

## sDiv working group meeting summary

# “sTREEDIV - Using Tree Diversity as an Insurance for the Stable Functioning of Forest Ecosystems”

### Areas of discussion

Our workshop brought together for the first time key participants from TreeDivNet, an international network of experimental biodiversity plantations. Our objectives were to compile a database on tree mortality and to conduct a combined analysis that tests for effects of tree diversity and estimates its impact on future forest structure.

- **Problem:** When the mortality rate of a species is high, tree density in monoculture might become too low to ensure canopy closure and adequate ecosystem service provision.
- **Question:** Can mixed stands that combine species with different mortality rates reduce this risk?
- **Rationale:** This corresponds to the insurance value of biodiversity, meaning that species with lower mortality can compensate for others with higher rates.
- **How will we answer that:** We will use the estimated mortality rates of tree species across TreeDivNet experiments to parameterize models that will compare monocultures with mixtures to test this potential insurance effect of tree diversity.

### Content of presentations

The first day of the workshop was dedicated to presentations of each TreeDivNet experiment, describing the individual designs and presenting some preliminary survival data:

- **The Synthesis Centre for Biodiversity Sciences – sDiv**, by Marten Winter, sDiv coordinator, an introduction talk about the structure of iDiv and its goals.
- **TreeDivNet: brief history of the network**, by Kris Verheyen.
- **Agua Salud**, by Dylan Craven (sDiv postdoc, on behalf of Jefferson Hall).
- **BangorDIVERSE**, by Andy Smith.
- **B-Tree**, by Andy Smith (on behalf of Douglas Godbold).
- **BEF-China**, by Helge Bruehlheide.
- **BiodiversiTREE**, by John Parker.
- **BIOTREE**, by Michael Scherer-Lorenzen.
- **CommuniTree**, by Hervé Jactel.
- **FORBIO**, by Kris Verheyen.
- **Gazi Bay**, by Simon Bilodeau-Gauthier (on behalf of Mark Huxham).
- **IDENT**, by Alain Paquette.
- **Kent**, by Nadia Barsoum.
- **Kreinitz**, by Harald Auge.
- **ORPHEE**, by Hervé Jactel.
- **Ridgefield**, by Michael Perring.
- **Sabah**, by Andy Hector and Sean Tuck.
- **Sardinilla**, by Catherine Potvin.
- **Satakunta**, by Julia Koricheva.

We also had other presentations focusing on new experiments and related studies:

- **Upcoming experiment ("Yangambi") in Congo in former forest concessions** (mixed plantations established in 1938-1946 with a pool of 12 economically important species), by Kris Verheyen.
- **New biodiversity tree plantation in Brazil** (a reforestation and diversity study in the semi-arid tropical forest of the Caatinga region, aiming for instance at assessing whether diversity could prevent desertification), by Gislene Ganade.
- **Temporal changes on diversity effects: the role of monocultures and polycultures** (a meta-analysis that involves a few of the TreeDivNet experiments and uses plant biomass as a response to diversity in temperate forests and grasslands), by Nathaly Guerrero.
- **Microbial respiration measurements in different tree diversity experiments** (the first ever TreeDivNet-wide field sampling, which found out that diversity had no effect on soil microbial respiration), by Simone Cesarz.

As well as a guest speaker on the second day:

- **Carbon dynamics: a key component of mortality in multi-species tree plantations?** (Research on drought-induced mortality and tree hydraulics, on what controls carbon storage in trees, and on how carbon limitation can help investigating ecological interactions), by Henrik Hartmann (from the MPI-biogeochemistry).

## Parallel work and discussions in subgroups

- Discussing the aims and scope of a manuscript showcasing the TreeDivNet network (see "proposed outputs" below for more details).
- Exploring the survival data and discussing the potential ways to tackle the statistical analyses for the meta-analysis. Issues and topics discussed included: should the combined data from all experiments be treated as a single dataset and analysed via a GLMM, or should a meta-analysis be conducted? In the latter case, what effect size would best represent our data and answer our questions? How should we treat differences in design (e.g., species, mixtures, SR gradient, timeframe) between experiments? How should we build the model? What fixed and random effects, moderators or covariates, should be included?
- Exploring the survival data to assess the possibility of analysing variance components with this dataset. Looking not only at means (as does a meta-analysis) but also at data variability will complement the analysis, allow estimating how much of the variance is due to random effects and how uncertainty is distributed around estimates.
- Providing suggestions and insights for the experimental design and the establishment of the Brazil experiment with Gislene Ganade.
- Discussing the technical details of managing experimental plantations, notably important decisions that will need to be taken in the coming years such as thinning, as well as recurring issues like weeding.
- PIs subgroup: Discussing the future of the network, the post-FunDivEurope phase, and potential new sources of funding (e.g., ANAEE, BEST).

## Proposed outputs

Three manuscript ideas were identified through the discussions that took place during this workshop:

1. A “position paper” presenting the design and concept of TreeDivNet experiments, focusing on demonstrating how the network as a whole can provide more information than single experiments and advance both the field of biodiversity functioning research and the sustainable management of forest resources. Questions that will be explored in this paper: (1) What can the network provide to foresters? (i- increase productivity, ii- risk reduction, iii- multiple benefits via ecosystem services) (2) What have we learned from the network? (Examples provided for survival and growth) (3) What future experiments would we need to expand our knowledge of the effects of diversity in planted forests?
2. A research paper detailing the meta-analysis of survival data across the network, comparing survival rates of mixtures to those of monocultures, and seeing how increasing species richness affects this survival–diversity relationship.
3. A research paper analysing the variance components of survival data, and how they are partitioned among various covariates (during the workshop, preliminary testing was done with plot, species, and SR).

## Realized outputs:

Verheyen, K., M. Vanhellemont, H. Auge, L. Baeten, C. Baraloto, N. Barsoum, **S. Bilodeau-Gauthier**, H. Bruelheide, B. Castagneyrol, D. Godbold, J. Haase, A. Hector, H. Jactel, J. Koricheva, M. Loreau, S. Mereu, C. Messier, B. Muys, P. Nolet, A. Paquette, J. Parker, M. Perring, Q. Ponette, C. Potvin, P. Reich, A. Smith, M. Weih, M. Scherer-Lorenzen. 2016. Contributions of a global network of tree diversity experiments to sustainable forest plantations. *Ambio* 45(1): 29-41. <https://doi.org/10.1007/s13280-015-0685-1>

## General working atmosphere and feedback on sDiv support

The support provided by the sDiv team, together with the excellent meeting facilities were key to the success of the workshop. The feedback from the participants was mostly enthusiastic, with the scientific relevance uniformly rated as excellent and the expectations well surpassed.

## Follow-up steps identified during the workshop

In addition to the aforementioned manuscripts, other ideas have been mentioned for the future of TreeDivNet:

- Compiling a network-wide database of tree growth, as it was done for tree survival (time horizon to start this: Fall 2014). The first day’s presentations showed us that more experiments than expected had already a reasonable number of annual growth measurements.
- Exploring spatial analyses of survival (and growth, when available) using tree positions within a plot (xy plot coordinates or GPS coordinates), or at least starting to compile this information for the network.
- Start assembling data for multiple plant traits (e.g., seed size, wood density, SLA) across the TreeDivNet network, ideally with traits measured directly in the experiments. Some experiments already possess such information, but for most it will imply new measurements.
- There has been some preliminary talk between a few TreeDivNet members and our invited speaker, Dr. Hartmann from the MPI, regarding potential field sampling of trees in order to

estimate carbohydrate reserves and analyse physiological aspects of mortality. This could eventually lead to a second (after Simone Cesarz's) network-wide field study with a standardized protocol.

## Participants:

Eric Allan (University of Bern); Harald Auge (Helmholtz Centre for Environmental Research – UFZ); Lander Baeten (Ghent University); Nadia Barsoum (Forest Research UK); Simon Bilodeau-Gauthier (German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig); Helge Bruelheide (Martin Luther University Halle Wittenberg); Simone Cesarz (Friedrich Schiller University Jena); Gislene Ganade (UFRN, Federal University of Rio Grande do Norte); Nathaly R Guerrero (Friedrich-Schiller-Universität Jena); Josephine Haase (Albert-Ludwigs University Freiburg); Henrik Hartman (MPI Biogeochemistry); Andrew Hector (University of Oxford); Hervé Jactel (INRA); Julia Koricheva (Royal Holloway University of London); Simone Mereu (University of Sassari); Bart Muys (KU Leuven); Alain Paquette (UQAM); John Parker (Smithsonian); Michael Perring (The University of Western Australia); Quentin Ponette (Université catholique de Louvain (UCL)); Catherine Potvin (McGill University); Claire Salisbury (McGill University); Michael Scherer-Lorenzen (University of Freiburg); Andy Smith (Bangor University); Stefan Trogisch (University Halle); Sean Tuck (University of Oxford); Thomas Van de Peer (KU Leuven); Kris Verheyen (Ghent University).