	Formation of traverse reddish brown stripes (banding) and presence of elliptic carpophores (ligth brown or the same colour than the needle)
				Phaeocryptopus gaeumannii		*Pseudotsuga*	
				Rhabdocline pseudotsugae		*Pseudotsuga*	
				Mycosphaerella laricina		*Larix*	
				Naemacyclus nivens		*Pinus*	Ligth coloured carpophores. When they come off, they leave holes in the needles.
				Thyriopsis halepensis		*Pinus*	Needles with circular black carpophores with brown centre.
				Mycospherella pini = Dothistroma septospora		*Pinus (radiata, nigra, halepensis)*	It is the so called "red banding" in needles
				Chrysomyxa abietis		*Picea*	yellow to orange-brown spots on needles which fall prematurely
		Stem and shoot rusts	302	*Melampsora pinitorqua*		*Pinus*	Shoots are curved in shape of "C" or "S". To complete its biological cycle needs host trees pertaining to Populus and/or Pinus genus
				Cronartium ribicola		*Pinus strobus*	
				Coleosporium tussilaginis = Coleosporium senecionis		*Pinus*	"Blister rust" of the needles. Blisters are orange when full and white when empty.
				Cronartium flaccidum = Peridermium pini		*Pinus*	"Blister rust" of the bark. Girdling of the branches or trunk with abundant resin flows. Blisters are orange when full and white when empty.
		Dieback and canker fungi	309	*Gremmeniela abietina*		*Pinus*	Death of branches and buds with black carpophores over the bark. When it ripens pink pendants with conidia go out.
				Cenangium ferruginosum		*Pinus*	Death of branches and buds. Black carpophores over the bark
		Blight	303	*Shaeropsis sapinea = Diplodia pinea*		*Pinus*	Side shoots are curved, presenting deformations, resin flows and black carpophores.
				Sirococcus conigenus		*Pinus (halepensis)*	Death of shoots and reddish brown hanging needles.
		Decay & root rot fungi	304	*Fomes pini = Trametes pini*		*Pinus*	Flat woody carpophores with "horse hoofs" shape, greyish brown
				Amillaria mellea		*many tree species*	White leather cover visible when debarking roots and root collar, goes up. Forms honey coloured mushrooms with foot, in small groups
				Heterobasidion annosum		*Abies, Pinus, Picea, Larix, Pseudotsuga*	White leather cover but less dense than the one from Armillaria visible when debarking the root or root collar. Mushrooms are greyish brown with white margins and they are stuck to the root collar surface
		Other fungi	390				
				BROADLEAVES			
Agent	**Code**	**Class**	**Code**	**Main species**	**Code**	**Affected genus**	**Symptoms**
FUNGI	300	Leaf Spot fungi	305	*Drepanopeziza punctiformis = marssonina brunea*		*Populus, Salix*	Small round spots, with brown margins and greyish white centre.
				Rhytisma spp		*Salix, Acer*	Big black irregularly- shaped scabby spots
				Taphrina aurea		*Populus*	Yellowish swellings or bumps
				Mycosphaerella maculiformis		*Castanea*	Chestnut rust. Reddish brown dots distributed all along the leaf
				Septoria populi		*Populus*	Grey spots limited by a necrotic margin
				Harknessia eucalypti		*Eucalyptus*	Reddish brown irregular spots
				Mycosphaerella eucalypti		*Eucalyptus*	Red spots
		Anthracnose	306	*Apiognomonia spp.*		*Quercus, Juglans*	Affects to the veins
		Powdery mildew	307	*Uncinula spp.*		*Populus, Salix,*	Greyish white powder over buds and/or leaves (oidium)
				Microsphaera alphitoides		*Quercus*	White powder over the leaves (oidium)
		Wilt	308	*Ophiostoma novo - ulmi*		*Ulmus*	Shoots and buds wilt, when cutting the buds and thin branches you can see a necrotic ring which corresponds to the vascular collapsing
				Ceratocystis fagacearum		*Quercus*	
				Venturia populina = Pollaccia elegans		*Populus*	leaves are brown coloured and curved by the stalk
		Rust	302	*Mellampsora allii - populina*		*Populus*	Yellow to orange dots in the back side of the leaf
				Melampsoridium betulinum		*Betula*	rapidly multiplying small spots on leaves which fall prematurely
		Blight	303	*Botryosphaeria stevensii = Diplodia mutila*		*Quercus*	Dry and curved shoots (dieback) with necrosed bark and longitudinal cracks where the carpophores appear
				Hypoxilon mediterraneum		*Quercus*	The bark comes off, showing plates, in trunk and branches
				Fusicoccum quercus		*Quercus*	
				Dothichiza populea		*Populus*	Black carpophores in buds and branches bark
		Canker	309	*Cryphonectria parasitica = Endothiella parasitica*		*Castanea*	Yellowish leather cover (triangle shaped) under the cracks of the bark
				Pezicula cinnamomea		*Quercus*	
				Stereum rugosum		*Quercus, Fagus*	
				Cytospora crysosperma= valsa sordida		*Populus*	Orange carpophores over the bark
				Nectria spp.		*Quercus*	Red carpophores under the bark cracks
		Decay & Root rot	304	*Fomes fomentarius*		*Fagus*	Flat woody carpophores with a "horse hoofs" shape. The upper part has a concentric flat area greyish brown coloured
				Ganoderma applanatum		*Fagus*	Flat woody carpophores with a "horse hoofs" shape. The upper part is covered by a reddish brown powder
				Ungulina marginata		*Fagus*	Flat woody carpophores with a "horse hoofs" shape. The upper part is reddish brown with yellowish margins and the bottom part is yellowish.
				Amillaria mellea		*many tree species*	
				Phytophthora spec.		*Alnus, Castanea, Quercus, Betula, Fagus*	Black spot with jagged margins under the bark and blackish flows
		Deformations	310	*Taphrina kruchii*		*Quercus*	Witches broom, with many buds presenting chlorotic and abnoramlly small sized leaves
		Other fungi	390				

Tab. IV-8: Codes for agent group 300 (fungi)

				CONIFERS/BROADLEAVES				
Agent group	Code	Class	Code	Type	Code	Specific factor	Code	Symptoms
ABIOTIC	400	Chemical factors	410	Nutritional disorders-nutrient deficiencies	411	Cu - deficiency	41101	
						Fe - deficiency	41102	
						Mg - deficiency	41103	
						Mn - deficiency	41104	
						K - deficiency	41105	
						N - deficiency	41106	
						B-deficiency	41107	
						Mn - toxicity	41108	
						Other	41109	
				marine salt + surfactants	412			
		Physical factors	420	Avalanche	421			
				Drought	422			
				Flooding /High water	423			
				Frost	424	Winter frost	42401	
						Late frost	42402	
				Hail	425			
				Heat /Sun scald	426			
				Ligthning	427			
				Mud/ land slide	429			
				Snow /Ice	430			
				Wind/ Tornado	431			
				Winter injury - winter desiccation	432			
				Shallow/ poor soil	433			
				Rock fall	434			
		Other abiotic factor	490					

Tab. IV-9: Codes for the agent group 400 (abiotic factors).

Agent group	Code	Class	Code	Type	Code	Symptoms
Direct action of men	500	Imbedded objects	510			
		Improper planting technique	520			
		Land use conversion	530			
		Silvicultural operations or forest harvesting	540	Cuts	541	
				Pruning	542	
				Resin tapping	543	
				Cork stripping	544	
				Silvicultural operations in close trees and other silvicultural operations	545	
		Mechanical/ vehicle damage	550			
		Road construction	560			
		Soil compaction	570			
		Improper use of chemicals	580	Pesticides	546, 581	
				Deicing salt	547, 582	
		Other direct action of men	590			

Tab. IV-10: Codes for the agent group 500 (direct action of man).

Agent group	Code	Class	Code
Atmospheric pollutants	700	SO_2	701
		H_2S	702
		O_3	703
		PAN	704
		F	705
		HF	706
		Other	790

Tab. IV-11: Codes for the agent group 700 (atmospheric pollutants).

Agent group	Code	Class	Code	Species/Type	Code	Affected genus	Symptoms
Other	800	Parasitic/Epiphytic/Climbing plants	810	*Viscum album*	81001	*Pinus*	
				Arceuthobium oxycedri	81002	*Juniperus*	
				Hedera helix	81003	*All sps*	
				Lonicera sp	81004	*All sps*	
				Clematis sp	81005	*All sps*	
		Bacteria	820	*Bacillus vuilemini*	82001	*Pinus halepensis*	Swellings of different sizes in branches and branchlets
				Brenneria quercinea	82002	*Quercus*	Slime flux in fruits
		Virus	830				
		Nematodes	840	*Bursaphelenchus xylophilus*	84001	*Pinus*	fast reddening of the crown and sudden death of the tree
		Competition	850	Lack of ligth	85001		
				Physical interactions	85002		
				Competition in general (density)	85003		
				Other	85004		
		Somatic mutations	860				
		Mites	870	*Eriophyes ilicis*	87001	Quercus	Areas with abundant reddish brown hair at the back side of the leaf
		Other (known cause but not included in the list)	890				

Tab. IV-12: Codes for the agent group 800 (other).

5.3.2.1 Scientific name of cause

If the organism involved can be identified, the scientific name must be reported, using the codes of 7 letters. As a general rule the codes consist of the first 4 letters of the Genus name, followed by the first 3 letters of the species name (e.g. Lophodermium seditiosum = LOPHSED). If the Genus name has only 3 letters, these are followed by the first 4 letters of the species name (e.g. Ips typographus = IPSTYPO). Codes for the most common damaging species are listed in the internet file http://www.icp-forests.org/WGbiotic.htm >> click on annex 3. This table also provides information on synonyms and tree species on which the damaging agents occur most frequently. If no code for the identified species can be found in this table, please inform the data centre of PCC which will in cooperation with the Working Group on Biotic Damage amend the list and make it available to the NFCs. The most recent version of the damaging species list can be found at the above mentioned URL.

The following sources of information facilitate the diagnosis for the field observers to

- Tables 5 – 12 specify the coding system for damaging agents. Especially the sheets on insects and fungi provide information about specific symptoms caused by a selection of relevant organisms.
- http://www.icp-forests.org/WGbiotic.htm >> click on Annex 3, provides codes for the scientific names of causal agents.
- http://www.icp-forests.org/WGbiotic.htm >> click on Annex 4, provides examples, descriptions and photographs of damage caused by important categories of insects and fungi.
- http://www.icp-forests.org/WGbiotic.htm >> click on Annex 5, provides a key with symptoms linked to frequently occurring damage causes. However keep in mind that these are possible damage causes, other factors may cause similar symptoms. Diagnosis should always be confirmed by an expert phytopathologist (whenever possible).

Important remark

The tables IV 4 – 12 give an overview of some important damaging factors in Europe. At national level however, important factors may be missing, while others may be less important. Therefore countries may wish to compose their own national list of damaging agents/factors and classify these according to the groups and classes of the manual. Reporting to the international data centre should always be done according to the categories and codes of the manual.

5.3.3 Quantification

For foliage and branches quantification of symptoms is referring to the assessable crown.

5.3.4 Extent

The **extent** of the damage indicates the portion (%) of affected leaves/needles, branches or stem due to the action of the causal agent or factor. Damage to the branches is expressed as percentage of affected branches, damage to the stem as percentage of the stem circumference.

The extent of **symptoms** reflecting defoliation (e.g. leaf damage by defoliators) indicates the percentage of the leaf area which is lost due to the action of the agent/factor concerned. This means that the extent should take into account not only the percentage of affected leaves, but also the 'intensity' of the damage on leaf level: physiologically it makes a difference for a tree if 30 % of its leaves show only some small holes or if 30 % of its leaves are totally devoured.

The affected **leaf area** is expressed as a percentage of the actual foliage in the assessable crown at the time of observation.

Examples:

- Crown condition assessment results in a total defoliation score of 40 % (including defoliation by identified causes like defoliators). 20 % of the leaves in the assessable crown are totally devoured by defoliators → extent of defoliator damage = 20 % (class 2 – see Table IV-13);
- Crown condition assessment results in a total defoliation score of 40 % (including defoliation by identified causes like defoliators). 20 % of the leaves in the assessable crown are partly devoured by defoliators → extent of defoliator damage is e.g. 10 % (in any case < 20 % since the affected leaves are only partially devoured).

Extent classes

The damage extent will be reported in seven classes. Respective codes are listed in the explanatory items of the forms document available under www.icp-forests.org/Manual.htm.

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

Tab. IV-13: Damage extent classes.

Countries using different classes (e.g. 5%) should report their results according to the classes as above.

Specifications:

a.) Damage to the stem is expressed as a percentage of the stem circumference according to the classes as above.

b.) Signs of insects and fungi which are not observed on affected part needles/leaves and the symptoms 'tilted tree' and 'fallen tree' should not be quantified.

c.) When two or more similar symptoms caused by different agents/factors occur on the same part of the tree, it may be extremely difficult to assess the respective contributions of the agents/factors in the damage extent. In this case only the overall extent and the different factors involved should be reported.

d.) Assessments in coppice (and macchia) stands:

- Quantification of stem damage present on different shoots: the damage is expressed as a percentage of the total stem circumference of coppice i.e. the sum of circumferences of each shoot;
- stem damage present on different parts of different shoots (for example cankers present on crown stem in one shoot and on roots & collar in other shoots): for 'specification of affected part' use code 34 (whole trunk); for quantification see above;
- Assessment of a dead shoot(s) with the contemporary presence of other living shoots: by convention the dead shoot(s) shall be recorded as illustrated in the table below. Quantification of the symptom (dead branches of varying size) follows the general rule, thus is expressed as % of affected branches.

N. tree	Specification of affected part	Symptom	Location in crown
1	25	14	4

Coppice shall only be recorded as a dead tree (code 4) when all the shoots are dead.

Note: The symptom description is related to the total crown and the quantification is related to the assessable crown. Therefore it is possible that the presence of damage symptoms is indicated in the symptom description, but that the extent is 0 % if symptoms occurred outside the assessable crown.

6. Reference standard

6.1 Quality Assurance and Quality Control

The scientific value of tree vitality time series underline the need of further efforts to follow up quality assurance and quality control tools in particular in the field of temporal consistancy of data.

6.1.1 Field teams and training

Expertise of field teams, standardised training and field checks on national and international level are the most relevant procedures to guarantee high quality data.

It is recommended that any assessments should be done by a team of two trained observers. All countries should have a designated person who is considered as a national expert on tree condition assessments and who is responsible either for undertaking the assessments or for training teams to make the assessments. It is recommended that the person is familiar with assessments at an international level and should if possible be a member of the National Reference Team in international calibration meetings (International Cross-Comparison Courses).

The knowledge of regional forest ecology, patterns of tree morphology of given species and indicators of biotic and abiotic diseases and phytopathology is needed. Frequent changes of staff should be avoided. Each team or team member has his own ID coordinated by the NFC. All training and control assessment data must contain the surveyors' IDs and date of assessment.

Training of field teams has to be done at national level. Prior to the beginning of the annual field season, survey crews should undergo a period of mainly practical training in measurement and assessment procedures for all relevant tree species, age classes and biotic and abiotic factors. In addition, filling out the various forms should be trained.

Training should be given in the use of the ICP Forests or national manuals. The latter has to be updated (at least for those parameters that are used at an international level) in line with recommendations and updates in the ICP Forests manual.

6.1.2 Plausibility checks

There are two major concepts to understand and document data under field conditions:

a) Calibration courses on international and national level.

Calibration courses offer the option to analyze variation of classes or codes in a sample under given field conditions.

For selected tree species and age classes a large number of trees have to be assessed. It is necessary to include all relevant classes or codes in the calibration course. E.g. regarding defoliation, in the range from 0 % to 100 % at least each 10 % step should be represented in the sample, the number of repetitions per step has to be derived from real variability of data in the field. As, in addition, other parameters than defoliation may be assessed and checked, the minimum number of trees per species in the field check should be 30.

Calibration courses have to be organized on the international and on the national level at regular intervals (at least every second year).

b) Test repetition of 5 % of plots (Level 1) or of 5 % of trees (Level II, Core plots)

Test repetition allows to document if a certain percentage of similar estimations can be achieved in a field survey. It is defined that at minimum 70 % of assessments should vary less than plus/minus 10% (or one class) regarding defoliation (or fruiting) assessments.

	Test repetition	Measurement quality objective	Data Quality Objective
Defoliation	▪ 5 % of plots (Level 1) ▪ 5 % of trees (Level 2, Core plots)	+/- 10 %	70 % of repeated assessments have to be conform with the defined quality frame
Fruiting	▪ 5 % of plots (Level 1) ▪ 5 % of trees (Level 2, Core plots)	+/- one class	70 % of repeated assessments have to be conform with the defined quality frame

Tab. IV-14: Quality limits.

In a first step the Expert Panel on Crown Condition and Damage Assessment agreed in Tampere (2010) to use both measures of mandatory quality assurance for the variables:
"defoliation" and "fruiting" assessment.

6.1.2.1 National quality control

Regular quality field checks have to be included in the training and in the assessment in the field. An independent check survey should remeasure a proportion (at least 5%) of the Level 1 sample plots (5 % of trees at Intensive monitoring and Core plots) assessed by each survey crew. This should be done very close to the actual survey date to avoid differences due to crown development. In case of significant discrepancies, adjustments or clarification of instructions and their application must be arranged immediately to avoid serious systematic errors.

Plausibility checks should also be integrated into the national data analysis system. For defoliation and fruiting assessment, field checks are mandatory. Regarding these parameters, original field check data have to be reported to the data coordinating center. A summary of quality checks together with details of any action that has been taken should be documented for potential evaluations. National Focal Centers are responsible for the quality of national data reported.

6.1.2.2 International quality control

International Calibration Courses (ICCs) are field exercises that aim to (i) document the relative position of individual National Reference Teams (NRTs) within the international context, (ii) monitor the consistency of NRTs' position through time, (iii) improve the traceability of the data by establishing a direct connection with the data collected at national level. Detailed methodology see Annex I.

6.1.3 Documentation and photographs, photo guides

Photo guides are a very helpful tool. All observer teams should be provided with locally applicable, standard photographs of trees of each species and of various defoliation classes.

In addition it is advisable to document and photograph a selection of the trees in different defoliation classes in each area in each year. Photographs should be accompanied by complete assessments of the trees using the relevant forms (PHOT, see below) and should be permanently stored at the appropriate National Focal Centres. It is necessary to document reference trees.

Photo examples of biotic and abiotic factors support the assessment of damages. In addition photo examples of other tree vitality indicators help to clarify definitions of the manual.

Photographs are an essential tool to evaluate and to confirm the observer level of assessments over periods of many years. Photographs should be used as a part of the training exercise both to determine variation between surveyors and field scores and variation over time by using the same (or a sub set) of photographs every year. Results of national training courses should be available for national and international audit/analysis.

Photo calibration courses have to be organized on the international and on the national level at regular intervals (at least every second year) see Annex I.

"Form PHOT

Form for recording characteristics of photographed tree

Surveyor name/code :

Characteristics of plot/location

Countrycode :
Plotnumber :
Date (DDMMYY) :
Latitude (+DDMMSS) :
Longitude (+DDMMSS) :
Altitude :

Photo

Tree Characteristics

Tree identificat.	Species code	Soc. class	Cr. Shad.	Defol.	Disc.

Visib ility	Specificat. affect. part	Symp tom	Spec. sympt	Location in crown

Cause	Scientific name of cause	Ex tent

Flowering		Fruiting		Foliage
ass cr	whole	ass cr	whole	transp.

Crwn form	Sec. shoot	Obs.

Distance to tree (m):
Direction to tree (^{o}):

Description of location:

Description of photographed tree and crown:

Reasoning of scoring of assessment, including specific details (to be photographed in detail (zoom) and documented in separate page)

Other remarks

6.1.4 Field condition of assessments, direction of assessments

Observers should have a satisfactory view of the tree from several observation points. On ground level, the optimal view is given at a distance of one tree length. On slopes, trees should be observed at a distance of about one tree length above the tree or at least on the same level. Assessments should be done in full daylight.

6.1.5 QA/QC related to the assessment of damage causes

In general the field observers who are performing crown condition assessment will also be responsible for the assessment of damage causes. Ideally at least one of the observers of a team should be familiar with forest pathology.

Field crews should undergo a theoretical and practical training in diagnosing and quantifying the more important damage symptoms at national level prior to the start of the annual field season. At the international level, training and intercalibration courses will be organised. Participation in these courses is a precondition for data submission. At national level, National Focal Centres (NFC) are responsible for quality control.

Surveyors should be provided with forest pathology field guides to facilitate diagnosis (see References). Annexes 4 and 5 provide a 'list of symptoms and possible causes' and 'examples and definitions of causal agents'.

6.1.5.1 Plausibility limits

When performing crown condition assessment, defoliation is estimated in 5% classes relative to a tree with full foliage. This score reflects the overall defoliation, regardless what the causes are. If the observed defoliation can partially or totally be attributed to a certain identified cause (e.g. defoliators) this should be reported in the damage causes section, using the appropriate extent class. This implies that the overall defoliation score should always be higher than the lower limit of the extent class for the symptom "devoured/missing leaves".

e.g. overall defoliation score of a tree (CCA) = 30 % → highest possible extent class for symptom "devoured/missing leaves" is class 3 (21 – 40 %).

Remark:

In order to collect more detailed information about the impact of defoliators on crown condition an additional visit in spring may be needed. At the time of crown condition assessment in summer trees may have developed new foliage after spring defoliation by e.g. defoliating insects. As a result the overall defoliation (CCA) assessed in summer may be lower than the defoliation estimated in spring. Therefore this plausibility check may not apply if a summer defoliation score is compared to the extent of "devoured/missing leaves" estimated in spring.

7. Data handling

The National Focal Centres (NFC) are responsible for data processing, data storage and submission and also for evaluations at the national level.

7.1 Data submission procedures and forms

For the submission of the data on damage causes to PCC the following form are to be used:

Damage parameters (Level I plots) .TRF

Damage parameters (Intensive monitoring plots) .TRD

7.2 Data validation

Make sure that no inconsistent combinations of tree species, specification of affected part (SAF) and symptoms occur. Most codes for SAF and symptoms can be used regardless the tree species. Some combinations, however, are only possible in broadleaves, while other combinations are only possible for conifers. E.g. current year needles (code 11) should always refer to a coniferous species, while affected leaves in broadleaves can only be reported using SAF code = 14.

All combinations of tree species and symptoms are possible except for resin flow which should always refer to a coniferous species, while slime flux is only found in broadleaves.

Inconsistent combinations of 'specification of affected part' and symptom should be avoided too, e.g. broken leaves. See table IV-3 for possible combinations of SAF and symptoms.

Validation rules Data should be checked and corrected or completed if:
Field 'specification of affected part' (SAF) is empty
Specification of affected part is present (and ≠ 0, 4, 9) but symptom is absent
Defoliation = 100 but specification of affected part ≠ 4
Specification of affected part<14 and species<100
Symptom = 18 and species <100
Symptom = 19 and species >= 100
Specification of affected part = 14 and species >=100
% Defoliation (data CCA) => lower limit of extent class for symptom "devoured/missing leaves" (cf. Plausibility limits)

Tab. IV-14: Examples of validation rules

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9. Annexes

Annex 1: Design of International Cross-Calibration Courses

A1.1 The concept of the ICC system

Details concerning the "New Design of International Cross-Calibration Courses of ICP Forests and the EU Scheme", hereafter referred to as International Cross-comparison Courses (ICCs), are described by Ferretti et al. (2002).

A1.2 Basic design elements

The system of the International Cross-comparison Courses (ICCs) is installed to provide exercises with sufficient space and time replication for the most frequent tree species of the transnational surveys under realistic work condition. It incorporates formally photo QA exercises and its link with the traditional field exercises.

For each of the most frequent tree species ICC sites are spread across Europe. These ICC sites are selected by the hosting countries to ensure the possibility of re-assessments of the same plots in a periodic system to provide data for the documentation of temporal consistency. The willingness of the host countries and of the forest owners to provide the ICC site must therefore be ensured.

A1.2.1 Plot and tree selection

For each ICC site, a number of visual assessment plots (hereafter referred to as visual plots), eventually supplemented by a special photo assessment plot (hereafter referred to as photo-plot), are selected. Each ICC in principle is dealing assessments on two tree species, 3-4 plots per species are used as visual plots, each of them covering a wide range of defoliation values. According to available field conditions the host countries should select the plots varying according to only one or two environmental factors. The plots should be designed consistently with the actual Level I plots in the host country. This will help to provide realistic assessment conditions

All plots should be located as close together as possible in order to prevent cost and time consuming travelling between the ICC plots. Each visual plot should consist of 24-30 trees of the same species. Trees within the visual plots should be selected according to the usual Level I tree selection criteria of the host country. When visual plots are unsuitable for the purposes of photo QA, an ad-hoc photo plot with 24-30 trees should be selected in the surroundings.

The plots should be managed as permanent plots. Plot locations should be recorded and trees permanently numbered and/or geo-referenced to enable the re-assessment of the same trees.

Photo-QA exercises can be carried out on the visual plots when the trees fulfil the selection criteria reported in the annex on photo QA. When the visual plots are not suited for the photo QA exercise, then there is the need to select ad-hoc photo-plots. The photos of the photo exercise should be assessed as long as possible after the field assessment of the respective trees. The photos can be mirrored to ensure that objective assessments are made and not the field assessments be remembered by the participants. Furthermore, photos from other ICCs on the respective tree species should be re-assessed in terms of the documentation of temporal consistency.

A1.2.2 Invitation and participation

The host countries decide in co-operation with the Programme Co-ordinating Centre (PCC) of ICP Forests about the dates of the ICCs at the end of the survey period (usually this period lasts from end of June to end of August). For the evergreen tree species in the Mediterranean region, an extension up to the end of September can be allowed. The host countries invite all other NFCs by end of March of the respective year to send their National Reference Teams (NRT) for participation in the ICCs.

The participants of the ICCs should be the NRTs for the concerned species. The National Focal Centres decide about the participation. Ideally National Reference Teams should participate as it is important that the participants at the ICCs also participate in the national courses to get the linkage to the survey results.

A1.3 Implementation of the ICCs

A1.3.1 Field work, use of home references

It is important that the participants work independently and that there is no mutual influence of their assessments. Each team should use its own method and reference standard. Positions for assessments should be marked in the field. After assessing from this position the participants may make a second assessment according to their national methods.

The host country should present site and stand information (age, below/above average site, altitude, etc.). Usually, local reference trees will be not presented, unless a specific request will be made by the crews.

Any discussions or exchange of information, especially concerning individual trees, between the teams should be avoided before and during the cross-calibration field work for the concerned species. However, the experience gained in the past suggests that a brief discussion about the most diverse assessments could help clarification.

There is no evaluation/presentation of assessment results in the field before finishing the last plot of a given tree species. Nevertheless, e.g. presentations of national or regional evaluations could be a topic in the evening to introduce a discussion about special issues.

A1.3.2 Codes

A1.3.2.1 Participant code

Participants of National and International Courses as well as field teams will receive a unique ID number that stays the same through time (**C**ountry, **R**egion, **P**erson // CCRRPPPPP). “Country” refers to the usual country code; “Region” (when applicable) refers to the code of a given region in a country. If it is not necessary to develop a code for “region” the digits for RR should be filled with “99”. “Person” is the code given by the NFC to every members of its NRT. NFCs are responsible for the distribution of codes to their staff. Code lists and their annual updates are submitted to PCC by the National Focal Centres by the end of September.

A1.3.2.2 Plot code

The host countries provide the plot IDs for the ICC test ranges according to the following method: the plot ID should be the plot number in case of Level I plots, otherwise “99” and an ICC plot specific ongoing number of 4 digits both divided by an underline. The test range specific ongoing number consists of the country code (first two digits) followed by a plot specific ongoing number.

An example of four plot IDs is given below with the second plot being a real Level I plot with plot ID 194:

99_5501, 194_5502, 99_5503, 99_5504

A1.3.3 Data to be recorded

The host countries are asked to provide the plot ID code and a detailed stand description for each ICC test site/plot including latitude, longitude, site type, altitude, exposition, canopy closure, tree species, tree heights, dbh, stand age and recent thinning.

Data	Provided by host	Collected by participant	Entry in the field form by participant	Submitted to PCC by host
General data				
Calendar date			+	+
Participant code			+	+
Plot data				
Plot ID	+		+	+
Latitude	+			+
Longitude	+			+
Altitude	+			+
Aspect	+			+
Canopy closure	+			+
Tree species assemblage	+			+
Tree height (dominant storey, average)	+			+
DBH (dominant storey, average)	+			+
Age (dominant storey, average)	+			+
Tree data				
Species	+	+	+	+
Number	+	+	+	+
determine assessed part of crown e.g. using photographs		+	+	+
Defoliation (0,5,10,15 ... 95,99,100%)		+	+	+
Specification of affected part (11, ..., 34), see		+	+	+
Symptom (01,..., 22)		+	+	+
Cause (codes see annex 2, e.g. 81001		+	+	+
Scientific name of cause (codes see annex 6, e.g. LOPHSED)		+	+	+
Extent of fruiting (0,1,2,3,4,5,6,7)		+	+	+

Table A1-1: Overview of the data and parameters to be provided, collected and reported.

Ideally, all mandatory parameters of the Level I and II crown condition surveys should be covered by the ICCs. However, given the importance of defoliation in the reporting of forest condition, this parameters has the highest priority. The mandatory damage parameters are to be assessed too. Additional parameters may be assessed after explicit requests of participating countries or in consequence of changes of the manual on a voluntary basis. Plot ID, date, and ICC participant code should be recorded by the participants once per plot. All these parameters and codes must be entered in the field form. The field forms should be supplied by the host countries.

A1.4 Data submission

If possible data should be digitised during the course. Thus, uncertainties could be clarified directly with the participants.

The data can be handed over to PCC directly at the end of the courses or should be sent to PCC latest by the end of September of the respective year. Furthermore the host country provides a list with the participants and their codes used during the ICC which should be the same as given for the field survey.

Excel Format:

All results of one species (ICC test range) are listed in one file (filename containing species, year, host country, e.g. "ICCFagusSylvatica2003Germany.xls", or short: "ICCFagSylv03GER.xls").

The file includes several sheets for the respective plots and parameters, the name of the sheet gives plot ID and parameter (e.g. 99_5501_defoliation, 194_5502_discolouration, …).

Structure of table as follows

Filename (e.g.ICC2003FagusSylvaticaGermany)						
Plot ID and parameter (e.g. 99_5508_defoliation)						
Tree No.	NRT1 (CCRRPPPPP, CCRRPPPP)	NRT2 (CCRRPPPPP , CCRRPPPP)	NRT3 (CCRRPPPPP , CCRRPPPP)	...		
1						
2						
3						
6						
...						
24						

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Annex 2 Codes for damage causes

Only available on the Internet

http://www.icp-forests.org/WGbiotic.htm