L'adaptation de nos pratiques forestières aux changements climatiques: *viser la diversité et complexité pour conserver ou augmenter l'adaptabilité*

Christian Messier. Ing. f. UQAM et UQO, Chaire de recherche CRSGN/Hydro-Quebec sur la croissance des arbre , Institut des Sciences de la Forêt Tempérée (ISFORT), Centre d'Étude de la Forêt (CEF) et Programme CRSNG/FONCER sur la modélisation de la complexité des forêts

Plan de la présentation

- Vers une foresterie écologique
- Nouvelles conditions biophysiques et socio-économiques
- Aménager pour tenir compte des changements globaux

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- ***Vers une foresterie écologique***
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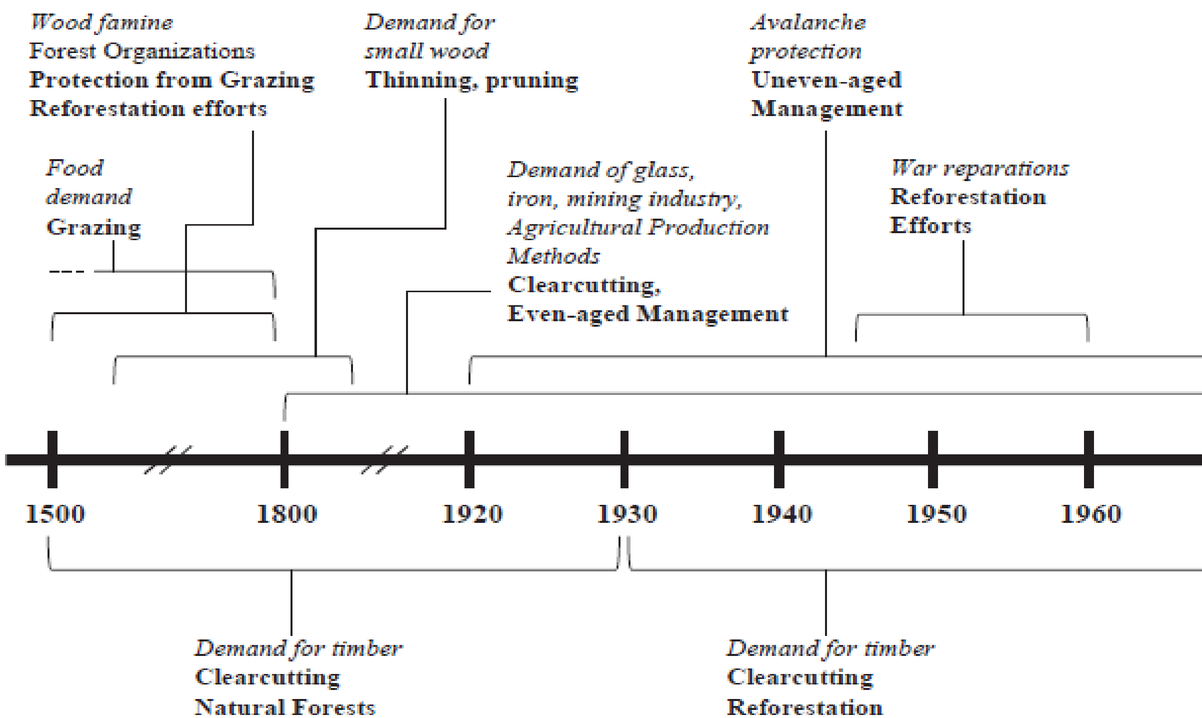
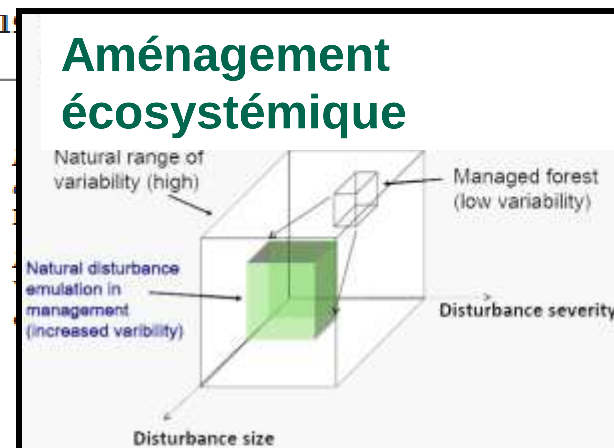
- **Aménager pour tenir compte des changements globaux**

Un peu d’histoire





Messier, C. et al. 2015. From management to stewardship: viewing forests as complex adaptive systems in an uncertain world. Cons. Lett. 8: 368

Plan de la présentation

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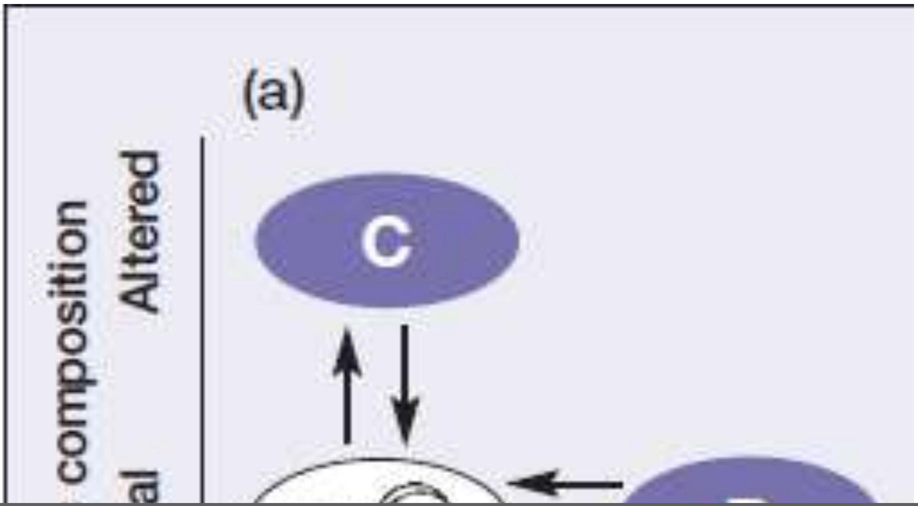
- **Nouvelles conditions biophysiques et socio-économiques**
- Aménager pour tenir compte des changements globaux

Front Ecol Environ 2008; 6, doi:10.1890/070046

Aménagement des nouveaux écosystèmes

Timothy R Seastedt[1*], Richard J Hobbs[2], and Katharine N Suding[3]



- *Baser nos pratiques forestières SEULEMENT sur nos connaissances passées des conditions forestières est risqué avec l'augmentation de l'incertitude*

Ecological Applications, 17(8), 2007 ...

CONCEPT PAPER

1426

NRC Research Press

Managing tree plantations as novel socioecological systems: Australian and North American perspectives

David Lindenmayer, Christian Messier, Alain Paquette, and Richard J. Hobbs

Abstract: Novel ecosyste... ...ccur when new combinations of species appear within a particular biome. They typically result
from direct human activ... ...ntal change, or the impacts of introduced species. In this paper, we argue that consid-
ering commercial tree... ...osystems has the potential to help policy makers, resource managers, and
conservation biologist... ...nd opportunities associated with managing plantations for multiple
purposes at both the s... ...er-related issues associated with managing tree plantations,
which are arguably ... ...ide. This is to ensure that these areas contribute
significantly to criti... ...dition to their wood production role. We
suggest that viewin... ...narrow stand-based perspective
and having to com... ...ement principles that
better integrate pl... ...ive ecological
effects are minin...

Curr Forestry Rep
DOI 10.1007/s40725-016-0036-x

ECOLOGICAL FUNCTION (K VERHEYEN, SECTION EDITOR)

Dealing with Non-linearity and Uncertainty in Forest Management

Christian Messier[1,2] · Klaus Puettmann[3] · Elise Filotas[4] · Dave Coates[5]

Abstract Forest managers today are struggling with the great uncertainties and rapid changes in many biophysical and socioeconomic aspects of their work. We argue in this review that viewing forests and forest management as complex adaptive systems and acknowledging non-linearity and uncertainty in forest dynamics and management provides ... both production ...

instead of the traditional mainly deterministic and static modeling tools.

Keywords Forest management · Silvicul...
Forest ...

Managing u... to...

Jeremy S. Littell,[1,†] Do...

[1]Center for Science in th...
[2]Pacific W...

Plan de la présentation

- Vers une foresterie écologique
- Nouvelles conditions biophysiques et socio-économiques
- **Aménager pour tenir compte des changements globaux**

Practical guidance for forest managers on helping boreal forests adapt/be more resilient to climate change

Rapport pour l’Entente sur la Forêt Boréale canadienne (EFBC)

Christian Messier
Professor at Université of Québec in Outaouais (UQO) and Montréal (UQAM)
Director of Institut des Sciences de la Forêt Tempérée (ISFORT) at UQO
Director of the research NSERC/Hydro-Québec Chair on tree growth

With the help of
Kim Bannon
Research Assistant, UQO and UQAM

February 11th, 2016

Qu’est-ce que dit la litérature?

- ***J’ai trouvé 28 suggestions dans la litérature afin de s’adapter aux changements globaux***

(1) Minimize fragmentation of habitat and maintain connectivity. Maintaining connectivity is important to allow various species to migrate more easily to new regions as climate changes (e.g. Craven et al., 2015).

(2) Apply silvicultural techniques that maintain a diversity of stand ages and mixture of species. When planting, favour mixed species. When relying on natural regeneration, allow a diversity of species with complementary traits.

(3) Include risk management into your approach to forest management. Currently, most computer models that calculate AAC do not include risk and uncertainty of natural disturbances and stressors due to climate change.

(4) Practice active adaptive management. This will be discussed further in section 6, but this is clearly an important element in developing in adapting forest management to climate change.

(5) Develop and monitor key indicators to evaluate the success of your adaptation strategies.

(6) Develop robust policy instead of precise ones. By robust, it is meant policies that perform well despite scientific uncertainties.

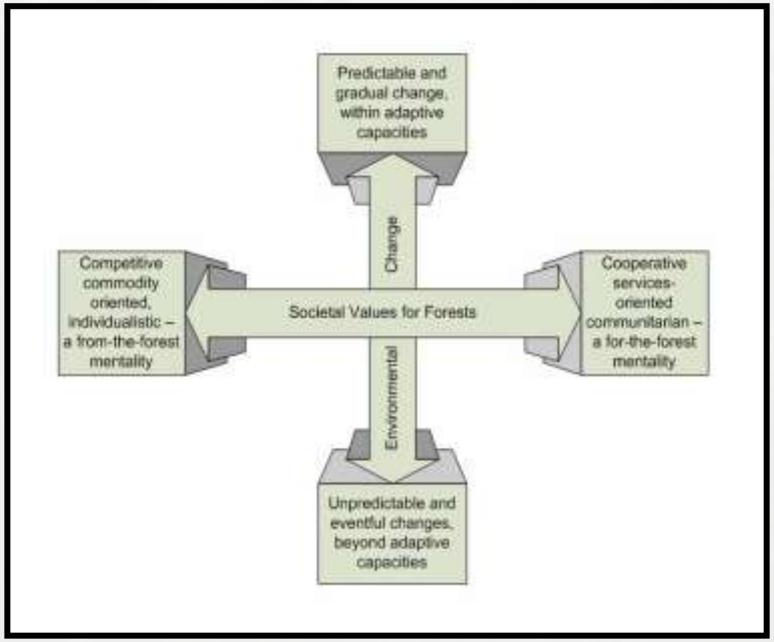
(7) Manage to maintain or encourage ecosystem heterogeneity at both the stand and landscape scales. This is already being achieve under the NRV target set by ecosystem

Qu'est-ce qu'il se fait au niveau Canadien et dans le monde?

- ***"Beaucoup de projets de recherche et de discussion, mais peu d'applications à grandes échelles"***

Qu'est-ce que je retiens et vous propose?

- **Revoir les principes du rendement soutenu √**
- **Faire une évaluation des vulnérabilités selon différents scénarios √**



Évaluation de la vulnérabilité

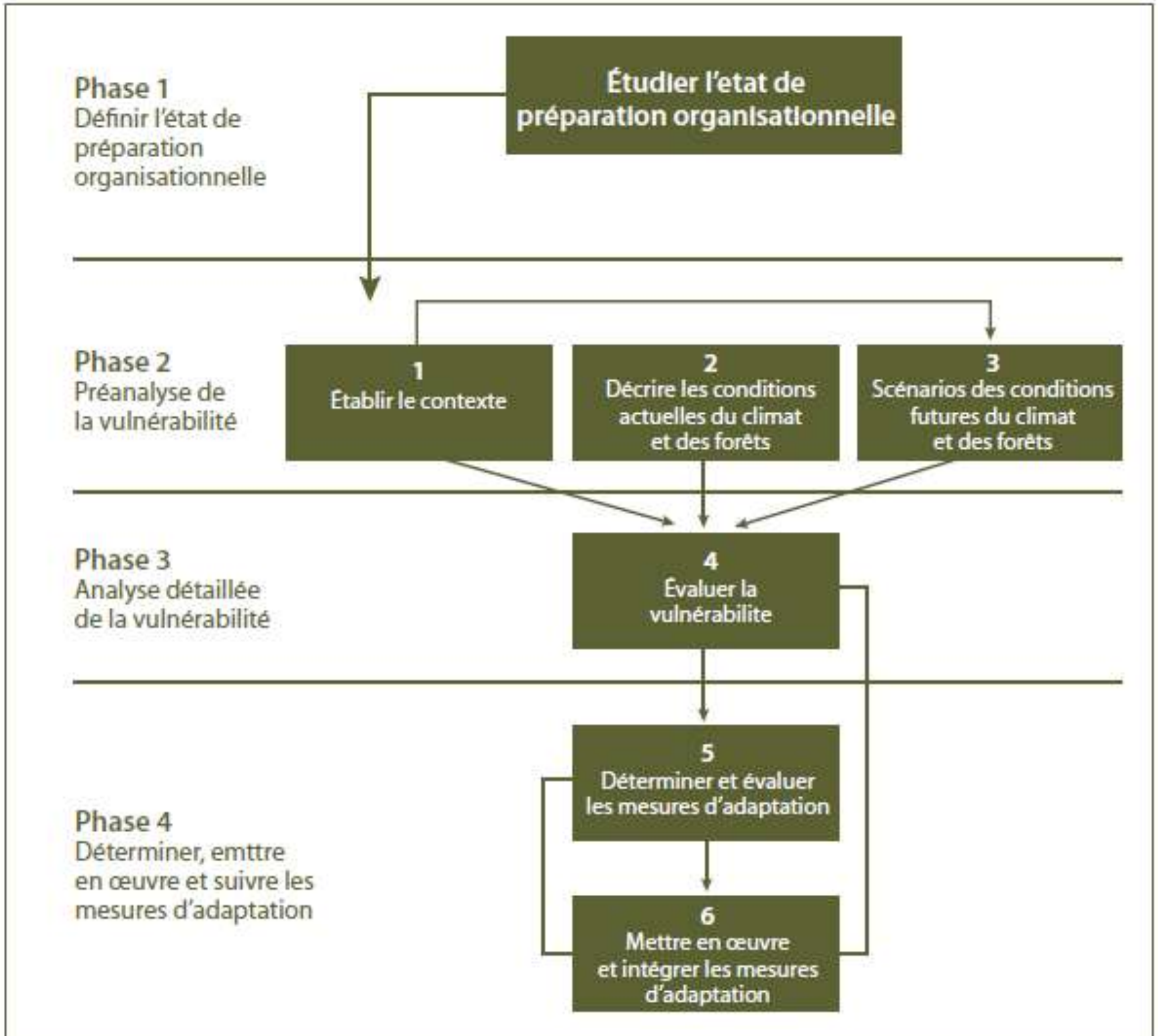


Figure 0.1. Les quatre étapes et les six éléments (dans les boîtes vertes) de l'adaptation aux changements climatiques dans le contexte de l'AFD (adaptation du rapport de Williamson et collab., 2012).

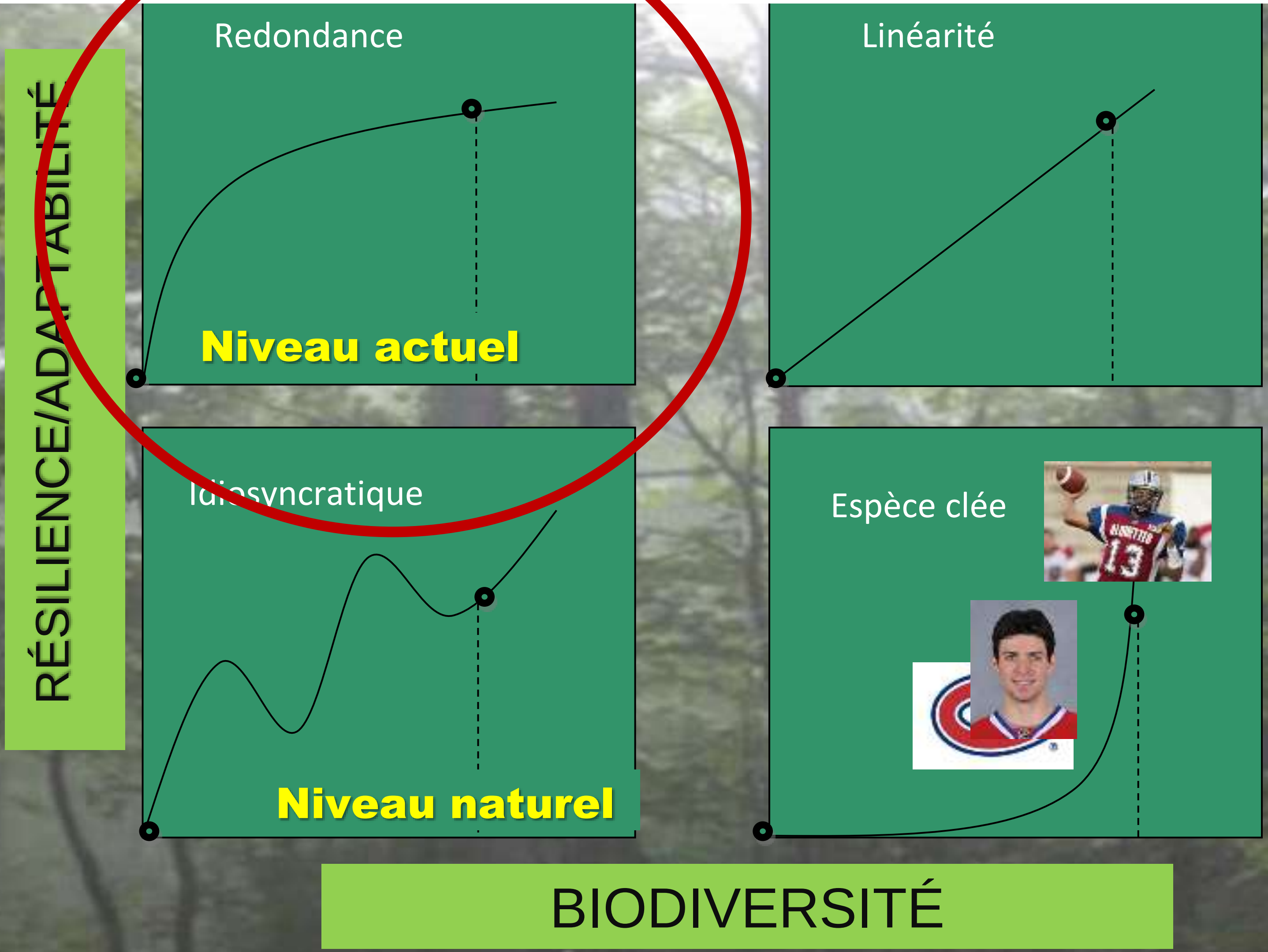
Qu’est-ce que je retiens et vous propose?

- Revoir les principes du rendement soutenu
- Faire une évaluation des vulnérabilités selon différents scénarios
- **Mettre en place l’aménagement écosystémique +++ √**

Quoi faire (suite)?

- Conserver le plus d’espèces d’arbres possibles ✓
  - Planifier et planter pour une grande diversité et redondance fonctionnelles en fonction des vulnérabilités anticipées ✓

Biodiversité vs Résilience/Adaptabilité



Adapté de: *Loreau, M., S. Naeem, and P. Inchausti, eds. 2002. Biodiversity and ecosystem functioning: synthesis and perspectives. Oxford, UK: Oxford University Press.*

NRC Research Press

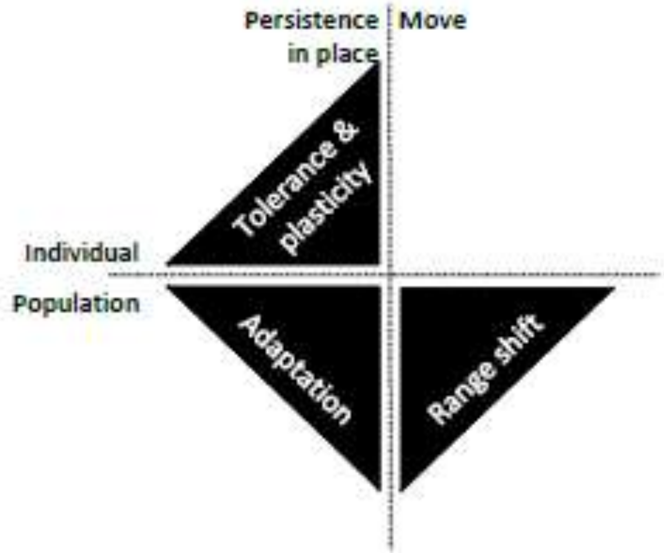
Environ. Rev. Vol. 24, 2016

REVIEW

Types de traits fonctionnels des arbres en fonction de la sensibilité et capacité d’adaptation aux changements climatiques

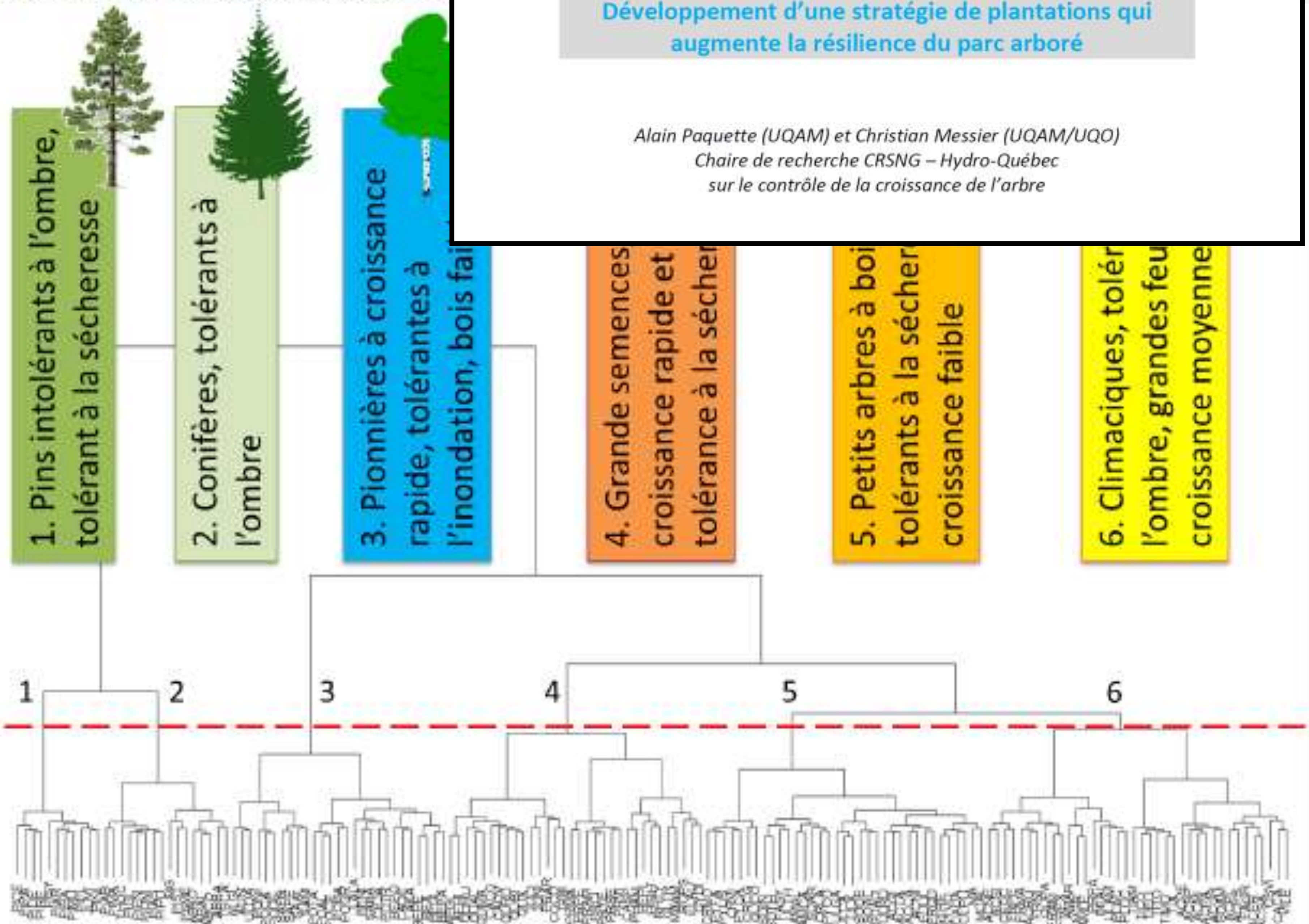
I. Aubin, A.D. Munson, F. Cardou, P.J. Burton, N. Isabel, J.H. Pedlar, A. Paquette, A.R. Taylor, S. Delagrange, H. Kebli, C. Messier, B. Shipley, F. Valladares, J. Kattge, L. Boisvert-Marsh, and D. McKenney

Abstract: The integration of functional traits into vulnerability assessments is a promising approach to quantitatively capture differences in species sensitivity and adaptive capacity to climate change, allowing the refinement of tree species distribution models. In response to a clear need to identify traits that are responsive to climate change and applicable in a management context, we review the state of knowledge of the main mechanisms, and their associated traits, that underpin the ability of boreal and temperate tree species to persist and (or) shift their distribution in a changing climate. We aimed to determine whether current knowledge is sufficiently mature and available to be used effectively in vulnerability assessments. Marshalling recent conceptual advances and assessing data availability, our ultimate objective is to guide modellers and practitioners in finding and selecting sets of traits that can be used to capture differences in species’ ability to persist and migrate. While the physiological mechanisms that determine sensitivity to climate change are relatively well understood (e.g., drought-induced cavitation), many associated traits have not been systematically documented for North American trees and differences in methodology preclude their widespread integration into vulnerability assessments (e.g., xylem recovery capacity). In contrast, traits traditionally associated with the ability to migrate and withstand fire are generally well documented, but new key traits are emerging in the context of climate change that have not been as well characterized (e.g., age of optimum seed production). More generally, lack of knowledge surrounding the extent and patterns in intraspecific trait variation, as well as co-variation and interaction among traits, limit our ability to use this approach to assess tree adaptive capacity. We conclude by outlining research needs and potential strategies for the development of trait-based knowledge applicable in large-scale modelling efforts, sketching out important aspects of trait data organization that should be part of a coordinated effort by the forest science community.



Strategy	Mechanism	Scale	*Main traits*
PERSIST IN PLACE (2.1)			
Via tolerance			
- Drought (2.1.1)			
Avoidance	Efficiency of water uptake	Ind.	*Root depth, root: shoot ratio*
	Mitigation of water loss	Ind.	*Stomatal sensitivity, water use efficiency?, LMA*
Resistance	Resistance to cavitation	Ind.	*Index of xylem resistance to embolism*
Recovery	Resumption of water transport	Ind.	*Xylem recovery capacity ?*
	Vegetative reproduction	Pop.	*Resprouting ability*
			Table 1a
- Heat and extreme temperatures (2.1.2)			
	Mitigation of heat-related physiological impacts	Ind.	*Heat shock proteins induction ?*
	Morphological plasticity	Ind.	*Branching pattern variability*
	Accelerated phenology	Ind.	*Bud burst timing*
- Change in fire regime (2.1.3)			
Resistance	Mechanical & architectural protection	Ind.	*Bark thickness, Height to live crown*
	Fuel potential	Ind.	*Leaf and bark flammability*
Recovery	Reproduction by seeds	Pop.	*Seed bank, seed heat tolerance, seed dispersal vector*
	Vegetative reproduction	Ind/Pop.	*Resprouting ability*

Figure 4. Dendrogramme fonctionnel re
fonctionnels (voir Tableaux 5-6 et Annexe 4



Diversité des arbres de la Ville de Québec:

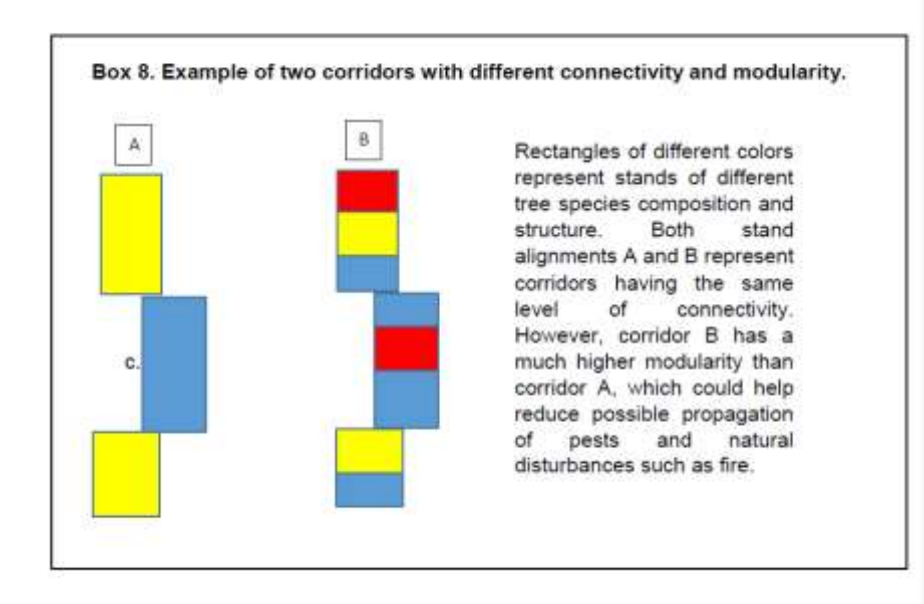
Développement d'une stratégie de plantations qui augmente la résilience du parc arboré

Alain Paquette (UQAM) et Christian Messier (UQAM/UQO)
Chaire de recherche CRSNG – Hydro-Québec
sur le contrôle de la croissance de l'arbre

Quoi faire (suite)?

- Conserver le plus d'espèces d'arbres possibles
  - Planifier et planter pour une grande diversité et redondance fonctionnelles

- **Favoriser la connectivité et la modularité au niveau du paysage forestier** v



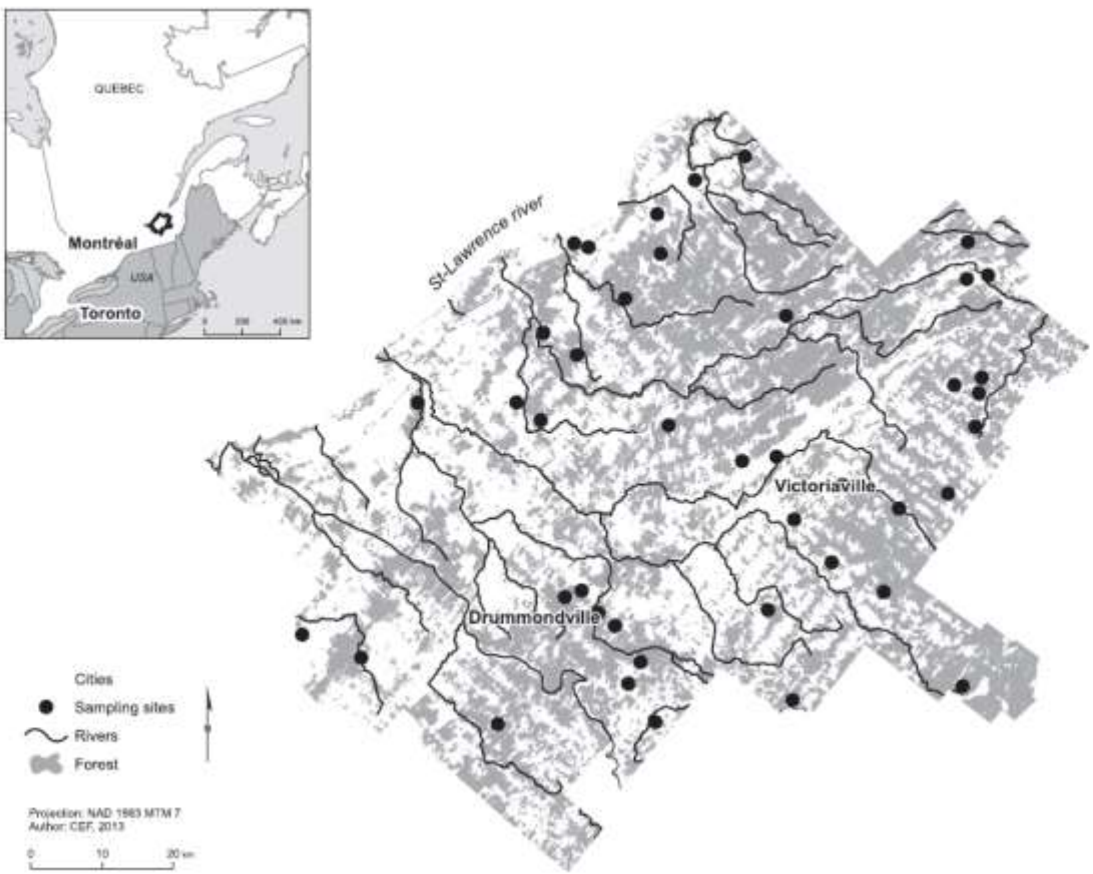
Diversity and Distributions, (Diversity Distrib.) (2016) 1–14

ation Biogeography

BIODIVERSITY RESEARCH

Evaluating resilience of tree communities in fragmented landscapes: linking functional response diversity with landscape connectivity

D. Craven[1,2,3*†], E. Filotas[4†], V. A. Angers[1] and C. Messier[1,5]



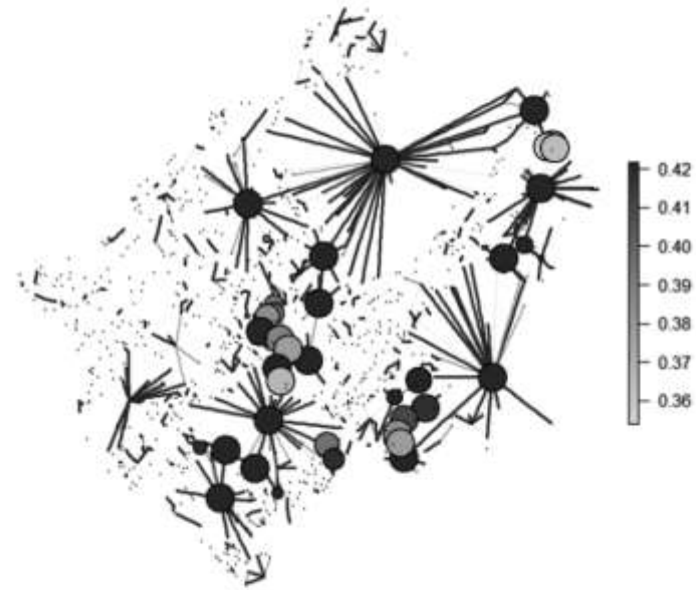
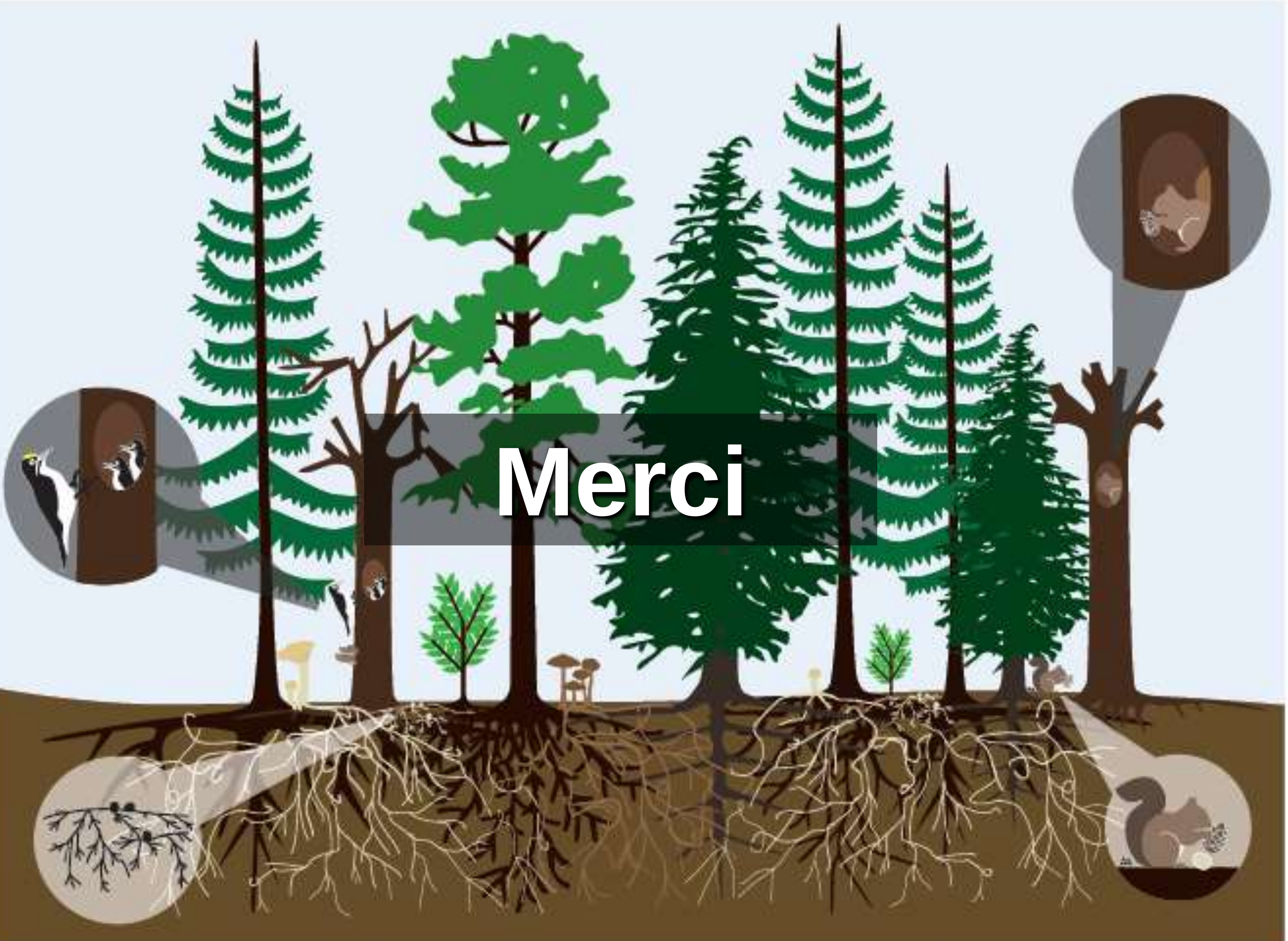


Figure 6 Spatial graph representation of the landscape of Centre-du-Quebec, Canada. Nodes of the graph represent patches of the fragmented landscape. Node size is scaled to the connector fraction $dPCconnector_k$, and node colour corresponds to estimated functional response diversity (FD) at the patch scale. Only nodes that are separated by a distance up to 350 m are linked. Links are weighted by $\%FD_{Potential}$ at the distance corresponding to their length (Fig. 4).


Merci