FunDivEUROPE

Functional significance of forest biodiversity in Europe

Project number: 265171

Sampling of wood cores

For isotope analyses, to assess anatomical traits, carbon and nitrogen stocks and to determine stem wood growth and stem eccentricity

FunDivEUROPE (FP7) field protocol

V1.0

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Content

1 Introduction

Stemwood is the largest store of carbon in most forests, and storage of carbon is an important ecosystem service. Even though N concentrations in wood are low, the total volume of wood is high and so N storage in stemwood can also be significant. Zianis et al. (2005) provide a review of existing equations for converting height and diameter measurements into biomass estimates for different species and sites. There are many functional forms. We are currently developing a new approach that will harmonise these approaches, based on knowledge of wood density, height and diameter. A relatively small proportion of all sugars produced by plants are used to build stem and branch systems. Although the annual investment is often small, xylem tissues are much more durable than roots or leaves, so make an important contribution to carbon storage in forests. They are the most significant source of recalcitrant organic matter (i.e. lignin and closely bound cellulose), and thus help regulate soil food webs and carbon sequestration.

The isotopic composition of carbon and oxygen ($\delta^{13}C$ and $\delta^{18}O$, respectively) provides information on transpiration, stomatal conductance and water use efficiency integrated over various time periods depending on the turn-over time of organic matter pools assessed. Stable isotopes are the only realistic means of estimating the variation in tree water balance across several hundred plots of the Exploratory Platforms. Tree rings archive the physiological response encoded in the stable isotope signatures and thus allow a retrospective analysis of tree response towards varying environmental conditions.

2 Scope and application

The objective of this Part of the Manual is to provide harmonized and standard procedures for the sampling and analysis of tree cores at the Exploratory sites of FunDivEUROPE. The protocols are harmonised with the ICP forest protocols for tree growth measurements (Dobbertin and Neumann 2010) where applicable and possible. Due to the different objectives and analyses performed, however, a complete compliance cannot be achieved.

A harmonised tree core sampling protocol for FunDivEUROPE is necessary to allow comparability between sites (where different teams might be responsible for tree coring) and species. In addition, the procedure guarantees that different measurements can be performed on the same material to minimise the effects of the destructive sampling. Procedures are intended for application at the Exploratory sites and will also be applied on the highly instrumented plots (HIPs) of this platform. All partners and site managers of FunDivEUROPE should follow the methods described here to minimise any potential bias by the sampling procedure. The parameters measured on the tree core samples by the different partners are listed in table 1.

Table 1: List of parameters measured on the tree core samples by the different partners.

Task	Task leader(s)	Partner responsible	Parameter determined	Additional information
T.3.9	Arthur Gessler, Damien Bonal, André Granier	ALU-FR, INRA	Stable isotope composition ($\delta^{13}C$, $\delta^{18}O$)	In the late wood of three rings (originating from contrasting years (dry, wet, average)
T.3.2A	David Coomes, Tommaso Jucker, Olivier Bouriaud	UCA, USC	Wood density, C and N concentrations (from tree ring cores)	
T.3.2B	David Coomes, Tommaso Jucker, Olivier Bouriaud	UCA, USC	Diameter increment in tree rings	
T.3.1	Jürgen Bauhus, Adam Benneter	ALU-RF	Stem wood eccentricity	

3 Objectives

The objectives of tree core sampling within FunDivEUROPE are:

- To collect data necessary for calculating the carbon and nitrogen stocks (kg per m^2) of all 209 forest plots.
- To collect data on wood anatomical traits for species found across different sites. To test the hypothesis that greater diversity equates to greater stem-wood production.
- To collect data for isotopic analysis to assess water use efficiency and stomatal and photosynthetic reaction of trees to environmental conditions in different years and as affected by biodiversity.
- To determine stem eccentricity from tree cores as a measure for timber quality.

4 Location of measurements and sampling

Sampling scheme

Separate cores will be collected for non-destructive (radial growth, stem eccentricity) and destructive (isotope, C and N stocks, wood density) sampling. A size-stratified (based on DBH) random sampling approach will be used in order to adequately represent all target species and size ranges. Cores destined for productivity analysis should aim to reach the pith. In contrast, isotope cores only need to be 15 cm in length (in order to cover the last 15-20 years). Isotope analysis will be performed predominantly on trees belonging to the emergent canopy.

Number of replicates

All Exploratory plots will be sampled.

Radial growth cores: 12 cores in monoculture; 8 cores/species in two species mixtures; 6 cores/species in all other mixtures. Restrictions to coring in the Polish site will require fewer samples/species to be collected (5 cores/species). In the German site, cores will not be collected within a central area within the plot (5m radius no-access zone).

Isotope cores: 5 cores in monoculture; 3 cores/species in all mixtures.

Sampling equipment

Wood cores (5 mm diameter) will be collected using manual tree borers for both isotope analysis and radial growth measurements. Microcores (2 mm in length) will be collected in regions where extracting regular cores is not permitted or limited.

Frequency of sampling

Cores will be taken only once during the project life. It may prove impossible to measure growth of some trees using cores, in which diameter increments will need to be determined from tapes. This would require a second round of diameter measurements on all plots.

Sample collection, transport and storage

After being collected, tree cores should be either allowed to dry or stored in a refrigerated environment in order to slow fungal growth. Polycarbonate boards, pierced with air holes, enable long storing and safe shipping. Cores should not be glued on mounts and/or sanded when they are also used for isotope analyses.

5 Measurements

Radial growth measurements: The tree rings will be measured primarily at Suceava University, Romania and also at Department of Plant Sciences, Cambridge, UK. The measurements will be based on images. The cores will be scanned at 2400 optical dpi on a flatbed scanner, 3200 dpi for cores containing very tiny rings. The software to be used is C-Dendro, which proved to perform better than very expensive ones, but offers the possibility to work on coloured images and compressed files (ex. jpeg, which limits the size of the images and greatly facilitates the sharing) and to export the data in various formats. Both scanned images, ring-limits files and resulting ring width series will be deposited on a server for sharing. Distance to pith will be estimated using concentric circles, in order to ensure reasonable age estimations and to gain accuracy in the reconstruction of the outside bark diameter, as well as assessing stem eccentricity. We will use the data to develop predictive models of individual tree growth. These predictive models will be used to estimate plot-level growth.

Isotope measurements: Only rings of three years will be measured. The late wood of these rings will be dissected with a scalpel or microtome and approx. 0.2-0.4 mg of homogenised dried whole wood will be used for carbon and oxygen isotope analysis each. We will bulk material from these cores and will also bulk the individuals of a given species per plot. The variability of $\delta^{13}C$ and $\delta^{18}O$ in a given species will be determined only on a few plots.

C, N and wood density measurements: C and N concentrations in the wood will be assessed in Cambridge using a mass spectrometer. Wood specific gravity (proxy of wood density) will be quantified through water displacement (Williamson and Wiemann 2010).

6 Data sheet template

A new template should be used for each plot.

General information:

Person responsible for sampling

Sampling date/time:

Weather conditions (T_{air}, Rainfall, cloud cover)

Site

Plot Nr.

Diversity level

Sample ID	Tree No	Tree Species	Core length	Core diameter	Processed for non-destructive tasks	Processed for destructive tasks	Comment

7 References

Dimitris Zianis, Petteri Muukkonen, Raisa Mäkipää & Maurizio Mencuccini (2005) Biomass and stem volume equations for tree species in Europe. Silva Fennica Monographs 4. 63 pages.

Dobbertin M, Neumann M, 2010: Tree Growth. Manual Part V, 29 pp. In: Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests. UNECE ICP Forests Programme Co-ordinating Centre, Hamburg. ISBN: 978-3- 926301-03-1. [http://www.icp-forests.org/Manual.htm].

Williamson G.B. and Wiemann M.C. 2010. Measuring wood specific gravity … correctly. American Journal of Botany 97519–524.