FunDivEUROPE

Functional significance of forest biodiversity in Europe

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Assessment of forest insect and pathogen damage on mature trees

FunDivEUROPE (FP7) field protocol

V1.0

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Content

1 Introduction

Herbivores and pest organisms – although being important components of forest biodiversity– can also impair forest stability and production functions. On the other hand, recent reviews have detected a significant decrease in insect herbivory in more diverse forests. However these results mainly originate from observational studies in which tree diversity was not controlled and where the species richness in forest mixtures was often limited to two tree species. Generally these studies also focused on one insect herbivore species, whereas it seems more relevant to consider the cumulative effect of all herbivores and pathogens on biomass production. There is therefore a need to deliver quantitative estimates of total insect and pathogen damage along explicit and extensive gradients of forest diversity, in realistic conditions of forest management in Europe.

2 Scope and application

Assessment of forest pest and pathogen damage on mature trees will be made in FunDivEUROPE Exploratory Platform because most of the Experiments are still too young and national forest inventories rarely document damage data.

3 Objectives

The objective of the damage assessment is to investigate the causal relationship between tree functional diversity and forest resistance to pest and pathogens.

4 Location of measurements and sampling

4.1 Number of replicates

Five individual trees per dominant tree species, i.e. five trees in monocultures and up to 20 trees in four-species mixtures, will be assessed in each sampled plot. All plots containing the two main dominant tree species (one broadleaved, one evergreen if possible) will be sampled per site, to provide at least two complete gradients of tree species diversity. If there is still some time left before the end of the month, more plots will be sampled.

Three groups of nine sentinel tree saplings ("phytometers") will be planted at a subsample of plots per region (for tree species with two best diversity gradients). Two years old saplings should be planted in autumn – winter 2011 so that they have sufficient number of leaves in the next summer (2012).

Two third (18) of them will be inside the enclosure (i.e. fences to allow mammalian herbivory exclusion) and nine will be exposed to mammalian herbivory. Among the 18 within

enclosure, nine will be caged (bird predation exclusion), and nine will be left uncaged. One of the planted species will be a conifer and another one a broadleaf species selected among the dominant tree species in each site.

Three sites will be monitored in 2012, and the other three in 2013.

4.2 Sampling scheme

The five trees per species and per plot will be selected at random in the core area of the plot (in agreement with colleagues from other tasks).

4.3 Sampling equipment

The visual assessment of crown condition will necessitate the use of binoculars.
Two pheromone traps per plot will be used to estimate the local abundance of tree defoliators.
Fences (ca. 3 m x 1 m), cages (1 m x 1 m) and 27 seedlings for each of the two focal tree species.

4.4 Frequency of sampling

Visual damage assessment of crown condition, of leaf damage on cut branches and sentinel saplings will be made only once per plot.

Pheromone traps will be assessed every month (ca. five times per growing season).

4.5 Sample collection, transport and storage – quality control in the field and between plots and sites

40 leaves per sampled tree will be collected, put into paper bags and dried, for further microscopic and DNA analysis to better characterize the leaf pathogen communities (see "Sampling of leaves and twigs", page **Fehler! Textmarke nicht definiert.**, for details). This can be done by placing the samples in a desiccator or a plastic bag containing silica gel.

5 Measurements

5.1 Crown condition

The crown condition assessment will be made according to methods reported in the ICP-Forest Manual (updated on 05/2010; see http://www.icp-forests.org/Manual.htm for more details), in a simplified way.

Crown condition assessment will be made on assessable crown. It is defined by the whole living crown from the lowest living branch upward, and includes recently dead branches.

The following variables will be quantified: defoliation and damage

Defoliation is defined as needle or leaf loss in the assessable crown as compared to a reference healthy tree in the same plot (or in the same site). It is assessed in 10% steps.

The assessment of damage will consist of three parts:

- Symptom description on three types of affected parts: leaves/needles, branches/shoots, stem/collar, using the first two digit ICP codes (from 01 to 12, see table IV-3, page 25 of the manual). A simplified table will be provided.
- Determination of the causal agent that is responsible for the observed damage symptoms. Causal agents are grouped into eight categories in the ICP manual but we will retain only four: game and grazing, insects, fungi, other factors. In each category a more detailed determination will be made if possible using the three digits code (see table IV-5, page 28-31 of the manual). A simplified table will be provided.
- Quantification of damage: the damage extent will be reported in seven classes (in 10% steps, i.e. 0%, 1-10%, …, 81-99%, 100%).

5.2 Leaf damage on cut branches

Four branches will be observed (or cut if not accessible): two opposite directions x two heights: at the lower part of tree crown and two at mid- or upper crown (depending on tree height). The damage assessment will be made on 25 leaves per branch according to the protocol developed for experiments. On coniferous trees herbivory and pathogen damage will be assessed on 10 shoots, from each yearly needle cohort separately, on each sampled branch. Nine categories of insects and eight categories of pathogens will be considered:

9 insect categories	**8 pathogen categories**
Chewers	Powdery mildew
Gall makers	Rust fungi
Leaf-miners	Leaf spots
Skeletonisers	Needle cast
Leaf-rollers	Canker or lesions on stem or branches
Leaf tiers	Shoot dieback
Sap feeders	Growth deformation
Shoot moths	Wilting of the whole tree (root problem)
Stem / bark borers	

The damage extent of these categories will be reported according to the following rules:

Chewer and Skeletonisers % damaged leaf area	**Cankers, stem deformations, shoot dieback**	**Other categories of pest and pathogens**
0%	Exact number per branch	% of leaves or shoots with the presence of insect or pathogen type
1 – 5 %		
6 – 10 %		
11 – 25 %		
26 – 50 %		
51 – 75 %		
more than 76 %		

5.3 Leaf damage on sentinel tree saplings

Measures will be done on a fixed number of 5 x 4 = 20 leaves/sapling. Five leaves will be randomly chosen at the tip of a branch at the upper part of crown and five at the basis of the same branch. Five top and five bottom leaves will be chosen on another branch at the lower part of the crown. If there are not enough leaves on the branch, one will choose another branch at the same height. If there are not enough branches, one will use the main axis.

Again nine categories of insects and eight categories of pathogens will be considered and damage extent will be quantified using the above table.

Mature trees and sentinel tree saplings will be monitored at the same time, once a year, preferably in mid-summer.