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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 VIII

Assessment of Ground Vegetation

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Annexes

1 Objectives

Vegetation is a major component of forest ecosystems. The composition, diversity, and structure of vegetation are important factors for assessing biological diversity of forest ecosystems. Vegetation is the source of primary production, plays a direct role in water and nutrient cycling, and interacts strongly with other biotic components (insects, game, etc.) being a determinant habitat for many species. Vegetation has also been identified as a specific target for the calculation of critical loads/levels.

The composition and structure of vegetation can serve as bio-indicators for environmental changes to ecosystems. Changes in vegetation and in underlying environmental factors can serve as indicators of the status of other organisms based on our current knowledge of the ecological niches of numerous plant species.

Thus, the long-term study of vegetation dynamics at selected locations will provide information on changes in other forest ecosystem variables (soil, microclimate, etc.). Ground vegetation is here defined as all terricolous vascular plants (herbs, shrubs and trees) bryophytes and lichens (excluding epiphytic and epilithic species).

The two main objectives of the vegetation assessment are to:

- characterize the current state of the forest ecosystems on the basis of the composition of the vegetation;
- monitor of the vegetation changes due to natural and anthropogenic environmental factors.

The characterization will allow plots to be positioned within identifiable vegetation types. The aim of the study of vegetation dynamics is to describe, explain and model succession, by analysis of pathways, causes and mechanisms of vegetation changes.

2 Sampling design

The area selected for vegetation assessments must be representative for the whole ICP Forests Level II plot (2500 m^2), in order to allow comparisons between vegetation changes and other parameters recorded on the same plot. Different sampling designs and methods can be applied in order to obtain a statistically representative sample and a reliable estimate of the species number and the mean cover of individual species, depending on the biogeographical zone and vegetation type.

Since there is a trade-off between the accuracy of species cover estimation and the area which can be surveyed, two different sampling designs are proposed, which either lead to a more qualitative or to a more quantitative characterization:

• in the first case, vegetation changes are studied over a large area, utilizing sampling units of a surface area ≥ 100 m^2, with a low to medium accuracy in estimates of changes in cover for each species;
• in the second case, the study concentrates on detecting small-scale temporal changes in plant populations. Small sampling units (in general ≤ 10 m^2) are used for a more accurate estimation of species cover.

Plot: the Intensive Monitoring (Level II) plot (0.25 ha).
Sub-plot: part of the Level II plot if this is located in a dense, homogeneous stand (e.g. 0.1 ha).
Sampling unit: surface unit on which the vegetation is assessed (e.g. 1 m^2).

2.1 Total area surveyed, number and shape of sampling units

According to phytosociological usage, the minimal requirement is to sample almost all of the species at the plot level. The number of plant species is dependent on the studied area. In order to achieve comparability of results between countries, a common sampling area (CSA) of 400 m^2, representative for the ground vegetation of the Level II plot, is mandatory. This area can be reached as the sum of smaller sampling units within the plot area. Countries are free to select the number and shape of the sampling units.

2.2 Spatial location of the sampling units

If sampling units are not contiguous, they should be placed as far apart as possible within the Level II plot or in its buffer zone in order to minimize spatial correlation between the sampling units within a plot. They should also exclude major heterogeneities at any scale of sampling (boulders and cliffs, tracks and paths, fire places, streams and ponds, ditches and channels, peaty pools).

2.3 Marking the sampling units

A permanent marking system has to be installed for the sampling units. The precise method to be used is at the discretion of each country (boundary markers, buried metal stakes, etc.) but the material used should be inert. The presence of markers should be regularly checked. It is recommended that maps should be used for recording the spatial arrangement and exact locations of the sampling units. Such maps should use the most permanent system of coordinates possible.

2.4 Additional survey of species outside the sampling units

If the sampling units do not cover the total plot area, which is the general situation, a list of all additional species not encountered within the sampling units should be established, if possible. Such a list will help to interpret future vegetation changes within the sampling units and will be of additional interest regarding the biodiversity. The list must be submitted through Data Accompanying Report (DAR).

2.5 Compatibility with other surveys

In all cases, the exact location of the vegetation plots has to be determined in that way that any conflict with other assessments will be avoided. During the installation of sampling units, areas already used for other intensive studies (e.g. soil studies or measurements of deposition) and the tracks leading to these areas have to be avoided. Adequate information (map, signs) must be provided to all survey teams in order to limit the intensity of vegetation trampling and soil compaction within the sampling units.

3 Measurement of species abundance or cover

In the large sampling units, countries are free to choose their own scales (see van der Maarel, 1979, for a presentation of these scales) as far as they can be directly converted into percentage cover (see table in Annex 1 for the correspondence between various scales and percentage cover values). A more accurate estimation of cover can be obtained using small sampling units (in general under 10 m^2), those possibly divided into smaller subunits (0.01 m^2), with visual estimates of individual species cover in these smaller subunits. In the finest-scale grids, a presence-absence assessment can be made and then transformed into a percentage cover estimate. It is also possible to use line intercept methods to obtain a quantitative cover estimate. Whatever the method used, the exact boundaries of the sampling units must be delimited during the survey operations, using strings, cords or ropes. A minimum of two people, of which at least one must be a trained expert, should assess all of the sampling units at each sampling date.

Records of additional information on each plant species, such as sociability or vitality, are also of interest. The latter is likely to be of particular interest in the context of atmospheric pollution effects (flowering, fruiting, height, leaf discolouration, etc.). However, this should be preferably the object of separate monitoring projects.

4 Layers to be recorded

A separate record must be made for each species in the different vertical strata. In order to attain comparability of results between countries, a common fixed definition of the following layers is mandatory:

- moss layer (i.e. terricolous bryophytes and lichens),
- herb layer (all non-ligneous, and ligneous < 0.5m height),
- shrub layer (only ligneous and all climbers) > 0.5 m height,
- tree layer (only ligneous and all climbers) > 5 m height.

Seedlings and browsed trees below 0.5 m are part of the herb layer.

A visual estimate of the average height and of the global percentage cover of each, above mentioned layers as well as the global cover of bare soil and litter, should be made.

A detailed record of saplings and seedlings is recommended (e.g. counting, coverage, etc.).

5 Mapping and pictures

Detailed maps of understory vegetation within the plots, as well as photographs, are recommended, especially at the beginning of the monitoring programme. Photographs are useful for recording small areas only (around 1 m^2).

6 Date of observations

The number of visits during one year must be defined in order to account for as many phonological stages as possible, so that the number of species observed is maximized. In forest types with a well-developed spring flora, at least two visits per year are needed. Moreover, two visits per year minimize the risk of missing or misidentifying species. Periods of heavy rainfall shouldbe avoided in order to limit soil compaction. The results of different surveys at different dates during a single year should not be merged but recorded separately.

7 Species studied

All phanerogams, vascular cryptogams, terricolous bryophytes and lichens shall be taken into account. The list of species must be complete for these groups. Non-terricolous species and fungi can be noted additionally, but should ideally be the subject of separate surveys.

Unidentified species should be noted as such, and, if not rare within the sampling units, should be sampled and stored in a herbarium for subsequent identification.

The nomenclature should follow the Flora Europaea (Tutin et al., 1968-1980; Tutin et al., 1993) for vascular plants and Frey et al. (1995) for bryophytes. In situations where these Flora are not valid, where a more accurate taxonomic identification is available, and for lichens, countries are free to use other regional Flora. Whichever Flora is used at the national level, the submission of data to the European coordination centre must follow the coded lists for vascular plants and cryptogams, available through the related Expert Panel. Species not included in the list should be reported to the Expert Panel for further evaluation. Species only encountered in special places (e.g. rocks, tree stumps, tracks and paths, dead wood, etc.) should be noted separately.

8 Frequency

Vegetation studies must be undertaken at least every five years. In order to help separating short-term fluctuations from long-term vegetation dynamics, it is recommended that vegetation assessment is undertaken every year. Recording errors during data collection can also be recognized earlier with an annual survey frequency. If the frequency of sampling is not annual, special attention should be given to disturbances that may affect the vegetation assessment. Heavy disturbances caused by management operations (e.g. thinnings) preceding or occurring during the sampling year should be avoided. Whenever possible, it is recommended to sample vegetation at least the year before these operations, in addition to the normal frequency.

9 Fencing

Level II plots are subjected to the same management practices as the surrounding forest, and fencing is not required. Thus, if there is any fencing, vegetation assessment should be done at least outside the fenced zone. However, a parallel assessment might be made inside the fenced zone, especially in areas where game have a significant impact on vegetation dynamics. Both the inside and outside of the fence must be comparable at the beginning of the survey and must be sufficiently large. The effectiveness of the fence must be regularly checked. Fenced and unfenced data should be clearly separated in the database.

10 Environmental data collection

A number of assessments are carried out in Level II plots (e.g. general plot conditions, soil analyses, atmospheric deposition). In recognition of the importance of light conditions in interpreting vegetation dynamics, it would be very useful to make a direct assessment of the light level in each sampling unit, on each assessment date.

11 Quality control

If different teams are employed in vegetation assessment, control plots will be used for crosschecking their observations. This will be done by successive operations of the different teams on the same plots. All the teams that assess these control plots must operate within a few days at each vegetation assessment date, especially in spring. The control will be based on a comparison between the percentage cover estimates of each species made by each team. All teams should be trained in common in order to standardize the protocol across the Level II network. If possible, the same trained personnel should monitor vegetation during successive inventories in order to minimize observer effects.

12 Data storage and submission

All data must be sent to the relevant national focal centre after each sampling year. Each focal centre is in charge of data validation. The data should be submitted in standard format, following the data submission forms of this manual.

The submission of data to the European coordination centre must follow the coded lists for vascular plants and cryptogams available through the Expert Panel on Biodiversity and Ground Vegetation. Species not included in the list should be reported to the Expert Panel for further evaluation. Species only encountered in special places (e.g. rocks, tree stumps, tracks and paths, dead wood, etc.) should be noted separately. Data are to be submitted for the total CSA area, not per sampling unit (aggregated data by arithmetic mean of % transformed data). NFCs should keep the results of separate sampling units in their national databases.

Information on ground vegetation shall be submitted as estimates of species coverage in percent (with a minimum of 0.01%).

13 References

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Annex 1

Proposal for the transformation between scales and percentage for the estimation of species cover

Cover-abundance estimation

Braun-Blanquet (1928)			Barkman et al. (1964)			Schmidt (1986)			Londo (1975)		
Scale	**Cover (%)**	**∅**	**Scale**	**Cover (%)**	**∅**	**Scale**	**Cover (%)**	**∅**	**Sc.=Cover (%)**	**Sc.=Cover (%)**	**∅**
r	rare	0.01 **[ ]	r	sporadic/association							
+	few	0.5 **	+r	sporadic (1-2 indiv.)/plot	0.01 **	+	<1	0.5	0.5	0.1 * <1	0.5
1	numerous, cover <5%	3.0 [2.5]	 +p +a +b	few (3-20 indiv.) <1% <1-2% <2-5%	 0.1 1.5 3.5	1a 1b	1-3 3-5	2 4	1 3 5	0.2 * 1-3 0.4* 3-5	2 4
			 1p 1a 1b	numerous (20-100 indiv.) <1% <1-2% <2-5%	 0.8 1.5 3.5				8 10 15 20 25	1 5-15 1- 5-10 1+ 10-15 2 15-25	10 7.5 12.5 20
			2m	very numerous (>100 indiv.) cover <5%	4						
2	5-25% or numerous, cover <5%	15.0 **	2a	5-12.5%	8.8	2a	5-12.5	8.8			
			2b	12.5-25%	18.8	2b	12.5-25	18.8			
3	25-50%	37.5	3	25-50%	37.5	3	25-50	37.5	30 40 50	3 25-35 4 35-45 5 45-55 5- 45-50	30 40 50 47.5
4	50-75%	62.5	4	50-75%	62.5	4	50-75	62.5	60 70 75	5+ 50-55 6 55-65 7 65-75	52.5 60 70
5	75-100%	87.5	5	75-100%	87.5	5	75-100	87.5	80 90 100	8 75-85 9 85-95 10 95-100	80 90 97.5

* additional symbols: r (rare) = 1 ind., p (paulum) = few ind., a (amplius) = numerous ind., m (multum) = very numerous ind.
** value contains abundance, the determination of an average cover degree is not correct
[ ] these average values are also mentioned in common literature
∅ average value of cover degree

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