Planning for the next generation of urban trees: how can research on biodiversity help?

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Chaire de recherche CRSNG - Hydro-Québec sur le contrôle de la croissance des arbres

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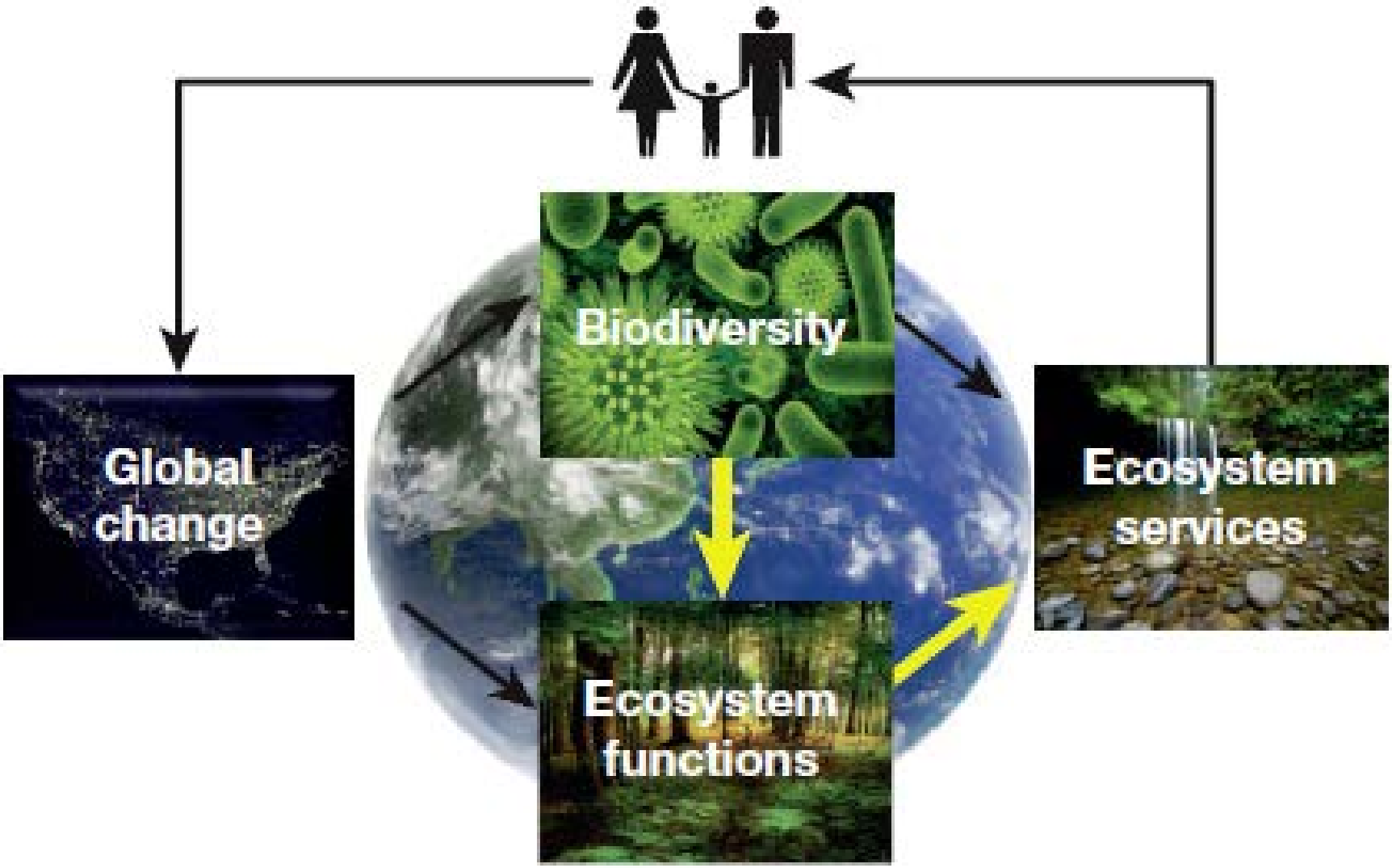
Framework: Biodiversity and Ecosystem Functioning



Cardinale, B. J., J. E. Duffy, A. Gonzalez, D. U. Hooper, C. Perrings, P. Venail, A. Narwani, G. M. Mace, D. Tilman, D. A. Wardle, A. P. Kinzig, G. C. Daily, M. Loreau, J. B. Grace, A. Larigauderie, D. Srivastava et S. Naeem. 2012. **Biodiversity loss and its impact on humanity.** Nature 486: 59-67.

Table 1 | Balance of evidence linking biodiversity to ecosystem services

Category of service	Measure of service provision	SPU	Diversity level	Source	Study type	*N*	Relationship	
							Predicted	Actual
Provisioning								
Crops	Crop yield	Plants	Genetic	DS	Exp	575	↗	↗
			Species	DS	Exp	100	↘	↘↗
Fisheries	Stability of fisheries yield	Fish	Species	PS	Obs	8	↗	↗
Wo								
Fod								
Regul								
Bio								
	Control of herbivorous pests (top-down effect of natural enemy diversity)	Natural enemies	Species/trait	DS*	Obs	18	↗	↗
		Natural enemies	Species	DS†	Exp/Obs	266	↗	↗
		Natural enemies	Species	DS‡	Exp	38	↘	↘↗
	Resistance to plant invasion	Plants	Species	DS	Exp	120	↘	↘
	Disease prevalence (on plants)	Plants	Species	DS	Exp	107	↘	↗
	Disease prevalence (on animals)	Multiple	Species	DS	Exp/Obs	45	↘	↘↗
Climate	Primary production	Plants	Species	DS	Exp	7	↗	0
	Carbon sequestration	Plants	Species	DS	Exp	479	↗	↗
	Carbon storage	Plants	Species/trait	PS	Obs	33	↘	↘↗
Soil	Soil nutrient mineralization	Plants	Species	DS	Exp	103	↗	↗
	Soil organic matter	Plants	Species	DS	Exp	85	↗	↗
Water	Freshwater purification	Multiple	Genetic/species	PS	Exp	8	↗	0
Pollination	Pollination	Insects	Species	PS	Obs	7	↘	↘↗

Where are the services to the millions living in cities?!

Linking Biodiversity and Ecosystem Services: Current Uncertainties and the Necessary Next Steps

PATRICIA BALVANERA, ILYAS SIDDIQUE, LAURA DEE, ALAIN PAQUETTE, FOREST ISBELL, ANDREW GONZALEZ, JARRETT BYRNES, MARY I. O'CONNOR, BRUCE A. HUNGATE, AND JOHN N. GRIFFIN

2014 update
Still nothing about cities!

Unde tal
Platfo ity
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under realistic conditions could fill these gaps and could inform the outcomes of alternative management and policy scenarios within IPBES.

Keywords: IPBES, management, experiment, biodiversity effects, meta-analysis

Balvanera P et al. (2014) Linking biodiversity and ecosystem services: current uncertainties and the necessary next step BioScience 64:49-57

Urban trees provide services

Air quality

Well-being

Rom

How is this affected by diversity?

Building energy use

San Francisco, USA

Microclimate

Beijing, CN

IDENT

International Diversity Experiment Network with Trees

Advancing biodiversity – ecosystem functioning science with the use of high-density tree-based experiments

Tobner et al. Oecologia 2014

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IDENT : International Diversity Experiment Network with Trees

La Tuque, Montréal, Auclair, Cloquet, SSM, Sardinia, Freiburg...

Partners of the TreeDivNet

Scientific coordinators: Christian Messier (UQO/UQAM) and Alain Paquette (UQAM)
Collaborators:
Christian Messier, Tanya Handa, Steve Kembel et Tim Work (UQAM), Dominique Gravel (UQAR), Alison Munson (Laval), Bill Shipley (Sherbrooke).
Peter Reich (UofM), Michael Scherer-Lorenzen (TreeDivNet), Bill Parker (OMNR), Simone Mereu (U. Sassari), Juan Posada (U.Bogota), Bart Muys (Leuven).

Complementarity: better utilization of available resources

Mechanism: niche partition

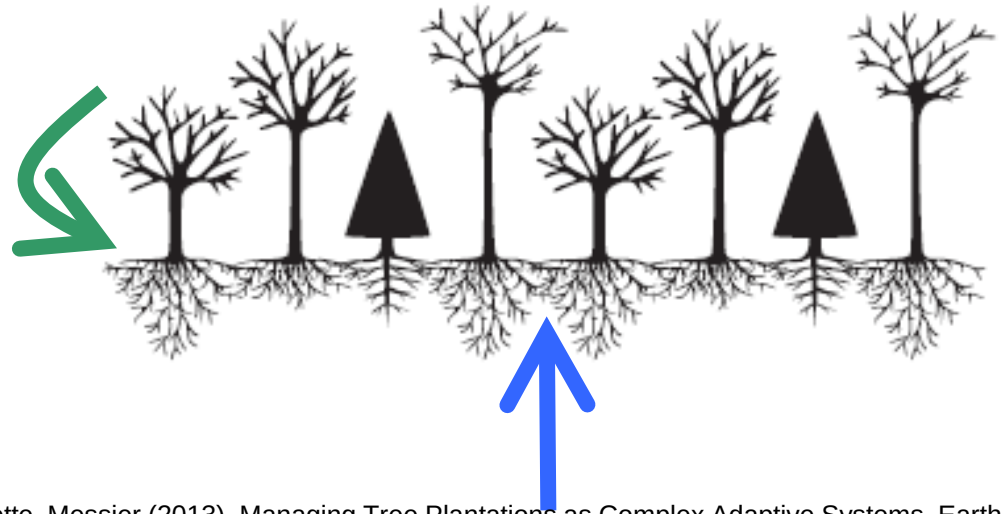
Measure: functional diversity; *the diversity of traits*

FIGURE A

Monoculture

3 similar species

FIGURE B



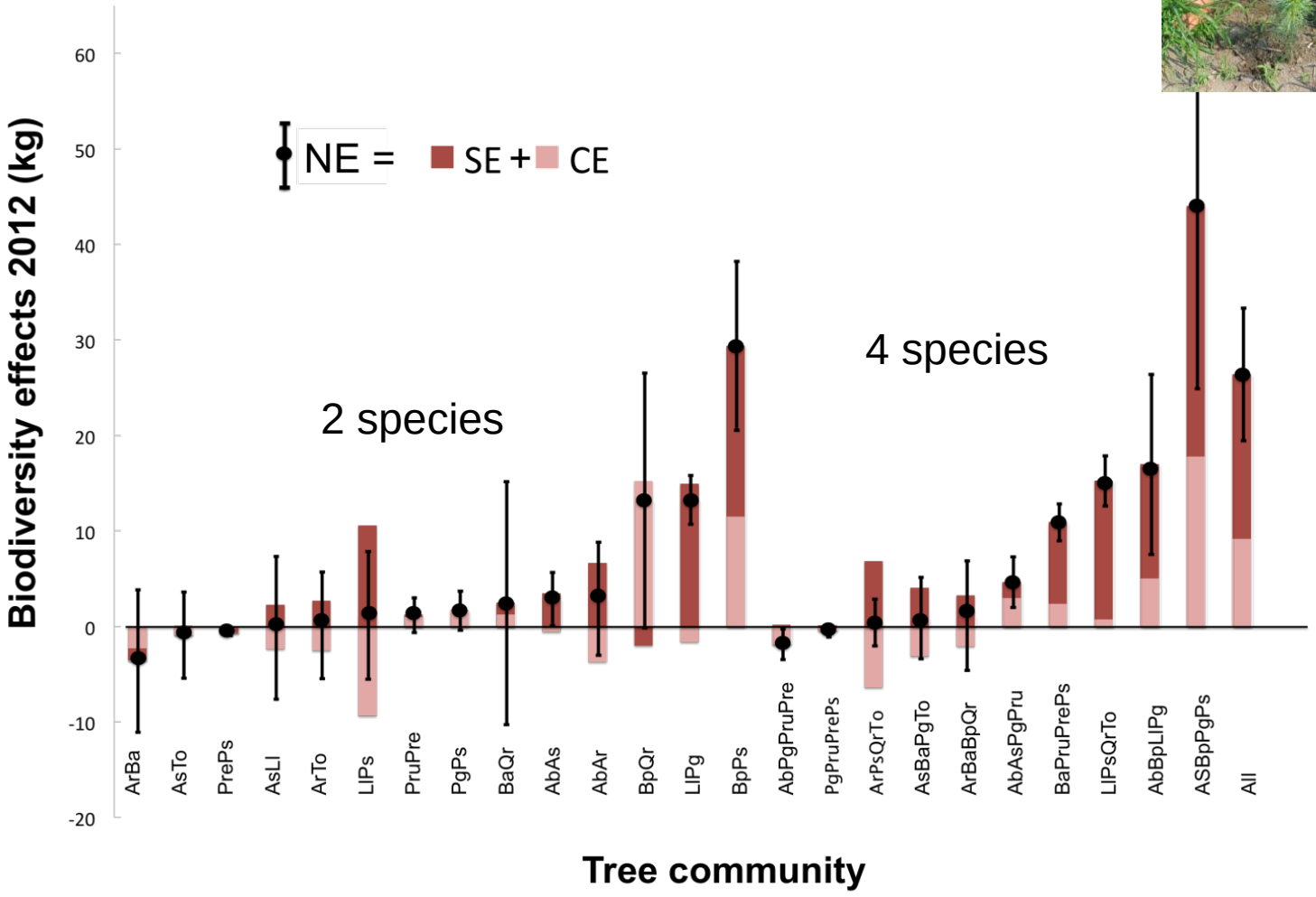
Diversified

3 « unique » species

Paquette, Messier (2013). Managing Tree Plantations as Complex Adaptive Systems. EarthScan, New York

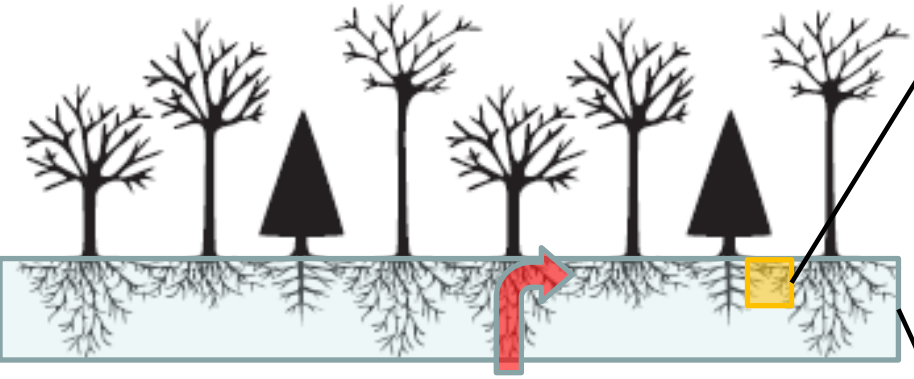
MAC 2009

Diversity effect on above-ground growth

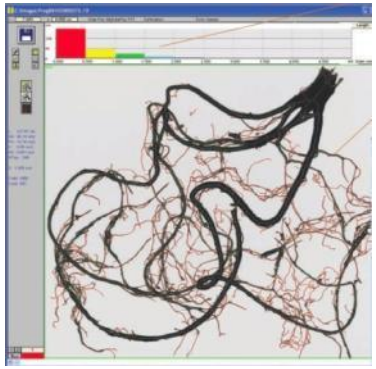


Conny Garbe (PhD) et al

Root complementarity

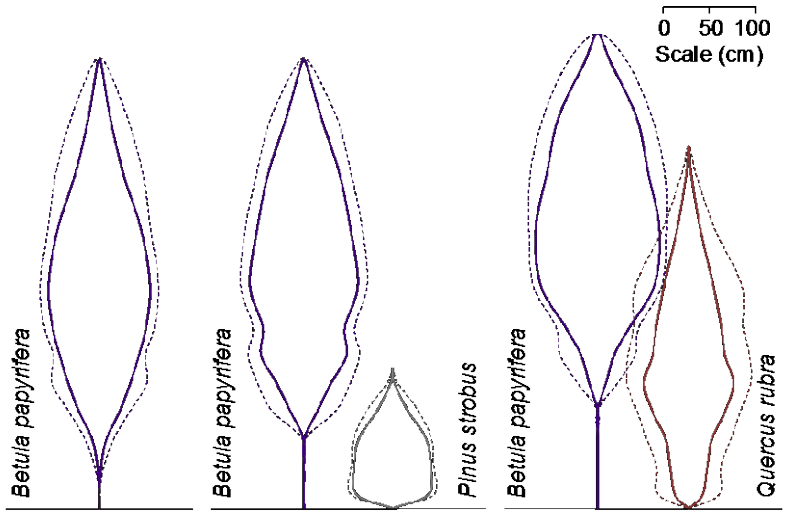


Plasticity
•Diameter
•Branching
•Specific Root Length



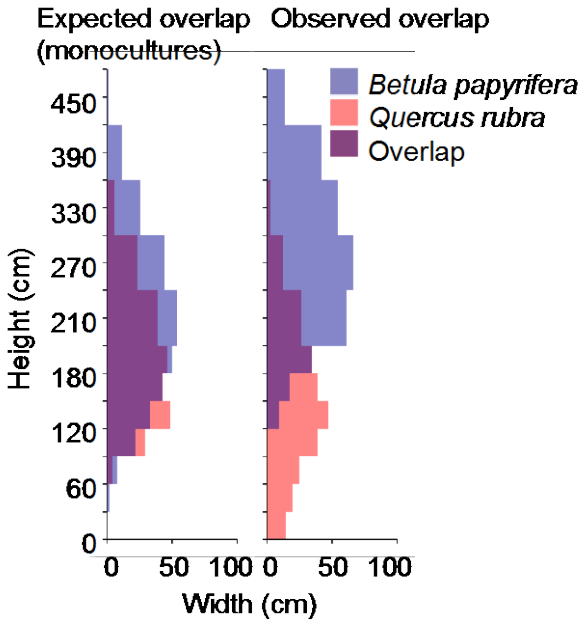
Complementarity
•Better use of volume (resources)

Chelsea Archambault et al

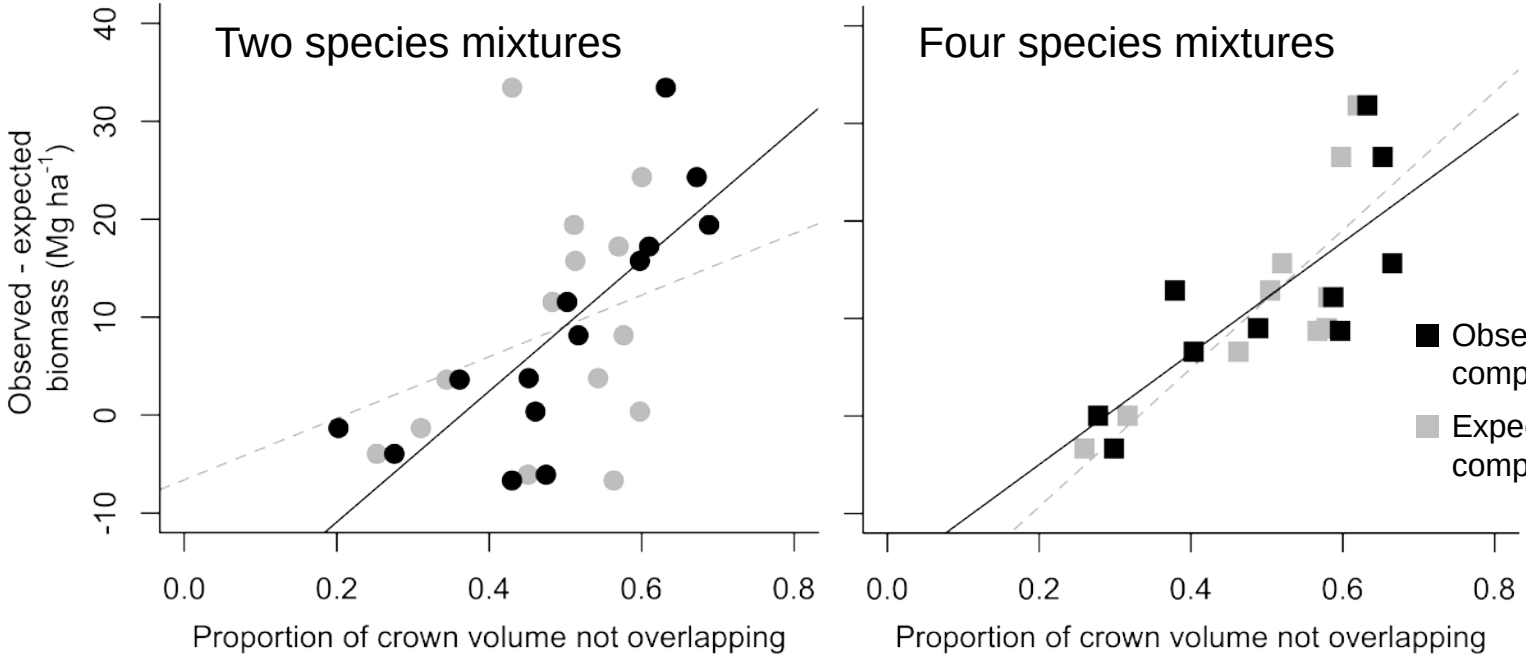


< Crown shapes of some species shift with neighbors

> Some shifts in crown shape enhance complementarity



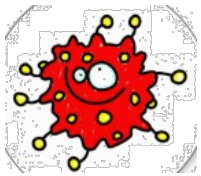
Complementarity in crown shape correlates with overyielding

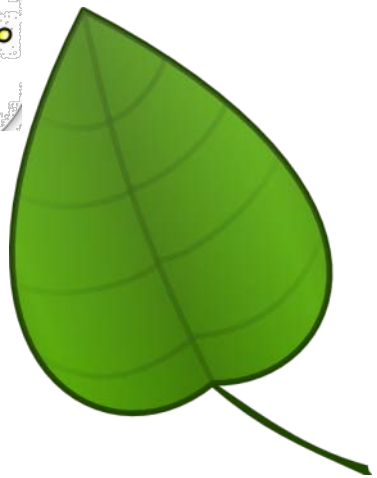


Laura Williams et al

What about other trophic levels?

- Very important for the resilience of the urban forest
- How does diversity affect
  - Litter and soil microathropods
  - Phylosphere and rhysosphere microbial communities
  - Canopy arthropods
  - Soil microbes' resilience and resistance

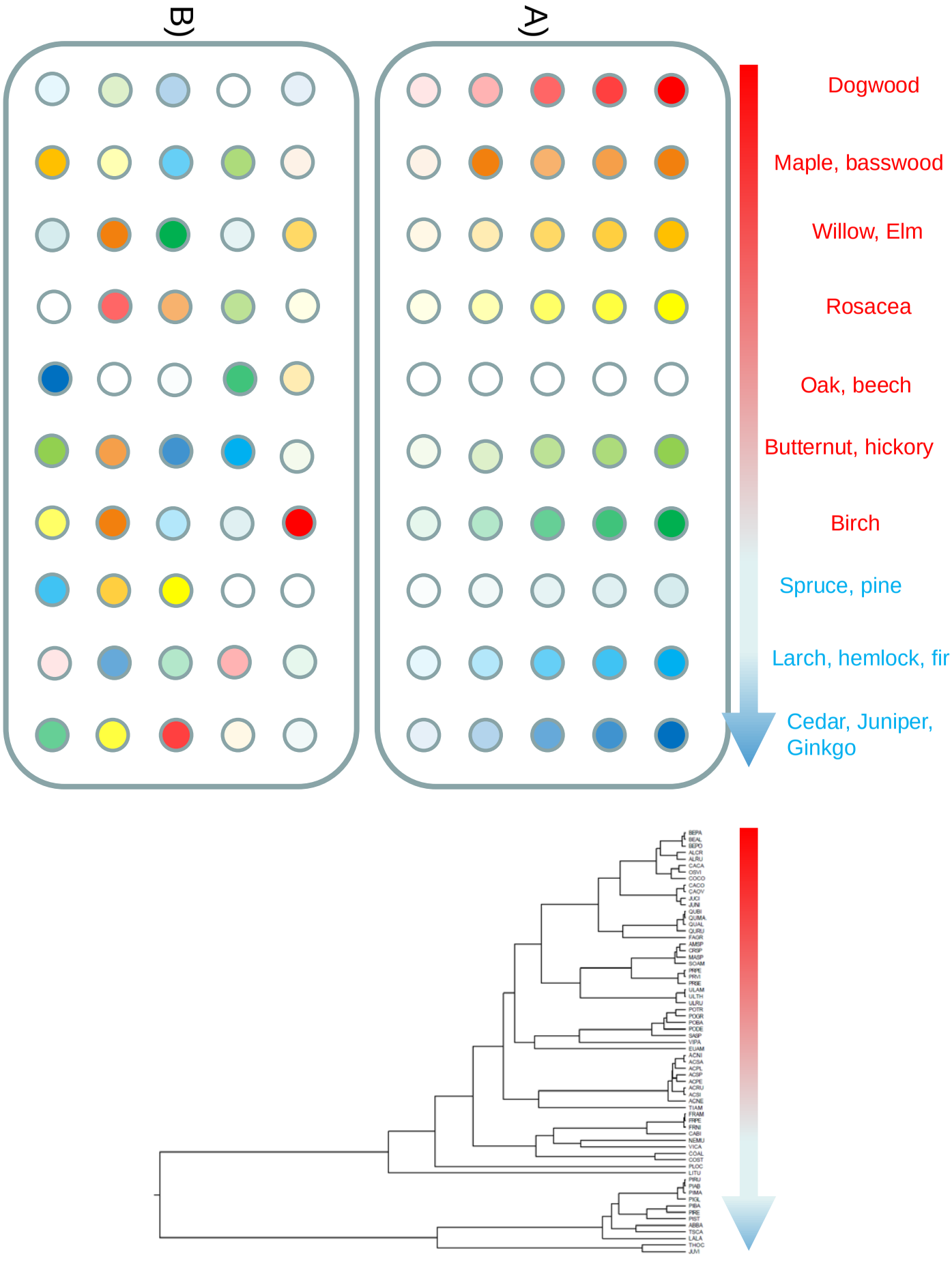




Isabelle Laforest-Lapointe et al

IDENT City

- Showcasing tree diversity and its importance for urban forests
- Diversity (and identity) matters for the production of services,
- as well as resistance and resilience
  - Invasion, insect, change in climate
- Importance of diversity in several forms: richness, functional, structural, phylogenetic


B)
A)
Dogwood
Maple, basswood
Willow, Elm
Rosacea
Oak, beech
Butternut, hickory
Birch
Spruce, pine
Larch, hemlock, fir
Cedar, Juniper, Ginkgo

Chaire
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