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.

OPTMix

Oak **P**ine **T**ree **Mix**ture

https://optmix.irstea.fr/

AnaEE Analysis and Experimentation on Ecosystems France

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., **Mårell A.**, Pérot T., Perret S.

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

Research Unit: Forest Ecosystem, Nogent-sur-Vernisson

RÉPUBLIQUE FRANÇAISE Liberté Égalité Fraternité

INRAE

Office National des Forêts

Région Centre-Val de Loire

Loiret votre Département

Workshop, WG3 BOTTOMS-UP, 5-6th October 2021, Vácrátót, Hungary

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

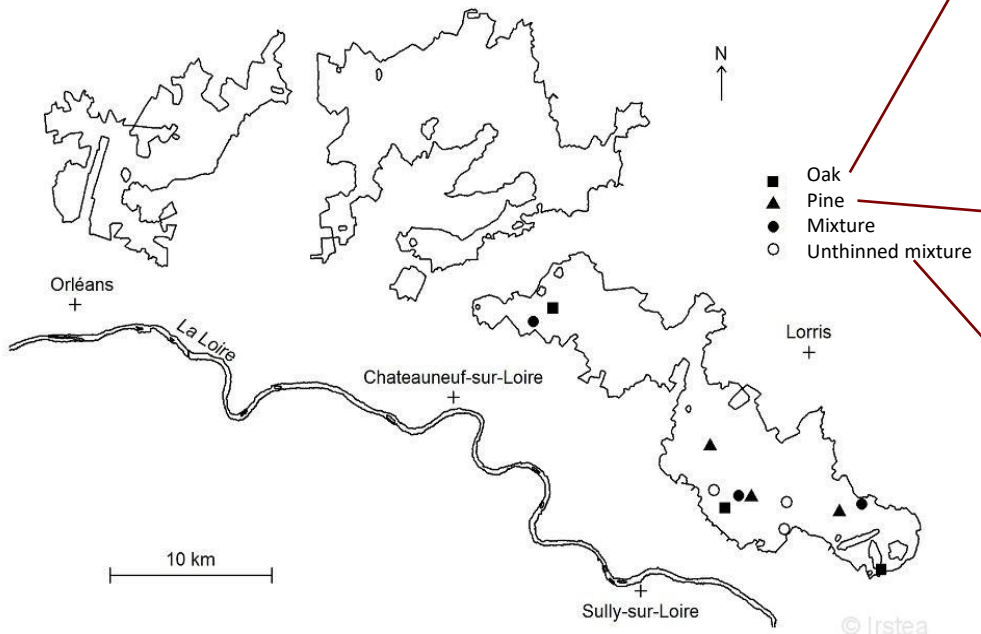
Herbivory, vegetation dynamic

Conservation of genetic tree biodiversity

Study area and description

OPTMix
Oak Pine Tree Mixture
https://optmix.irstea.fr/

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



Oak
Quercus petraea

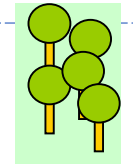
Pine
Pinus sylvestris

Mixture

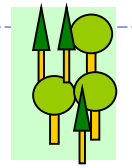
Factors tested

Composition

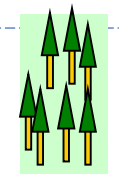
OAK



OAK-PINE MIXTURE



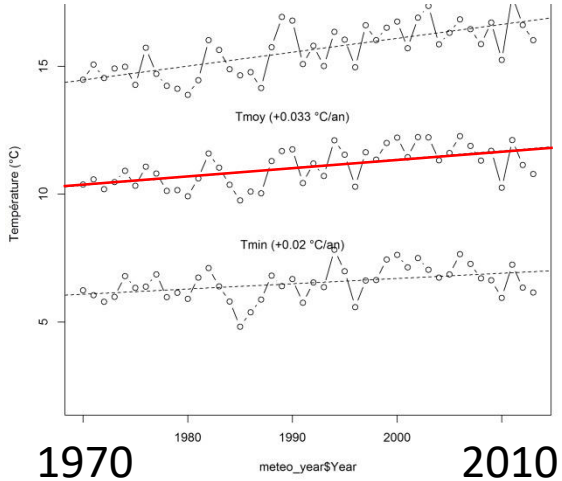
PINE



3 tree compositions

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

Evolution of the annual temperature



1970 2010

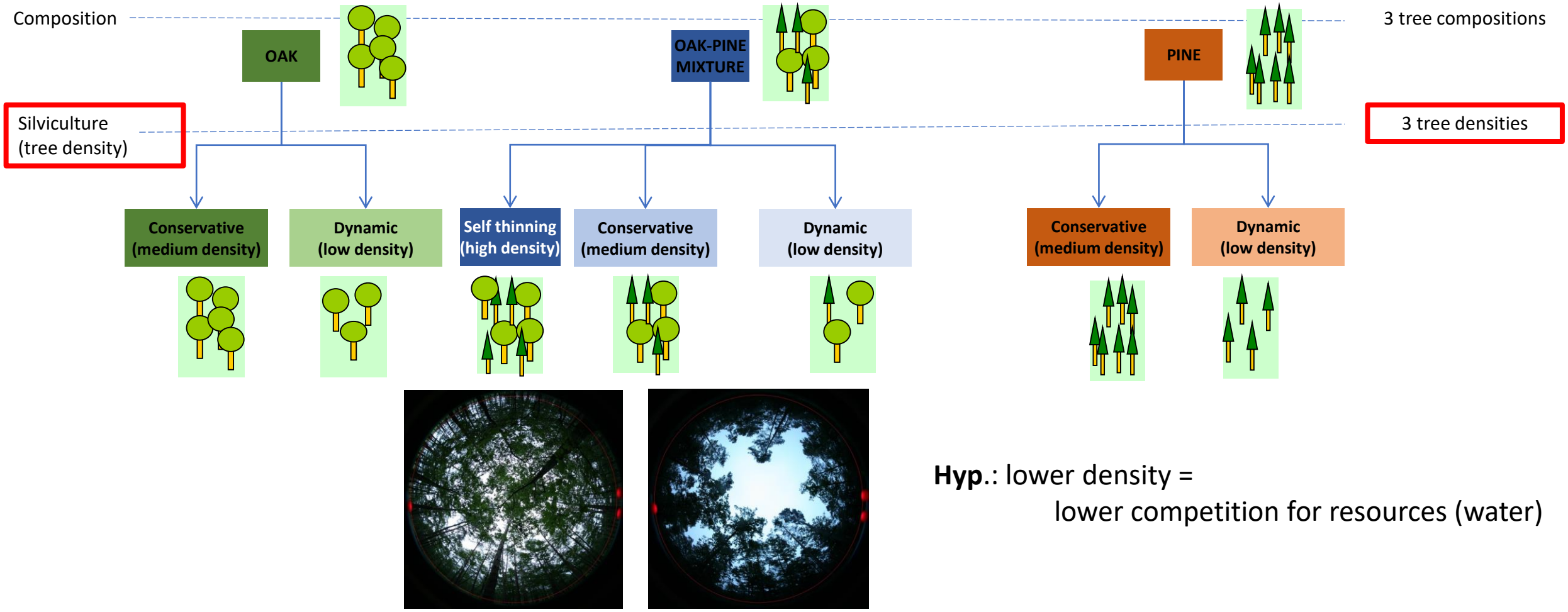
T° max

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

T° min

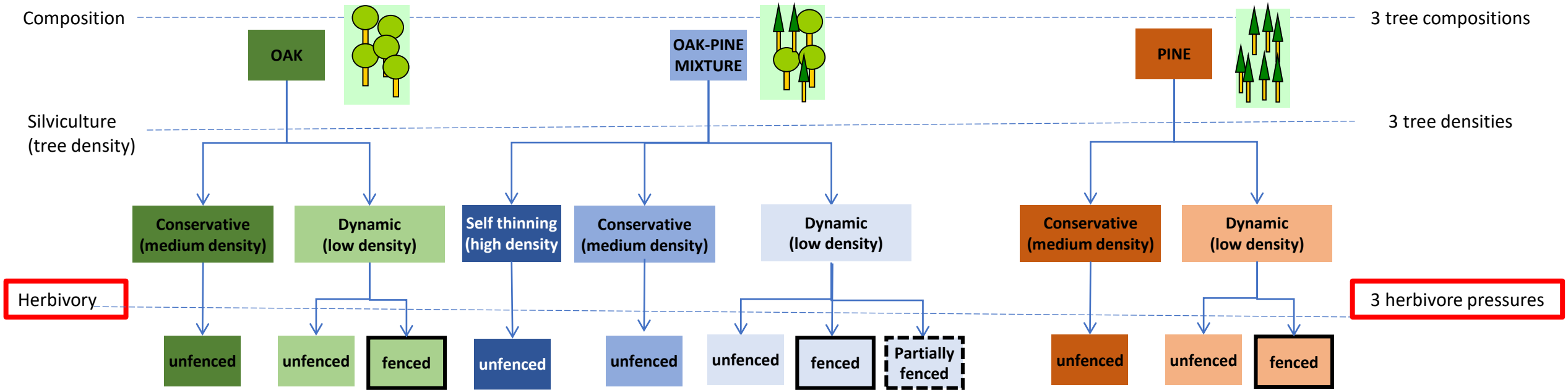
Weather station of Nogent

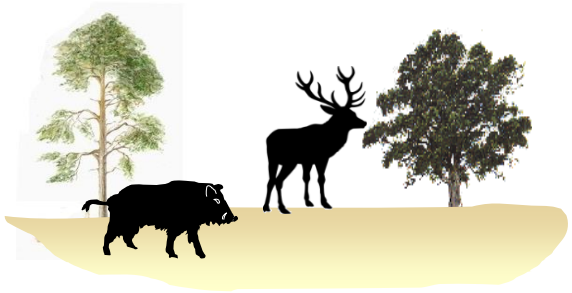
Factors tested



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

Factors tested





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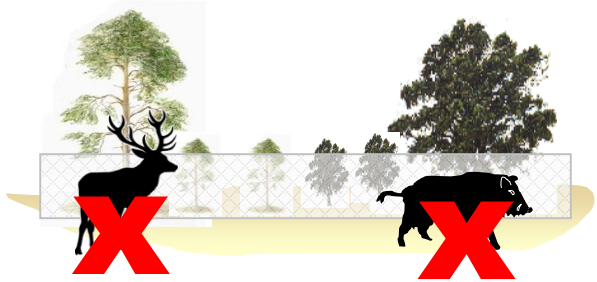
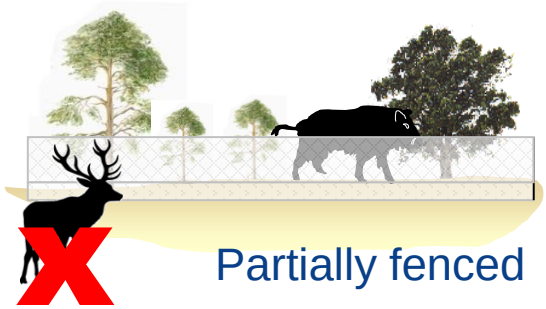
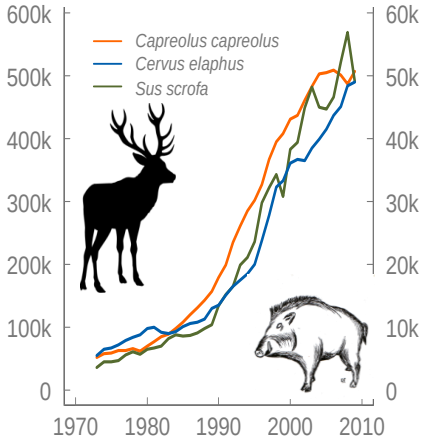


Fenced



Partially fenced

Hunted wild animals



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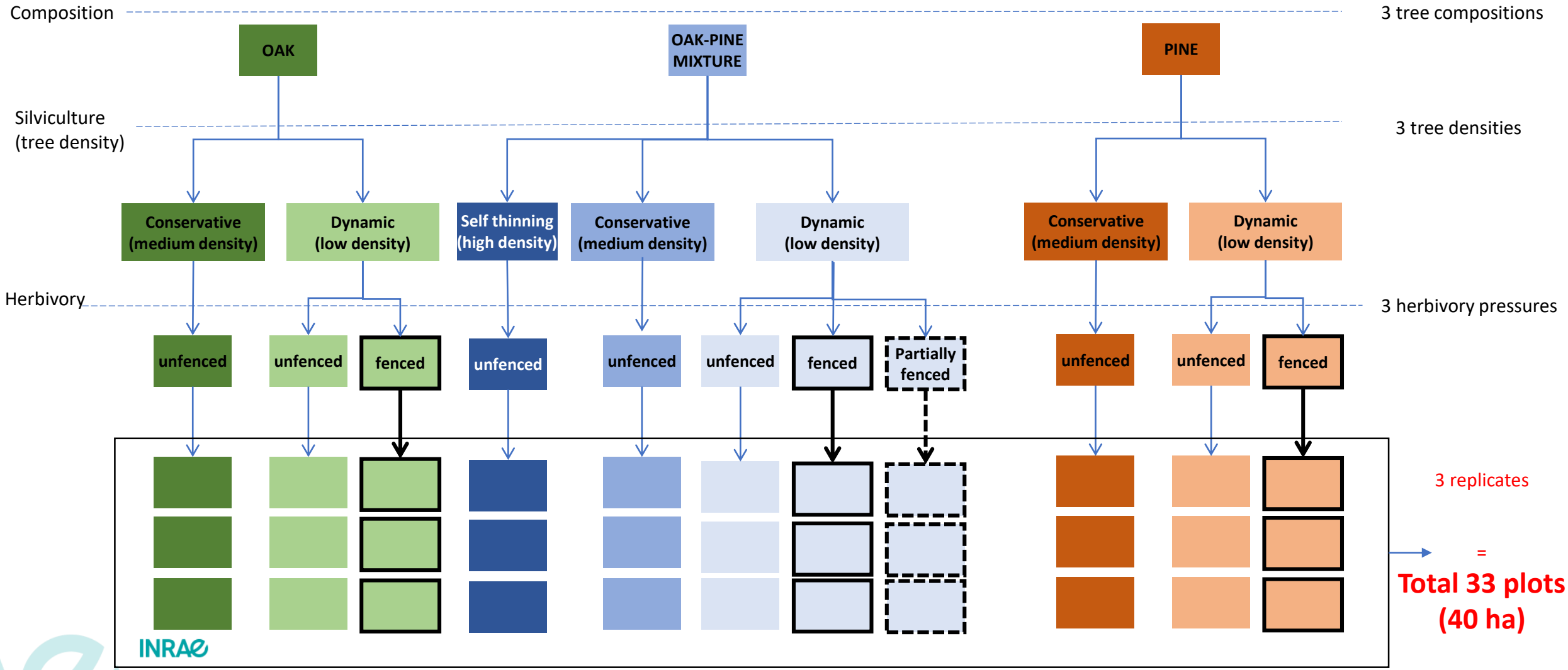
OPTMix: experimental site in mixed forest

5-6th Oct. 2021 / Korboulewsky et al.

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



We study…

Tree growth

10 000 trees
180 automatic dendrometers

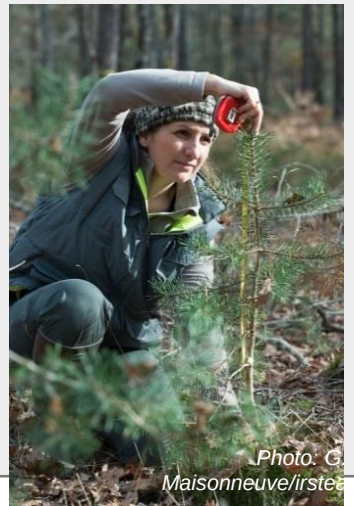
Resource use

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



OPTMix and more

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

Study management practices facing climate change

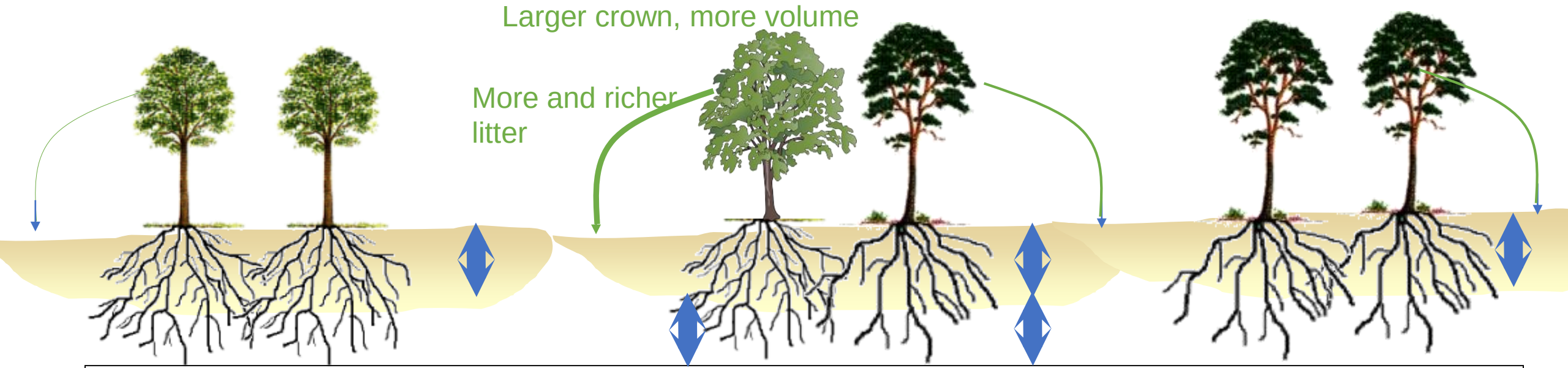
Open to collaborations

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

PhD, Master…

Integrated in networks: GISCoop, In-Sylva France, AnaEE France, Zones Ateliers LTSER France LOIRE, TEMPO, ODS

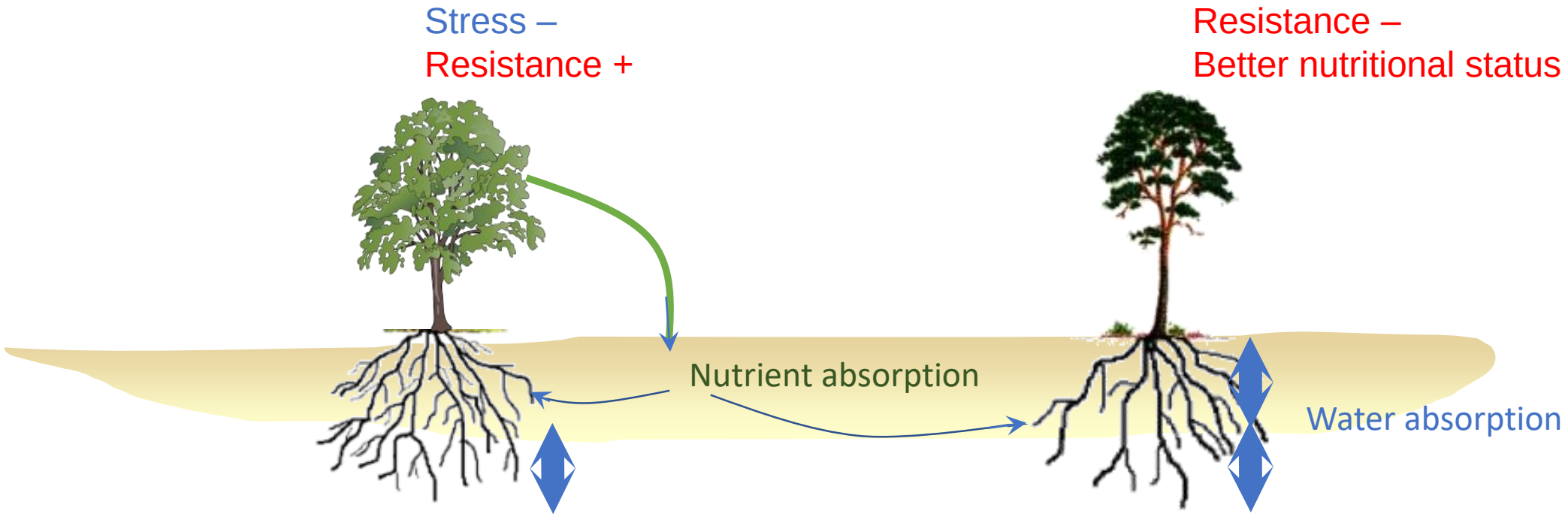
Mixture = modification of some functional traits



Water absorption:	oak	pine
the topsoil	deeper	topsoil + deeper
		topsoil

Preztsch et al. 2019, Eur J For Res
Kędra et al. 2019, Ann For Sci
Bello et al. 2019, Plant Soil

Mixture vs pure stands



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

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

Bello et al. 2019, For Ecol Manag
Bello 2019, PhD Thesis

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., Pretzscha H., del Rio 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, écophysiologique 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 ;
- A proximité (20 à 50 km) Irstea dispose d’une pépinière expérimentale, de serres et d’un laboratoire.