

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

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

MANUAL

on

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

Part IX

Phenological Observations

November 1999

Contents

1. Introduction	3
2. Observation and recording at plot level (Extensive)	3
3. Intensive phenological monitoring at individual tree level (Intensive)	4
4. Additional monitoring techniques	4
5. Quality control, data processing, storage, submission and evaluation	5

Annex 2: Technical instructions for the Phenological Observations on Level II Plots (optional)

Elaborated by:
Expert Panel on Phenology
Teja Preuhler

November 1999

Sub-Manual on
Phenological Observations in the Intensive Monitoring Programme (Level II)
(optional)

1. Introduction

Phenology is broadly defined as the study of the visible life cycle events. Knowledge about the timing and the duration of certain life events provides valuable information about possible effects of climate fluctuations and changes on trees and in explaining the actual condition of the trees themselves.

Within the aims of the Level II monitoring program, Forest Phenology is defined as the systematic observation and recording of:

- the biotic and abiotic (e.g. damaging) events and phenomena
- the yearly development stages of forest trees.

Main objective of phenological observation at the level II plots is to provide supplementary and complementary information on the status and development of forest tree condition during the year.

The value of such information is enhanced when phenological data can be evaluated in combination with the parameters of the other data collected on Level II plots - in particular meteorological, deposition or soil solution, crown condition and increment parameters.

Additional objectives of phenological monitoring are:

- to determine the course of the annual development stages of forest trees on the intensive monitoring plots, in order
- to explain possible changes in the timing of these stages (starting time, length of period and magnitude) in relation to environmental factors of natural and/or anthropogenic origin,
- to utilise this knowledge in interpreting observed changes in tree condition (e.g. crown condition, growth, nutritional situation).

These objectives will be achieved at a plot level (Extensive), and at an individual tree level (Intensive).

Technical details of observation, recording, evaluation and submission are described in the technical annex.

2. Observation and recording at plot level (Extensive)

The recording of the most obvious effects of biotic and abiotic (damaging) events and phenological phenomena that can be observed by a cursory examination on the plot and the buffer zone is recommended to be performed at least for those Level II plots where any continuous measurements (e.g. meteorological observations, deposition or soil solution measurements) are being carried out.

Observations and recordings are limited to:

- Biotic damage (pests and/or diseases)

- Abiotic damage (e.g. frost, wind, hail)
- Occurrence of flushing, colour change and leaf/needle fall

A briefing in these observations is necessary, in general a special in depth training will not be required.

3. Intensive phenological monitoring at individual tree level (Intensive)

The intensive phenological monitoring based on visual observations on individual trees in the plot or the buffer zone is recommended to be performed at least on those Level II plots where continuous monitoring of meteorological parameters is carried out.

The objectives include:

- to provide information at an European scale on the status of the various phenological courses of different tree species and their dependence on local (e.g. meteorological and site) conditions, incl. damaging events,
- to compare the timing of phenological phases between species at defined local conditions,
- to document and explain changes in phenological timing which may be influenced by the observed changes of the local conditions of the level II plots in the future.

Since this monitoring is time consuming and needs well trained staff, it is recommended to carry out in depth observations on a small number of plots. All species at intensive monitoring plots are of interest, however priority should be given to the main tree species in the plot.

The phases to be monitored are for conifers: needle appearance, appearance of Lammas shoots and flowering; and for broad-leaved trees: leaf unfolding, secondary flushing, flowering, autumn colouring, leaf death and leaf fall.

The definition and determination of the individual phases at different tree species are described in detail in the technical annex.

The number of trees to be selected for phenological monitoring depends on the tree species and the stand conditions.

It is important to ensure adequate Quality Assurance .

4. Additional monitoring techniques

Additional techniques (such as litterfall collection or girth band measurements) can be employed to provide supporting and supplementary information.

Litterfall sampling provides quantitative data, e.g. about flowering, seed production, leaf/needle shedding etc. The sampling date/frequency should coincide with the period for the litterfall survey in the deposition measurement.

Girth bands. Precise measurements of the onset and cessation of growth and the response of trees to stress phenomena can be provided by girth bands.

Pollen information may be used as far as available through other institutes or medical services in order to get information on the timing of pollination and on pollen quantity to estimate seed production as far as applicable.

5. Quality control, data processing, storage, submission and evaluation

In addition to the fulfillment of the above mentioned objectives and aims, phenological data (biotic and abiotic events as well as intensive phenological monitoring results) are required for integrated evaluations in different aspects of level II plots (e. g. in connection with meteorological parameters, crown condition assessment, deposition, increment ...). This will contribute to better understanding of their effects on measured values of the various ecological parameters and of stand characteristics on these plots.

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

To ensure adequate quality assurance, annual training and intercalibration of the observers are necessary at national and international level.

The relevant data centre (e.g. FIMCI) will analyse the data at European level, regarding the objectives, and report the results.

Annex 2

Technical Instructions for the Phenological Observations in Level II Plots (Optional)

1. Observation and recording at plot level (Extensive) 3
2. Observation and recording at individual tree level (Intensive) 5

1. Observation and recording at plot level (Extensive).

1.1 Introduction

The observation and recording should concentrate on the obvious effects of the events by a cursory examination. If these observations and recordings are performed by the same person in charge for any routine activity at the plot (e.g. collection of deposition or soil solution samples) the costs, both in labour and money, will be very low.

1.2 Location

The observations should be made in the plot and/or the buffer zone of all Level II plots where any continuous measurement is carried out.

1.3 Frequency

Observation dates should coincide with the collection of deposition samples, soil solution or meteorological data.

1.4 Observation and recording

All species at intensive monitoring plots are of interest, however priority should be given to the main tree species in the plot. NFC's are free to include more species. In this case each species should be recorded separately. Only effects on events that have occurred and/or have changed their frequency/intensity since the last visit should be recorded. As individual phases of phenological phenomena occur measurements need to be repeated until the phase is completed

Observation and recordings are limited to the following effects and phenological phenomena:

10 = Flushing;

20 = Colour changes;

30 = Leaf/needle fall;

40 = Significant signs of leaf or crown damage (e.g., eaten leaves or bare crown parts);

50 = Other damage (breakage, uprooted trees).

SCORING SYSTEM

Following a field form on national level it should include information on:

Occurrence of the events and phenomena:

- 1 = no
- 2 = infrequent, e.g. sparse, individual trees or limited part of the stand area (plot);
- 3 = common, e.g. a condition between code 2 and 4;
- 4 = abundant, e.g. the majority of the trees or of the stand area (plot).
- 5 = total, all trees of the stand area (plot).

Whenever possible the suspected causes should be stated such as:

- Biotic damage including damage caused by:
 - * insects (e.g. winter moths)
 - * diseases (e.g. fungi);
 - * game (e.g., deer).
- Abiotic damage including damage caused by:
 - * frost;
 - * wind;
 - * hail;
 - * fire;
 - * lightning;
 - * etc.

If damaging events occur in the plot and affect individual marked trees, the tree number should be noted. These events should be recorded with a view to a more detailed assessment by an expert at a later stage.

An example of the field form gives form 11a

1.5 Data processing, validation and analysis

Control checks on the field forms should be made as soon after the assessment as possible. The timing (start date – finish date), cause and extent of events should be recorded for subsequent analysis and evaluation.

1.6 Data submission

Summaries of damaging events and phenological phenomena and the periods in which they occurred shall be submitted to FIMCI on form 11b.

1.7 Quality Assurance

The National Focal Centres are responsible for quality control checks on the field forms and ensuring that any required follow up assessments by experts are made and recorded on the necessary forms.

2. Observation and recording at individual tree level (Intensive)

2.1 Introduction

The intensive phenological monitoring in Level II plots is dealing with observations on individual trees of the major species or group of species and on a limited set of phenological phases.

2.2 Location

2.2.1 Selection of species and plots

Priority should be given to:

- the most important species of the plot, which is already reported as the main species (other species on the same plot may be added),
- those plots where (at least) meteorological measurements are undertaken.

2.2.2 Criteria for the selection of sample trees

Criteria for selecting trees are:

- Trees should be selected from those on which crown condition assessments are carried out. Preference should be given to trees that are clearly visible when standing outside the plot, because the high frequency of the observation may affect the ground condition of the plot.
- In case there are not sufficient visible crown condition trees, it will be necessary to select additional trees from the plot or the buffer zone. In this case:
 - * trees should be dominant or codominant,
 - * trees on which a periodical measurement of DBH and height is (planned to be) made should be preferred,
 - * trees selected for leaf/needle sampling and analysis are not to be included.

Between 10 and 20 trees per species in a plot are generally recommended as a norm. All trees should be numbered. If they have already numbers (e.g. for crown condition or increment assessment) these numbers should be kept and used. If there is no number, a new range may be started e.g. 901, 902, etc. Do not start again with already existing numbering series (1,2,3 etc.).

Basic information on each tree has to be submitted using form 12a.

2.2.3 Crown to be assessed

Preferably the top of the crown (light crown) should be visible from one observation point. If this is not possible also the middle part of the crown is accepted. The same part of the crown should be considered for subsequent phenological observations throughout the whole year. The part of the crown observed should be reported at form 12a at the time the trees are selected, or whenever it changes, using the following codes:

1 = top of the crown visible

2 = middle of the crown visible

3 = top and middle of the crown visible

2.2.4 Direction of assessment

The direction from which the observations on individual trees are made should always be the same. It should be recorded using an eight class system at the time the trees are selected and reported on form 12a. Any change in this position should be recorded and reported as well.

The codes for the direction **from** where observations are made are:

1 = North

2 = north-east

3 = East

4 = south-east

5 = South

6 = south-west

7 = West

8 = north-west

2.3 Frequency of observations

At least during the periods from the beginning to the end of the concerned phenological phases, weekly observation always at the same day of the week are advisable, to obtain suitable data for modelling.

2.4 Methods of assessment

The manual provides information for the most important groups of species of Level II plots. It can also be used as guideline for monitoring other species.

2.4.1 Phases to be monitored

In principle all phenological phases are of interest for phenological monitoring. However in respect of practicability (e.g. financial effort, ease and reliability of the monitoring, European wide comparability, compatibility with other surveys like Crown Condition) it is necessary to concentrate on a limited set of phases and on the major species or groups of species. A distinction is made between conifers and broad-leaved species:

CONIFERS

Needle appearance

Lammas shoots

Flowering

BROAD-LEAVED SPECIES

Leaf unfolding

Secondary flushing

Flowering

Autumn colouring

Leaf death and leaf fall

For the phase flowering only the beginning of opening of the male flowers (characterised by pollen shed) is to be recorded, whereas the other phases are to be recorded quantitatively. In addition damage of needles, leaves or flowers caused by late frost in spring should be recorded as well as its intensity. The definitions and determinations of the individual phases are described hereafter.

2.4.2 Scoring system for phenological phases

Flowering phases:

The amount of male flowers that are in the described stage or already passed this stage is to be recorded using the following classification:

1 = the phase is absent

2 = the phase is present (e.g. three or more of the male (staminate) inflorescences)

Needle appearance, leaf unfolding, autumn colouring and leaf fall:

The amount of needles or leaves of the visible part of the crown that are in the described stage or already passed this stage is to be recorded using the following classification:

1 = the phase is absent

2 = > 1-33% of the needles or leaves

3 = > 33-66% of the needles or leaves

4 = > 66- 99% of the needles or leaves

5 = > 100% of the needles or leaves

Shedding of green leaves:

Shedding of green leaves caused by hail, windstorms or insects should be recorded using the following classification (according to the '*recording of biotic and abiotic (damaging) events*', but on individual tree level):

1 = absent

2 = slight, e.g. minor part of the crown

3 = moderate, e.g. large part of the crown

4 = severe, e.g. abundant all over the crown

5 = total

Damage of needles, leaves or flowers:

Damage of needles, leaves or flowers caused by late frost in spring should be recorded using the following classification:

2 = slight

3 = moderate

4 = severe

2.5 Quality Control

NFCs are responsible for Quality Control. Training should be ensured to the field teams, and control assessment should be carried out by an independent control team, at least once a year on e.g. 10% of the plots. These data should be submitted. Training for the responsible NFC-experts/control team might be organised on a European level in close connection with the Expert Panel on Crown Condition Assessment.