Leaf traits are related to functional interactions between trees in mixed forests

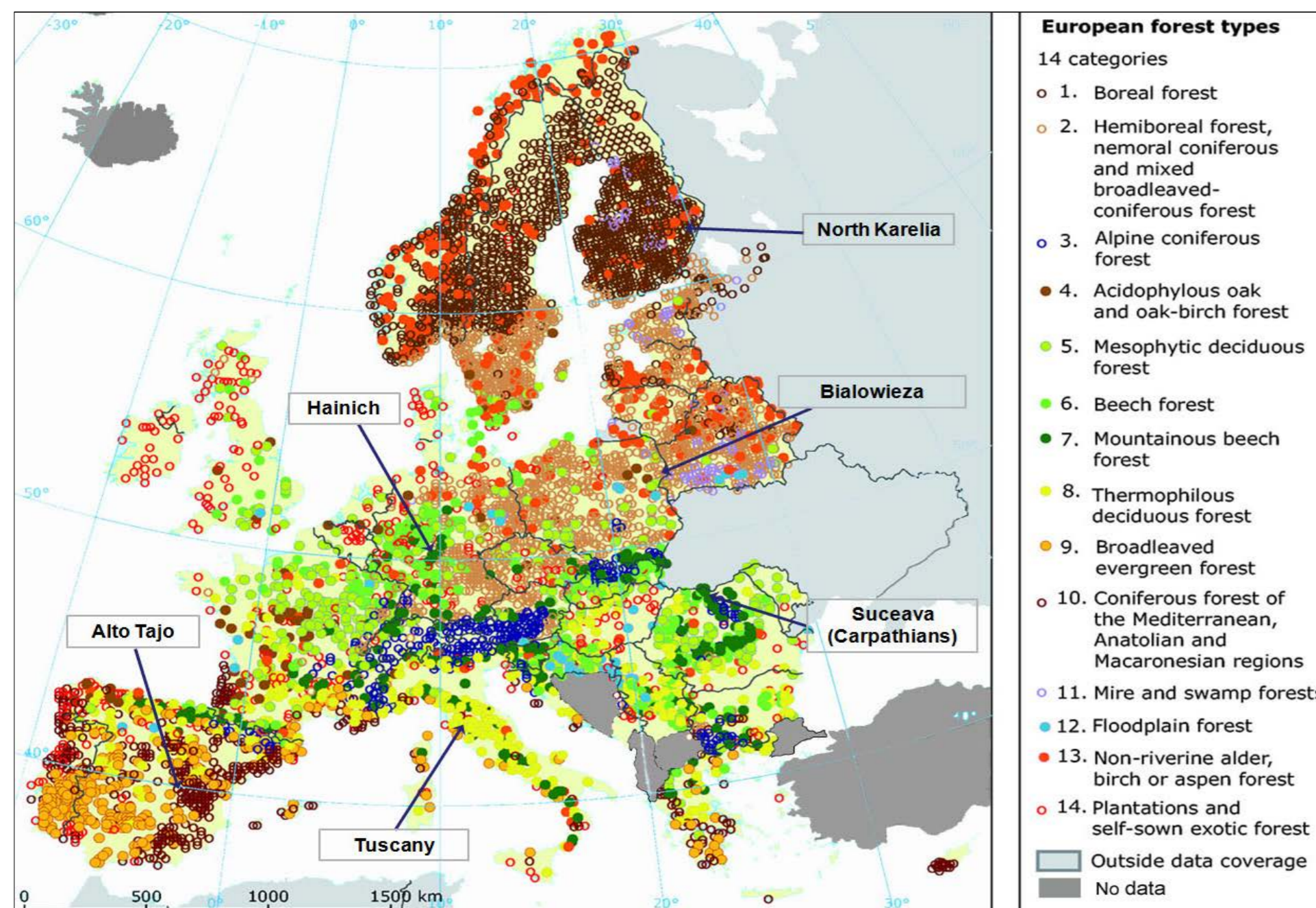Filippo Bussotti and Martina Pollastrini

Dept. of Agri-Food Production and Environmental Science, University of Firenze

The FunDivEUROPE project

Mixed forests are assumed to be more productive and resilient to environmental stress than monocultures, thank to positive interactions between tree species and their ability to exploit more efficiently the resources of the ecosystem. The effects of such interactions on the forest ecosystem functioning are studied in the project **FunDivEUROPE** (FUNctional significance of forest bioDIVersity in Europe). Tree diversity can be either beneficial or detrimental for the physiological functioning of trees, depending from belowground and aboveground mechanisms of facilitation and or competition for water, nutrient and light. These processes are reflected in leaf traits, such as mineral nutrition, carbon isotope composition, photosynthetic efficiency. Here are shown some results obtained in the Italian plots of FunDivEUROPE, were a comprehensive foliar sampling and an overall crown condition analysis of trees was carried out in mixed broadleaved forest stands.

FunDivEUROPE network

FUNctional significance of forest bioDIVersity in EUROPE (*FunDivEUROPE*) is a FP7 research project aimed to quantify the effects of *forest biodiversity on ecosystem functions and services* in major European forest types. These studies were carried out on an **Exploratory platform,** that is a network of approximately 250 plots in natural mature forests in six different European forest types and bioclimatic regions, located in: Spain, Italy, Germany, Romania, Poland, and Finland.

The study site in Tuscany

In Tuscany the study site represents the ***Thermophilous deciduous forest***. The sampling sites are located in Central-Southern Tuscany (Pisa, Siena and Grosseto Province), in five forest areas (in total 25000 ha), where extensive submediterranean woodlands dominated by broadleaf and evergreen trees occur in various species mixtures. The sites are located mainly in Nature reserves and public forests.
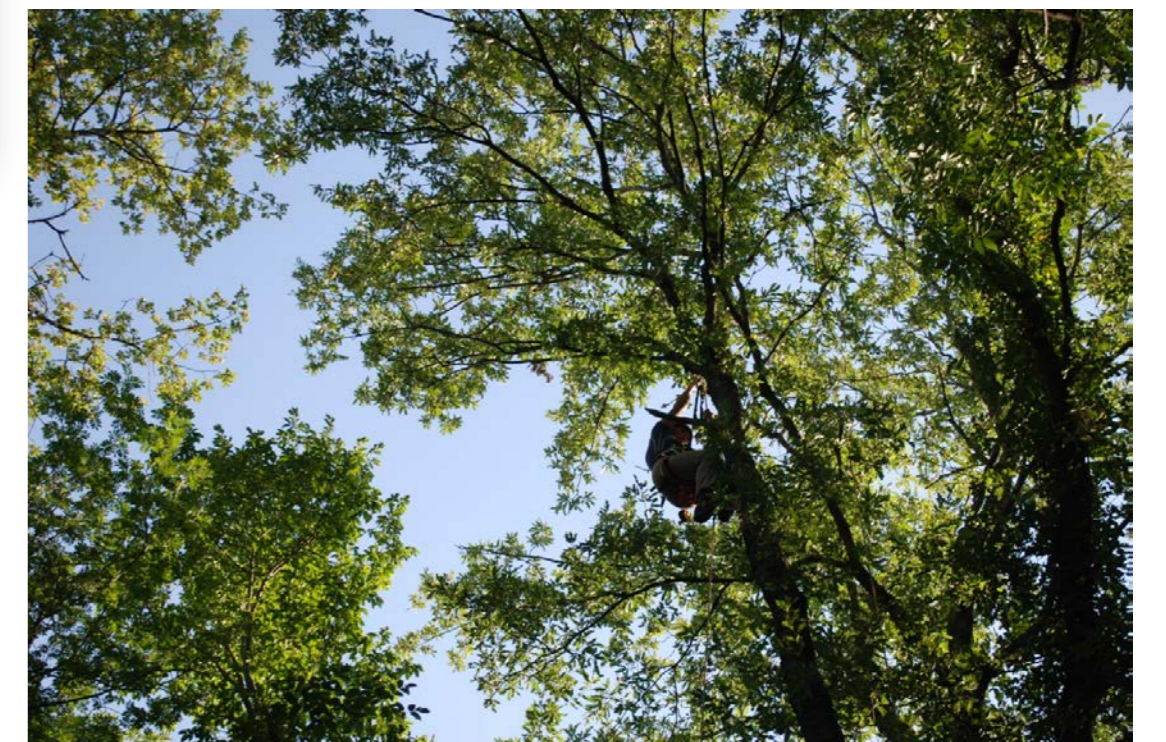
← Location of the mainly public forest areas of central and southern Tuscany where the sampling plots have been established.
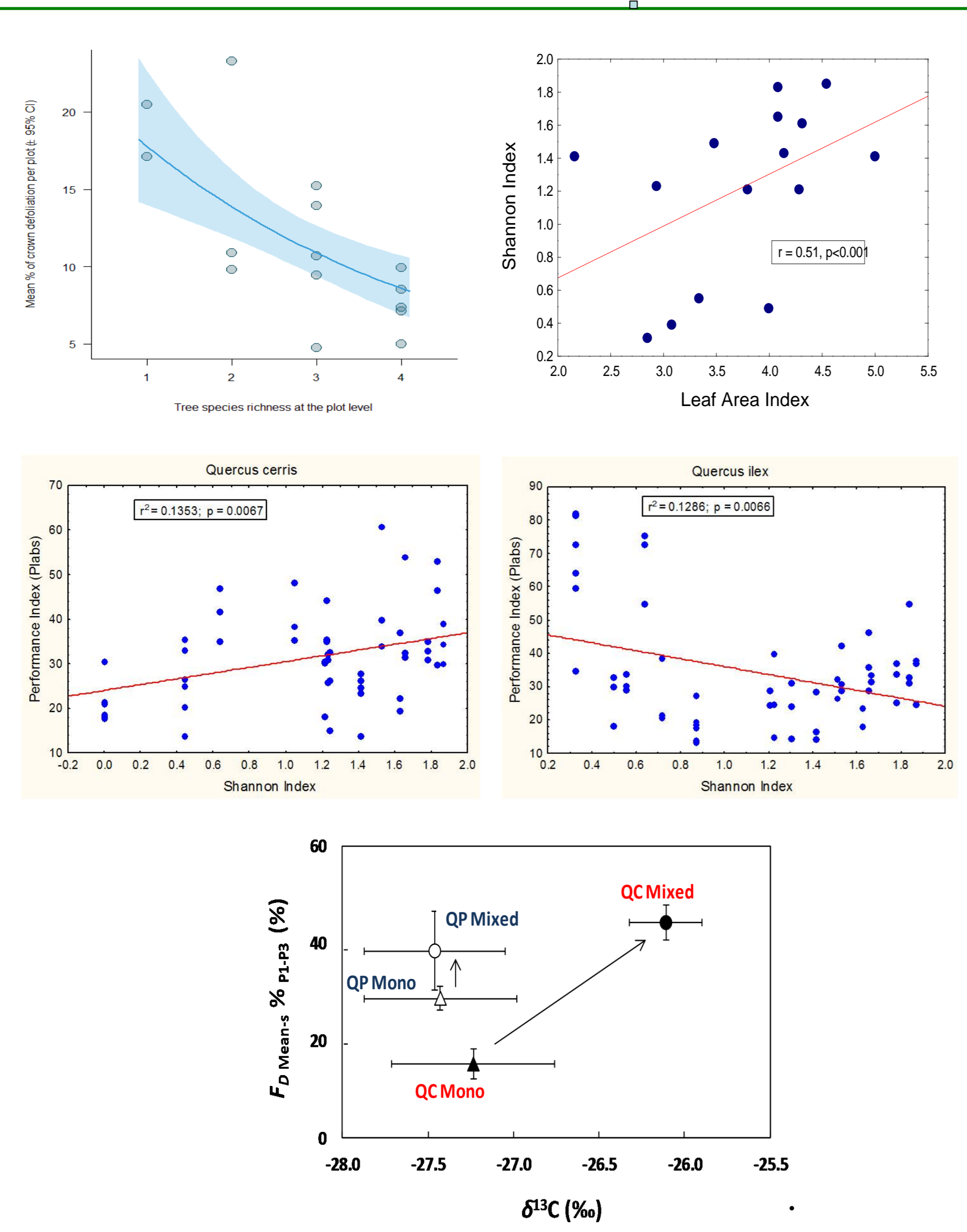

Forest structure of one plot in the study area

Climbers at work for leaf sampling

Some results

Chestnut trees (***Castanea sativa***) were severely defoliated by the chinese gall wasp ***Dryocosmus kuriphilus***. Attacks were alleviated in mixed plots, with special reference to the co-presence of oak species, thank to the action of the "natural enemies" (parasidoits) (Guyot et al., *submitted*).
Leaf Area Index was restored in chestnut mixed forests thank to the contribute of the other co-occurring tree species.

Photosynthetic efficiency, measured with the chlorophyll fluorescence parameter **Performance Index** (PI_{ABS}), increased with the tree diversity (**Shannon Index**) in ***Quercus cerris***, but decreased in ***Quercus ilex***. This contrasting behavior suggests that *Q. ilex* suffers the competition of the mesophilous species in the more fertile site.

In mixed plots (***Quercus cerris*** – ***Quercus petraea***) *Q. cerris* (QC) suffered for water constraints because of the belowground competition with ***Q. petraea*** (QP).
This condition of water stress was highlighted with the analysis of leaf carbon isotope composition ($\delta^{13}C$, ‰), that were higher in QC growing in mixed than in monospecific plots.
$F_{D\,Mean-s}$ % $_{P1-P3}$ %, indicates the percentage of decrease in mean daily sap flux density between P1 (June 2012) and P3 (August 2012). (Grossiord et al. 2014)

Sampling leaves for pahtogen assessment

Chestnut tree attacked by *D. kuriphilus*

Plot equipped for sap flow measurement

Conclusions

1. The analysis of the functional traits, as crown defoliation and foliar features, reveals the physiological functioning of trees relatively to the environmental conditions.

2. Tree mixture affects the physiological functioning of trees, with the effects that may be either positive or detrimental in according to species-specific interactions between tree species.

3. The knowledge of these interactions drives the identification and choice of the most appropriate tree species mixture for resilient forests.

Thank you from the FunDiv community

Reference:

Guyot V., Castagneyrol B, Vialatte A., Deconchat M., Selvi F., Bussotti F., Jactel H., 2015 (*submitted*). Tree diversity limits the impact of an invasive forest pest

Grossiord C., Gessler A., Granier A., Pollastrini M., Bussotti F., Bonal D., 2014. Interspecific competition influences the response of oak traspiration to increasing drought stress in a mixed Mediterranean forest. Forest Ecol.Man.318, 54-61