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## **OPTMix: A unique long-term experimental site in a mixed forest**

Nathalie Korboulewsky, Philippe Balandier, Yves Boscardin, Olivier Chantreuil, Adélie Chevalier, Camille Couteau, Yann Dumas, Marion Gosselin, Jean-Pierre Hamard, Aviva Kara, et al.

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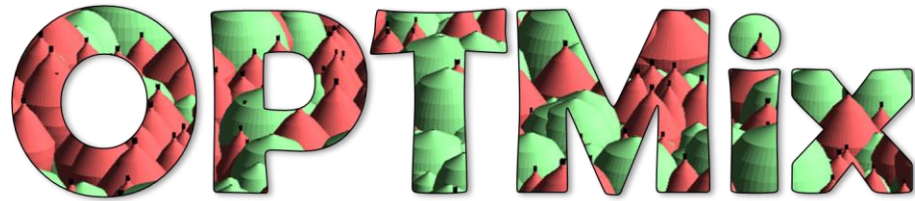
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**Oak Pine Tree Mixture**

<https://optmix.irstea.fr/>



## ➤ A unique long-term experimental site in a mixed forest

Korboulewsky N., Balandier P., Boscardin Y., Chantreuil O., Chevalier, A., Couteau C., Dumas Y., Gosselin M., Hamard JP, Kara A., Mârell A., Pérot T., Perret S.

**INRAE:** French National Research Institute for Agriculture, Food and Environment

**Research Unit:** Forest Ecosystem, Nogent-sur-Vernisson



# ➤ Research Unit: Forest Ecosystem, Nogent-sur-Vernisson

- ✓ 38 persons: researchers, engineers, technicians...
- ✓ 2-5 PhD
- ✓ 10 non-permanent staff /year
- ✓ 8-15 students (mostly master level) / an



Taxonomic biodiversity



Tree growth, ecosystem functioning



Herbivory, vegetation dynamic



Conservation of genetic tree biodiversity



Oak  
*Quercus petraea*

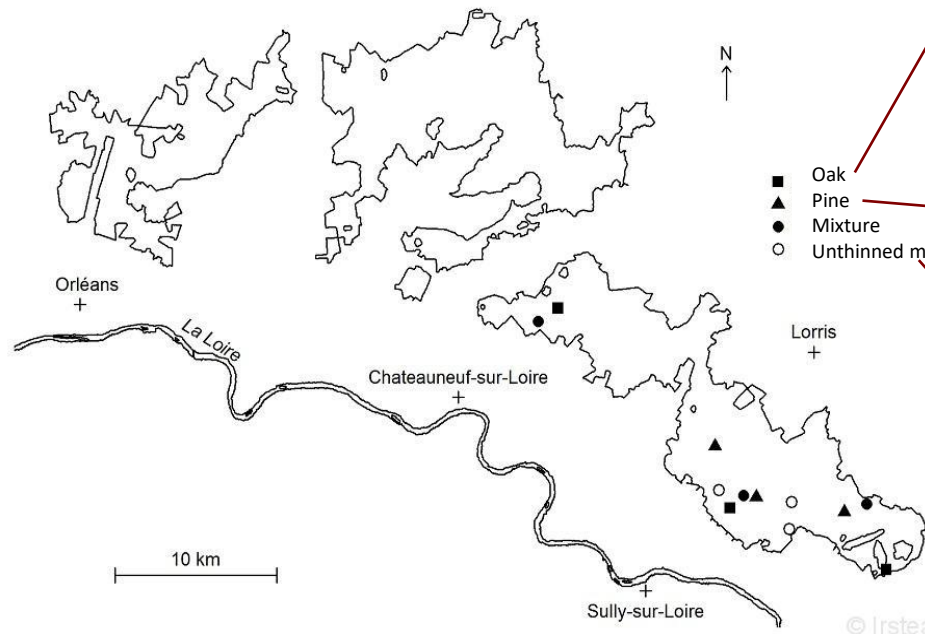


Pine  
*Pinus sylvestris*



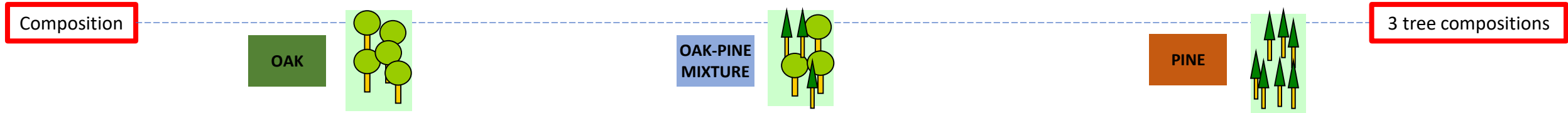
Mixture

**State forest of Orléans**  
Even-aged stands,  
60-80 yr old



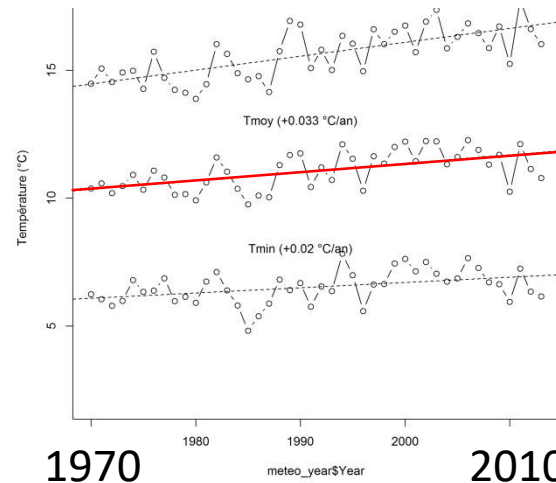


# ➤ Factors tested



**Hyp.:** better growth (niche complementarity), resilience, resistance

Evolution of the annual temperature



T° max

T° mean : ↗ 0.33° C / 10 yr  
+ 1° C the last 30 yr !

T° min

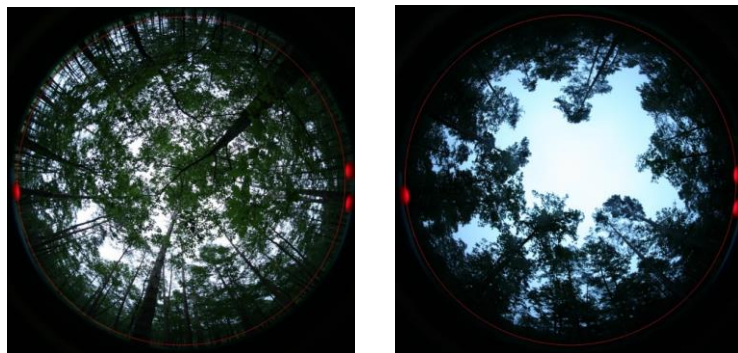
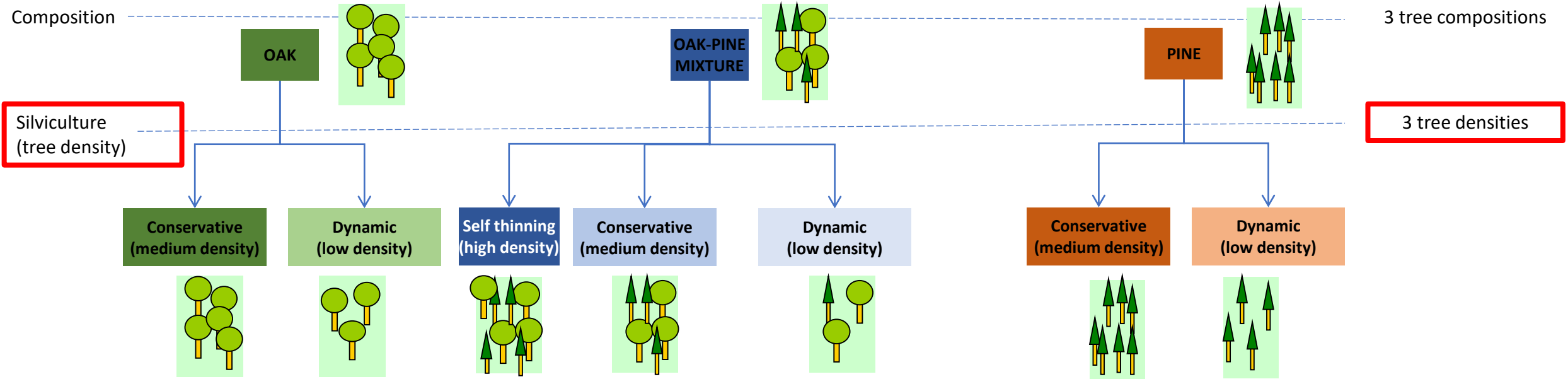
Weather station of Nogent



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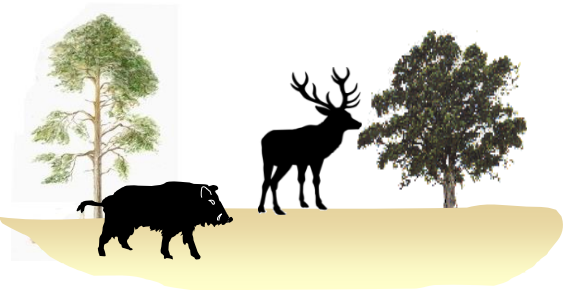
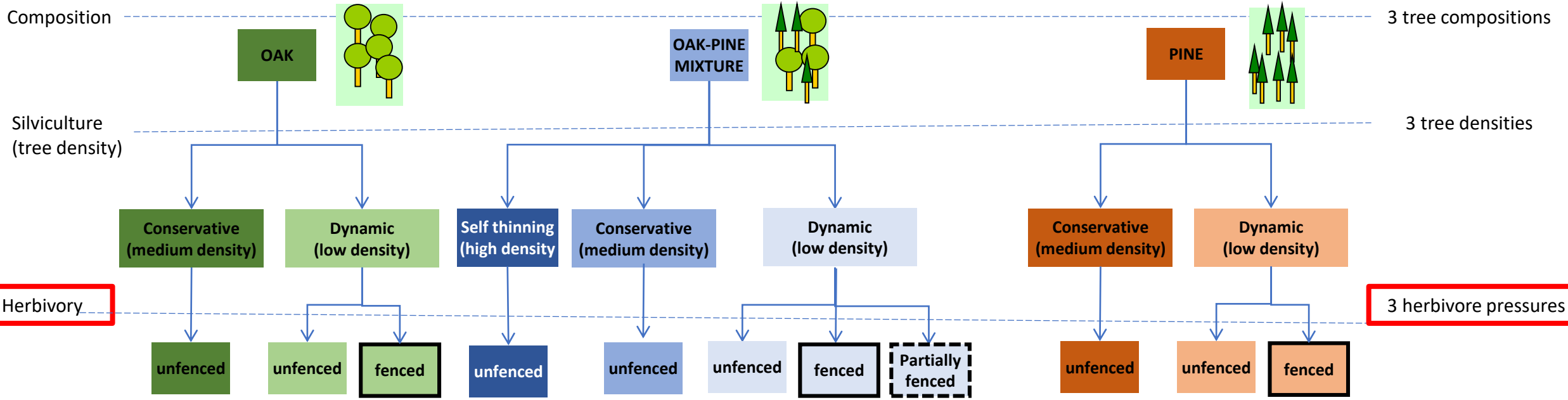
OPTMix: experimental site in mixed forest  
5-6th Oct. 2021 / Korboulewsky et al.

# > Factors tested

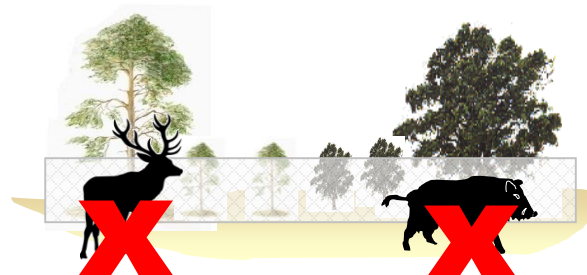


**Hyp.:** lower density =  
lower competition for resources (water)

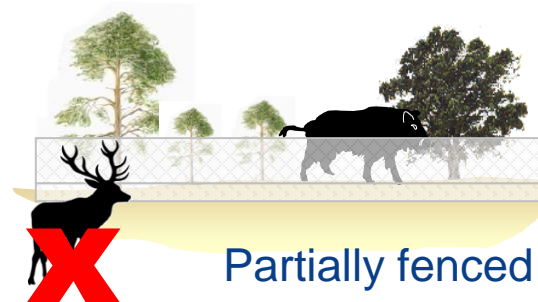
# Factors tested



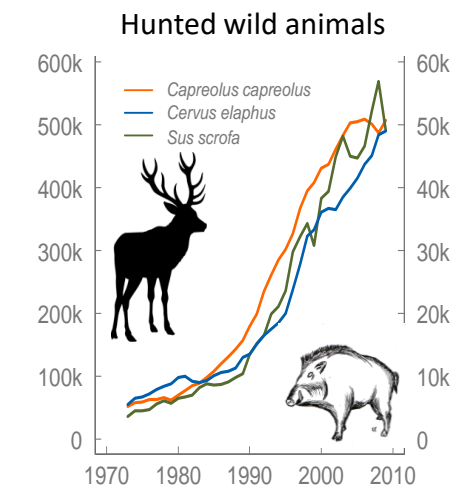
Unfenced



Fenced



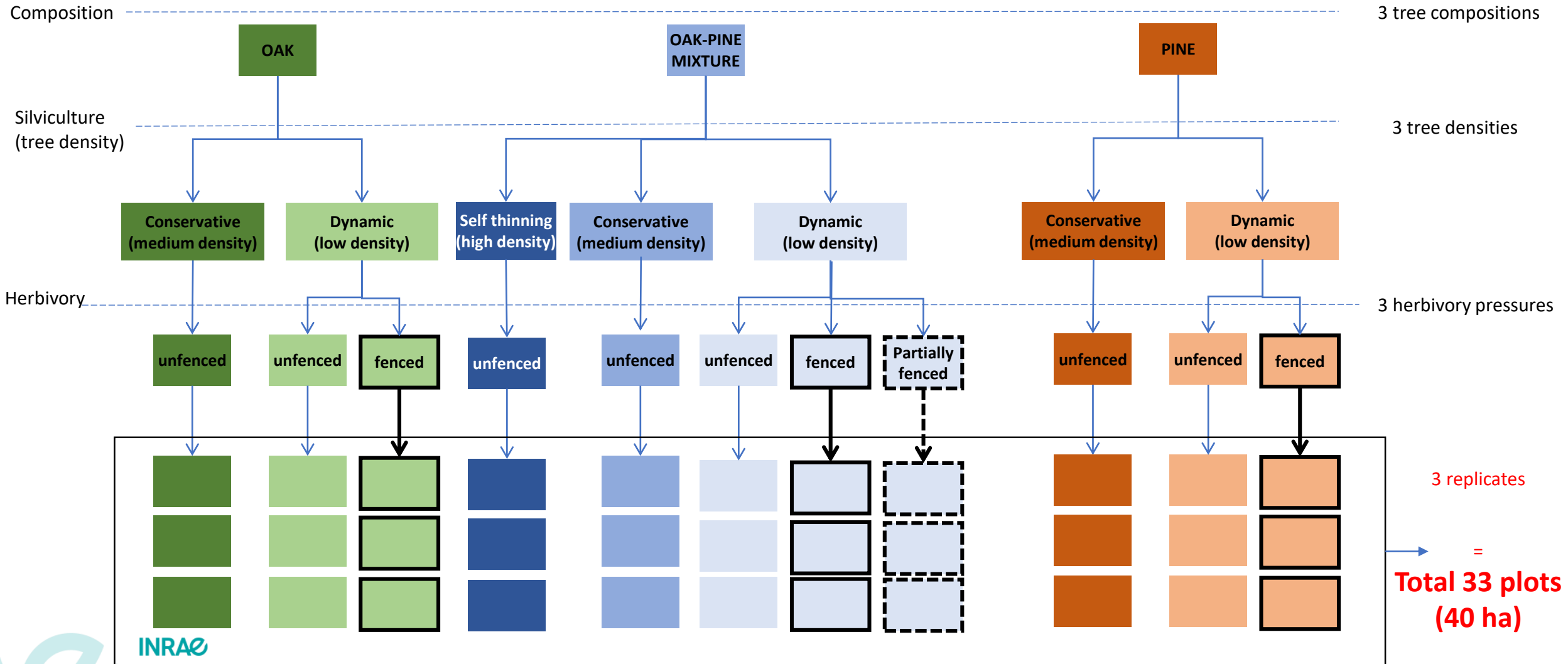
Partially fenced



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OPTMix: experimental site in mixed forest  
 5-6th Oct. 2021 / Korboulewsky et al.

# ➤ Three factors tested on stands with adult trees, over 40 ha !





## > We study...

### Tree growth



Photo: G. Maisonneuve/irstea

10 000 trees  
180 automatic  
dendrometers

### Resource use

water, light, nutrients

578 sensors  
100 000 data/day  
210 litter traps



### Understory dynamics and biodiversity

420 plots  
- regeneration  
- floral biodiversity  
800 days/yr camera traps  
Rodent traps



Photo: G. Maisonneuve/irstea



Photo: G. Maisonneuve/irstea



## ➤ OPTMix and more

OPTMix = a unique *in situ* factorial experiment with 3 factors over 40 ha

Study management practices facing climate change  
Open to collaborations

Staff: > 5 person eq. full time, but 20 persons working on OPMTix  
PhD, Master...

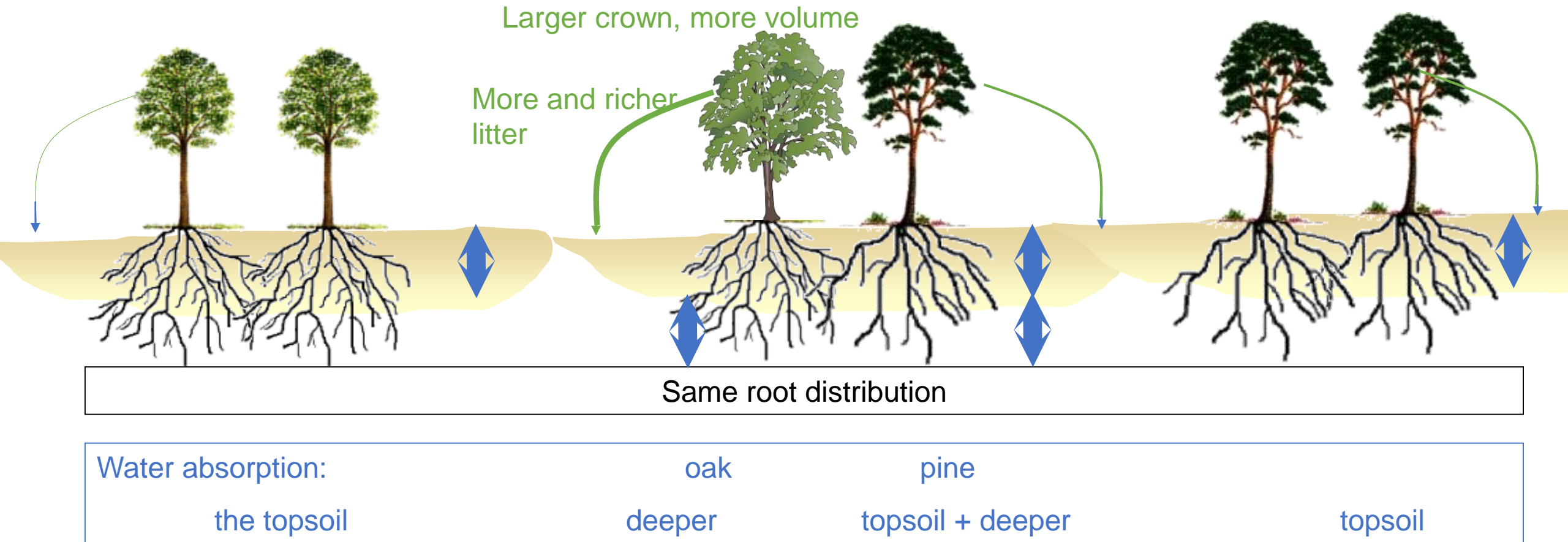
Integrated in networks:



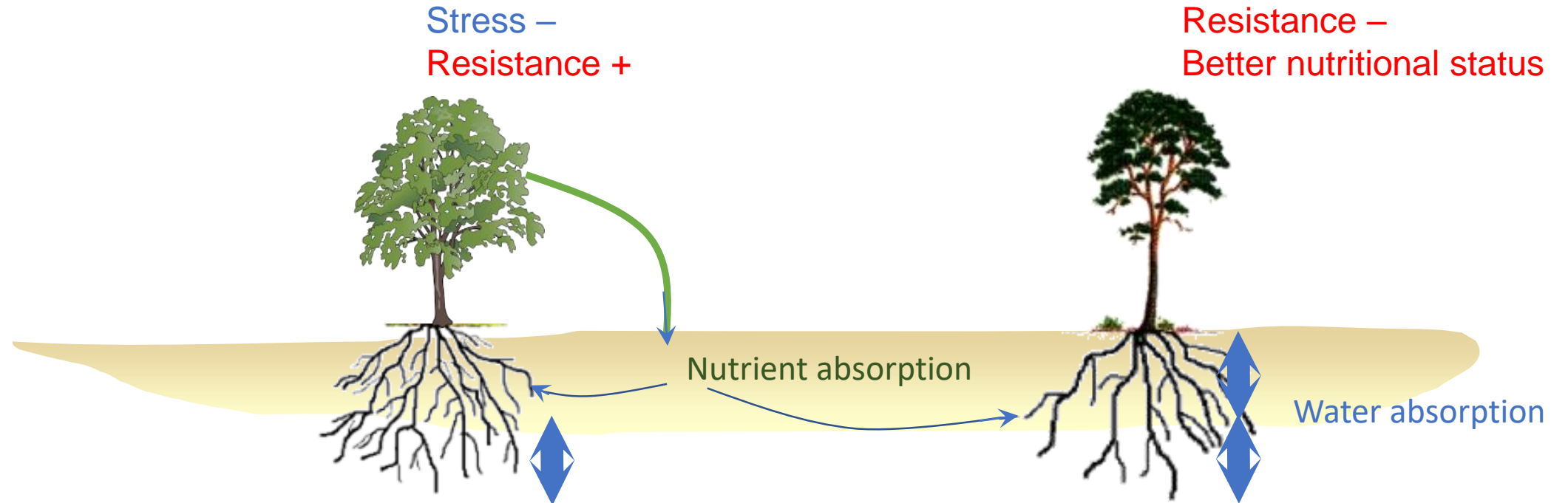
**INRAE**

OPTMix: experimental site in mixed forest  
5-6th Oct. 2021 / Korboulewsky et al.

## ➤ Mixture = modification of some functional traits



## ➤ Mixture vs pure stands



- Oak: lower water stress
- **Better resistance (+27%)**  
= higher growth during drought

- Pine stopped evapotranspiration
- **Lower resistance (-5%)**
- **Better nutritional status**

## ➤ OPTMix – list of peer-reviewed articles

### 2021

- Perot T., Balandier P., Couteau C., Delpierre N., Jean J., Perret S., Korboulewsky N. 2021. Budburst date of *Quercus petraea* is delayed in mixed stands with *Pinus sylvestris*. *Agricultural and Forest Meteorology*. Accepted.
- Korboulewsky N., Heininger C., De Danielli S., Brun J.J. 2021. Effect of tree mixture on Collembola diversity and community structure in temperate broadleaf and coniferous forests. *Forest Ecology and Management* 482: 118876
- Osei R., Titeux H., Bielak K., Bravo Oviedo F., Collet C., Cools C., Cornelis J.P., Heym M., Korboulewsky N., Löf M., Muys B., Najib Y., Nothdurft A., Pach M., Pretzsch H., del Río M., Ruiz-Peinado R., Ponette Q. 2021. Tree species identity drives soil organic carbon storage more than species mixing in two-species forests across Europe. 2020. *Forest Ecology and Management* 481: 118752

### 2020

- Steckel M., del Río M., Heym M., Aldea J., Bielak K., Brazaitis G., Černý J., Coll L., Collet C., Ehbrecht M., Jansons A., Nothdurft A., Pach M., Pardos M., Ponette Q., Reventlow D.O.J., Sitko R., Svoboda M., Vallet P., Wolff B., Pretzsch H. 2020. Species mixing reduces drought susceptibility of Scots pine (*Pinus sylvestris* L.) and oak (*Quercus robur* L., *Quercus petraea* (Matt.) Liebl.) – Site water supply and fertility modify the mixing effect. *Forest Ecology and Management* 461: 117908.

### 2019

- Pretzsch H., M. Steckel M., Heym M., Biber P., Ammer C., Ehbrecht M., Bielak K., Bravo F., Ordóñez C., Collet C., Vast F., Droessler L., Brazaitis G., Jansons A., Coll L., Löf M., Aldea J., Korboulewsky N., Reventlow D.O.J., Nothdurft A., Engel M., Pach M., Skrzyszewski J., Pardos M., Ponette Q., Sitko R., Fabrika M., Svoboda M., Černý J., Wolff B., Ruiz-Peinado R., del Río M. 2019. Stand growth and structure of monospecific and mixed-species stands of Scots pine (*Pinus sylvestris* L.) and oak (*Q. robur* L., *Quercus petraea* (MATT.) LIEBL.) analysed along a productivity gradient through Europe. *European Journal of Forest Research* 139:349-367.
- Cocquelet, A., Mårell, A., Bonthoux, S., Baltzinger, C., Archaux, F., 2019. Direct and indirect effects of ungulates on forest birds' nesting failure? An experimental test with artificial nests. *Forest Ecology and Management* 437:148-155. doi:10.1016/j.foreco.2019.01.025
- Kędra K., Barbeito I., Dassot M., Vallet P., Gazda A. 2019. Single-image photogrammetry for deriving tree architectural traits in mature forest stands: a comparison with terrestrial laser scanning. *Annals of Forest Science*, 76(1), 5. <https://doi.org/10.1007/s13595-018-0783-x>
- Pérot T., Balandier P., Couteau C., Perret S., Seigner V., Korboulewsky N. 2019. Transmitted light as a tool to monitor tree leaf phenology and development applied to *Quercus petraea*. *Agricultural and Forest Meteorology*, 275: 37-46. <https://doi.org/10.1016/j.agrformet.2019.05.010>.
- Bello J., Hasselquist N., Vallet P., Kahmen A., Pérot T., Korboulewsky N., 2019. Complementary water uptake depth of *Quercus petraea* and *Pinus sylvestris* in mixed stands during an extreme drought. *Plant and Soil*, 437 (1-2): 93-115.
- Bello J., Vallet P., Pérot T., Balandier P., Seigner V., Perret S., Couteau C., Korboulewsky N. 2019. How do mixing tree species and stand density affect seasonal radial growth during drought events? *Forest Ecology and Management*, 432: 436-445. <https://doi.org/10.1016/j.foreco.2018.09.044>



## ➤ OPTMix – list of peer-reviewed articles

### 2018

- Vallet P., Pérot T. 2018. Coupling transversal and longitudinal models to better predict *Quercus petraea* and *Pinus sylvestris* stand growth under climate change. *Agricultural and Forest Meteorology*, 263: 258-266.
- Mårell A., Hamard JP, Pérot T., Perret S., Korboulewsky N. 2018. The effect of deer browsing and understory light availability on stump mortality and sprouting growth capacity in sessile oak. *Forest Ecology and Management*, 430: 134-142.

### 2017

- Bonal, D., M. Pau, M. Toigo, A. Granier and T. Perot (2017). "Mixing oak and pine trees does not improve the functional response to severe drought in central French forests." *Annals of Forest Science* 74(4): 72. <http://dx.doi.org/10.1007/s13595-017-0671-9>
- Gosselin, M., Fourcin D. , Dumas Y., Gosselin F. , Korboulewsky N., Toïgo M. and Vallet P. 2017. Influence of forest tree species composition on bryophytic diversity in mixed and pure pine (*Pinus sylvestris* L.) and oak (*Quercus petraea* (Matt.) Liebl.) stands. *Forest Ecology and Management* 406 (Supplement C): 318-329. <https://doi.org/10.1016/j.foreco.2017.09.067>
- Laurent L., Mårell A., Korboulewsky N., Saïd S., Balandier P. 2017. How does disturbance affect the intensity and importance of plant competition along resource gradients? *Forest Ecology and Management*, 391: 239–245. <http://dx.doi.org/10.1016/j.foreco.2017.02.003>.
- Perot T., Mårell A., Korboulewsky N., Seigner V., Balandier P. 2017. Modeling and predicting solar radiation transmittance in mixed forests at a within-stand scale from tree species basal area. *Forest Ecology and Management*, 390: 127–136. <http://dx.doi.org/10.1016/j.foreco.2017.01.023>

### 2015

- Merlin M., Pérot T., Perret S., Korboulewsky N., Vallet P. 2015. Effects of stand composition and social status on resistance and resilience to drought in sessile oak and Scots pine. *Forest Ecology and Management* 339C: 22-33. DOI: 10.1016/j.foreco.2014.11.032
- Toigo, M., P. Vallet, V. Tuilleras, F. Lebourgeois, P. Rozenberg, S. Perret, B. Courbaud and T. Perot (2015). "Species mixture increases the effect of drought on tree ring density, but not on ring width, in *Quercus petraea*-*Pinus sylvestris* stands." *Forest Ecology and Management* 345: 73-82. doi: 10.1016/j.foreco.2015.02.019



## ➤ OPTMix en bref

OPTMix vise à améliorer les connaissances sur le fonctionnement des forêts mélangées en région tempérée avec des applications directes à la gestion forestière en particulier dans le cadre des changements climatiques.

- Un site unique
- Trois facteurs sont contrôlés : la composition du peuplement, la densité du peuplement et la présence des herbivores ;
- le site est équipé de nombreux capteurs ;
- plusieurs services écosystémiques y sont étudiés (e. g. : production de bois, biodiversité) ;
- plusieurs approches scientifiques sont combinées : descriptive, écophysiological et fonctionnelle, modèles basés sur les processus et modèles basés sur les observations ;
- Trois répétitions pour une surface totale de 40 ha dans la même forêt (47°46' – 47°55' N, 2°17' – 2°35' E) ;
- Le site est installé dans une forêt tempérée de plaine, avec du chêne sessile et du pin sylvestre, deux espèces importantes par leur surface couverte et par l'utilisation de leur bois ;
- le mélange chêne sessile – pin sylvestre est un des mélanges les plus répandus en France concernant les mélanges feuillus – résineux, et ces deux espèces ont des traits contrastés ;
- OPTMix est un dispositif de suivi à long-terme ;

• **INRAE** A proximité (20 à 50 km) Irstea dispose d'une pépinière expérimentale, de serres et d'un laboratoire.

OPTMix: experimental site in mixed forest

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