Intégrer la résilience dans l'aménagement des forêts pour promouvoir sa durabilité : transformer une source d'appréhension en une nouvelle perspective

RENDEZ-VOUS de la connaissance en aménagement forestier durable

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Votre gouvernement

Québec

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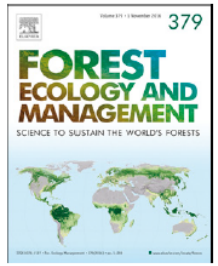

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Check for updates

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Plantation forestry

ABS

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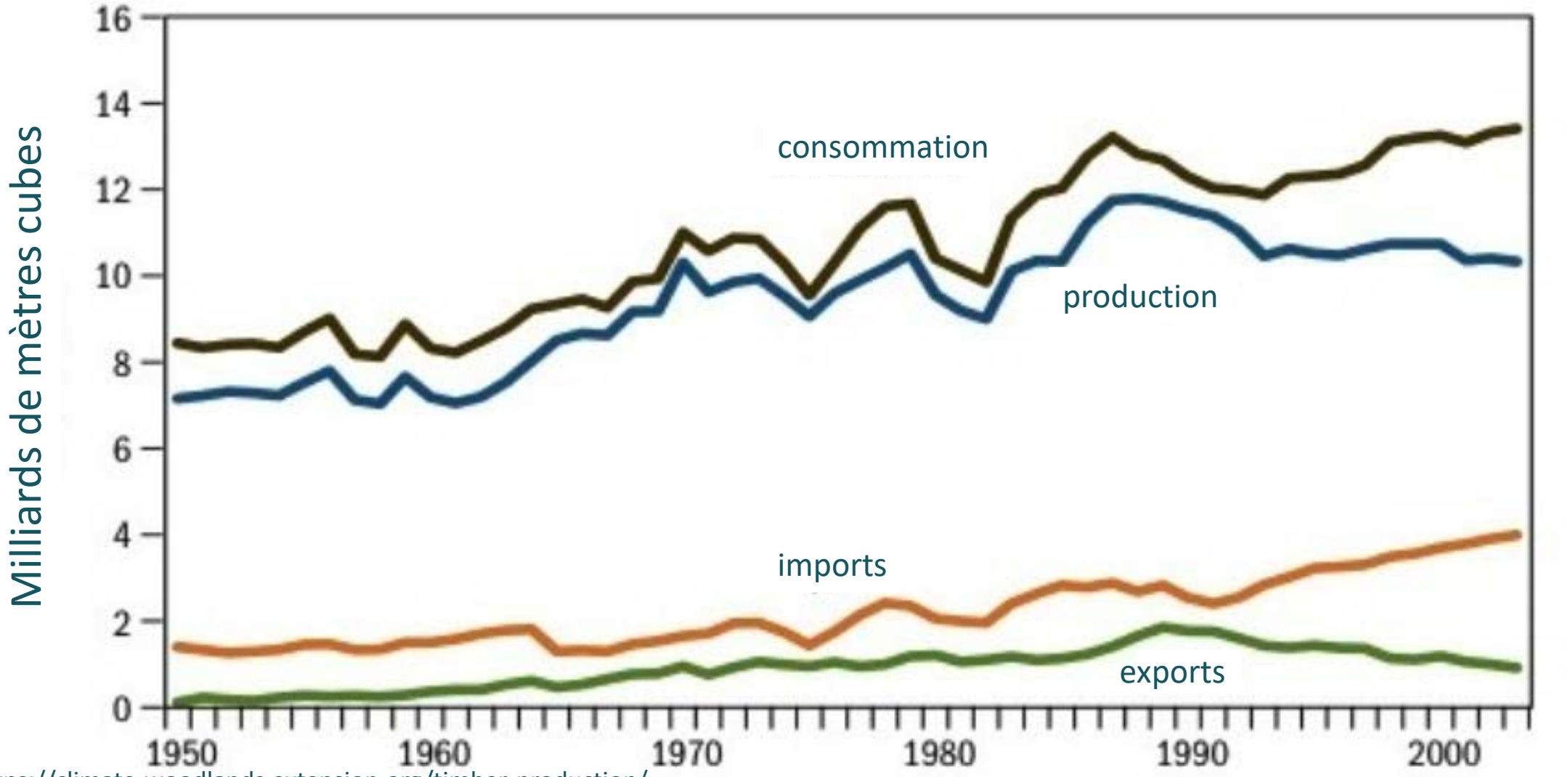
AVIS DE RECHERCHE FORESTIÈRE
OCTOBRE 2019
n° 135

Martin Barrette, ing.f., Ph. D., Nelson Thiffault, ing.f., Ph. D.,
Jean-Pierre Tremblay, biol., Ph. D., et *Isabelle Auger*, stat., M. Sc.
Vulgarisation : Marie-Ève Roy, ing.f., MBA

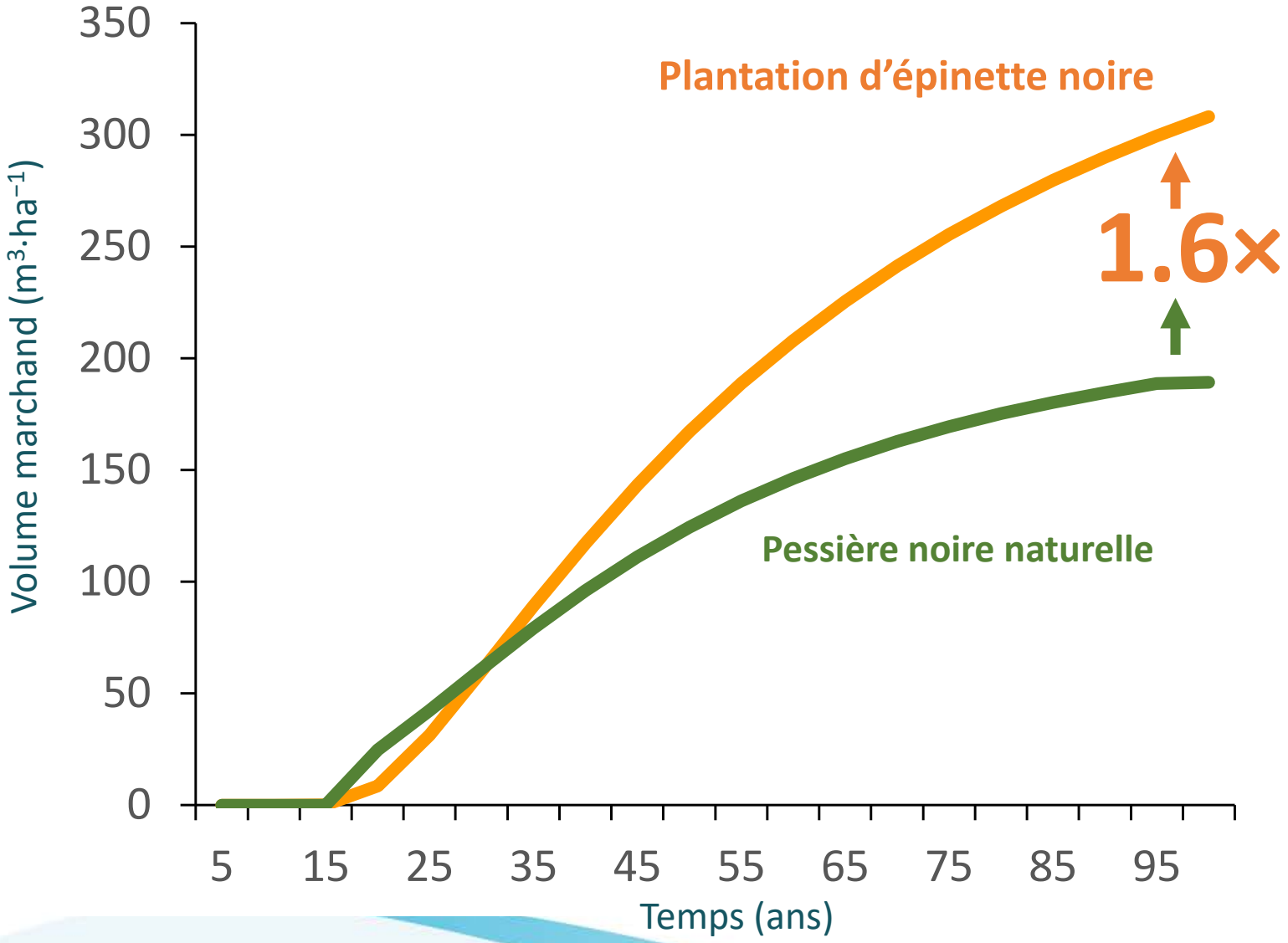
Territoires où les résultats s'appliquent.

Votre gouvernement

La demande mondiale pour les produits du bois ne cesse de croître.



https://climate-woodlands.extension.org/timber-production/



En raison de leur productivité, les plantations vont servir de plus en plus pour répondre à cette demande.

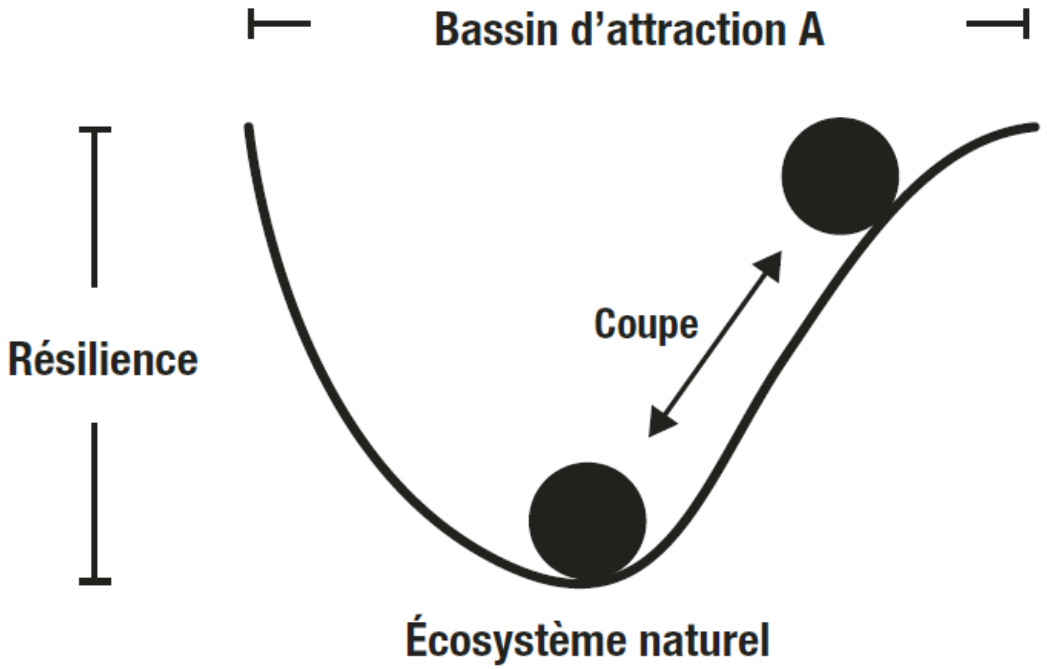
(Pothier et Savard 1998, Auger et Ward 2021)

Guy Prégent

Altérer la résilience?

Québec

La **résilience** est la capacité d'un écosystème à absorber une perturbation et de se réorganiser de manière à récupérer la même composition, la même structure et les mêmes fonctions.



Une perturbation anthropique cumulative

+

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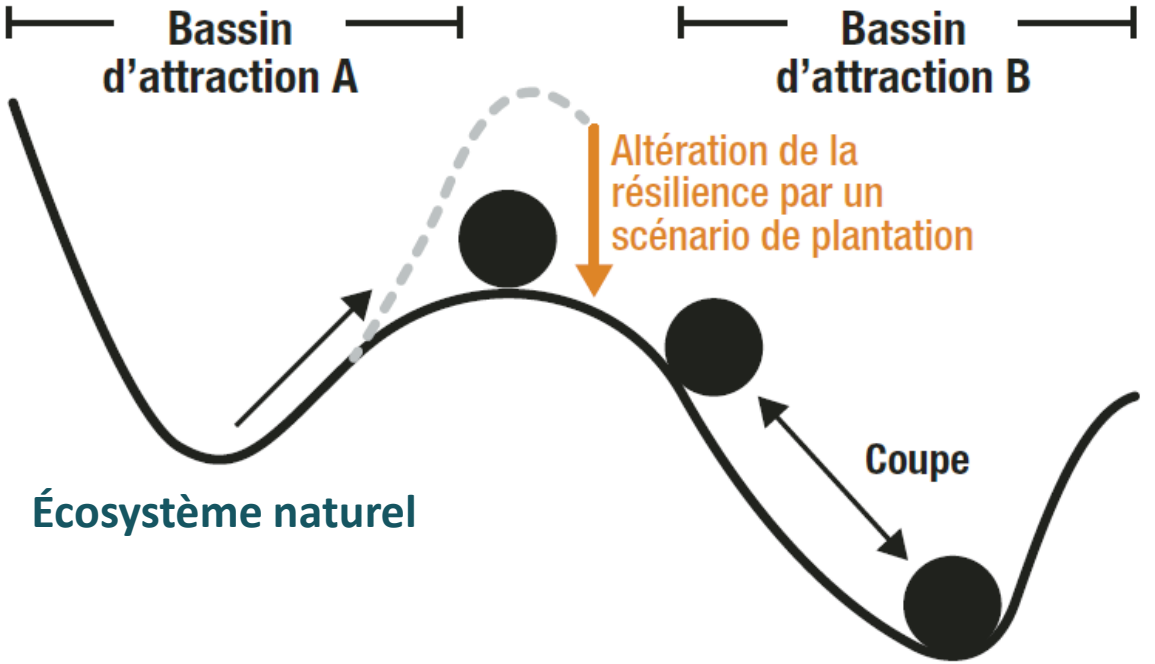
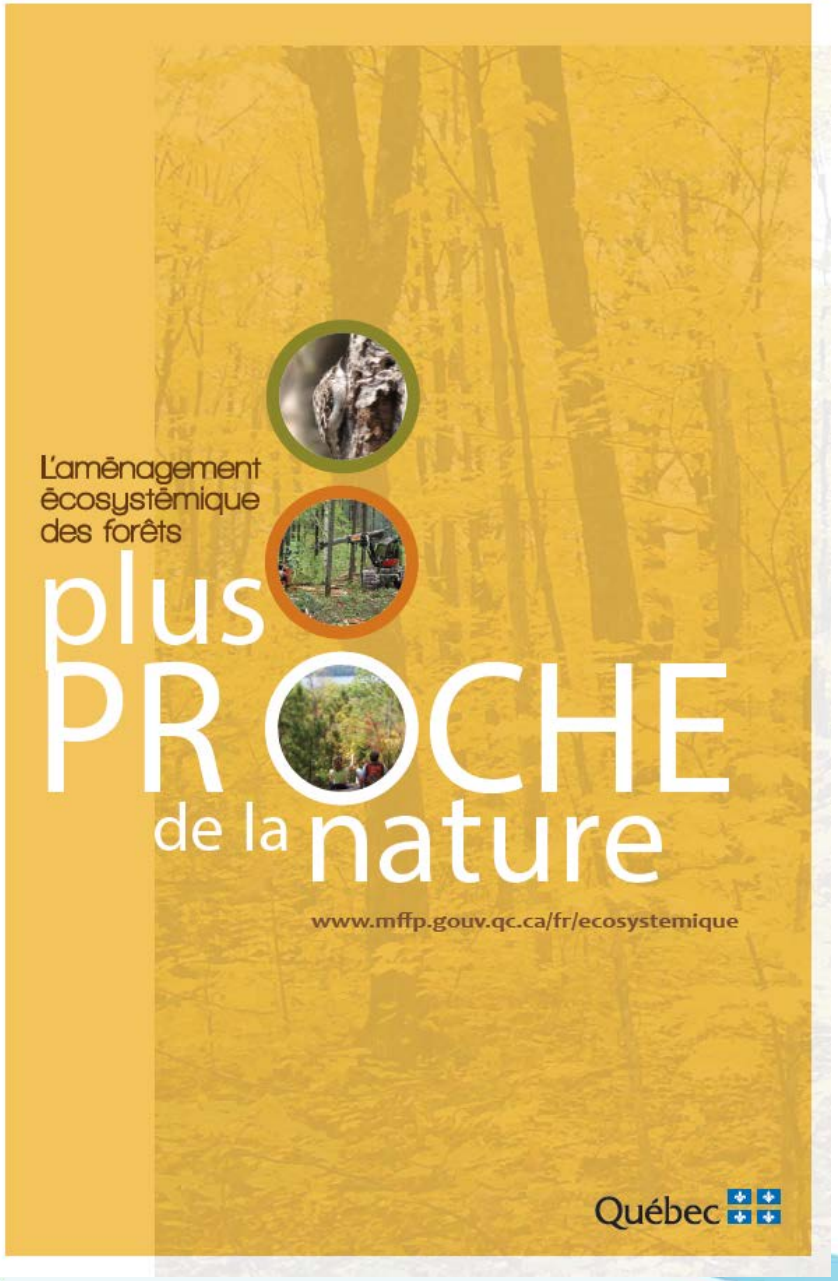
= Altérer la résilience?

Votre gouvernement



Écosystème naturel

Écosystème alternatif dominé par l'espèce plantée



Une source d'appréhension…

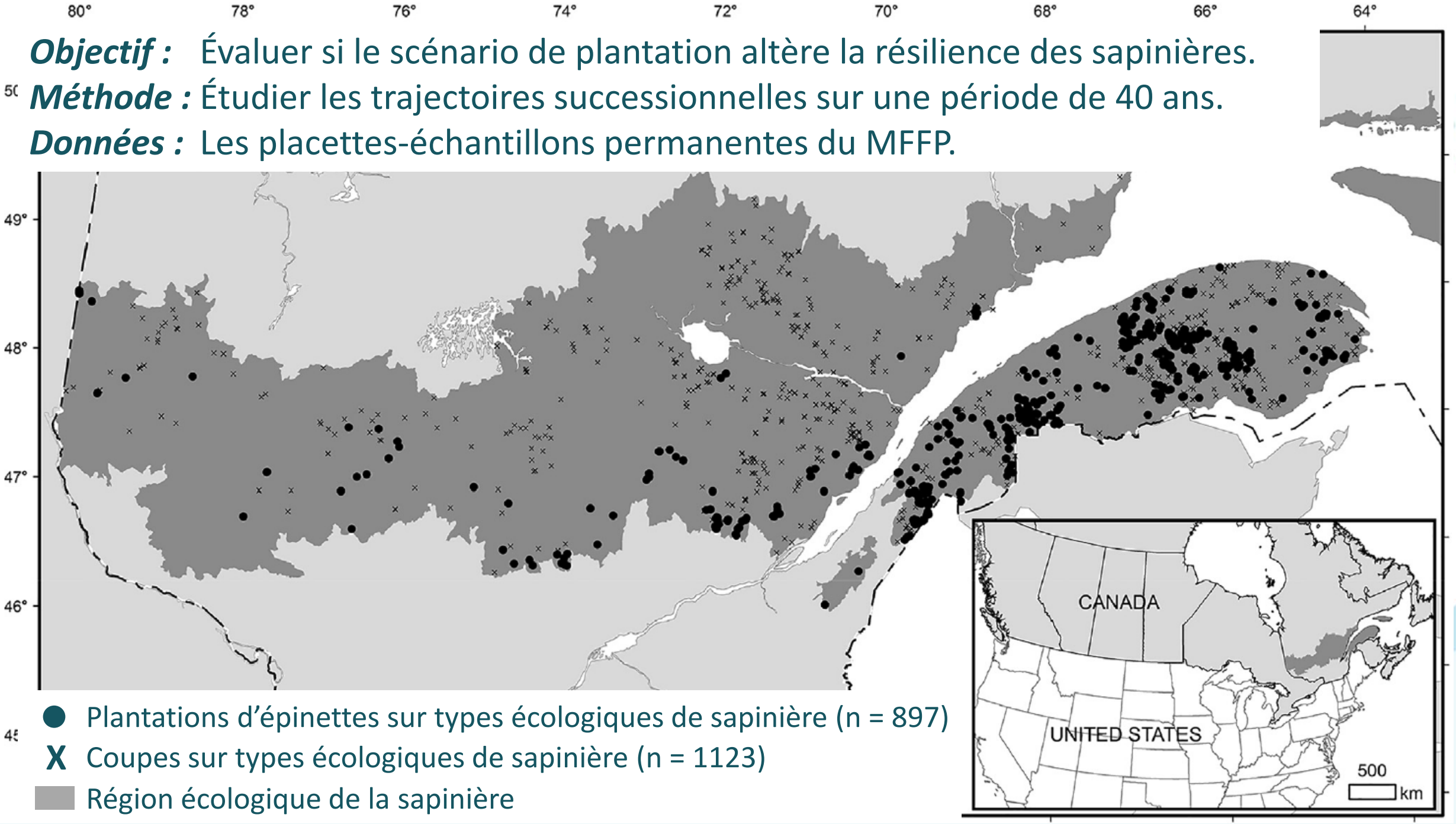
Nouveaux écosystèmes…

…une menace pour le maintien de la biodiversité et des services écologiques fournis par la forêt naturelle?

Objectif : Évaluer si le scénario de plantation altère la résilience des sapinières.

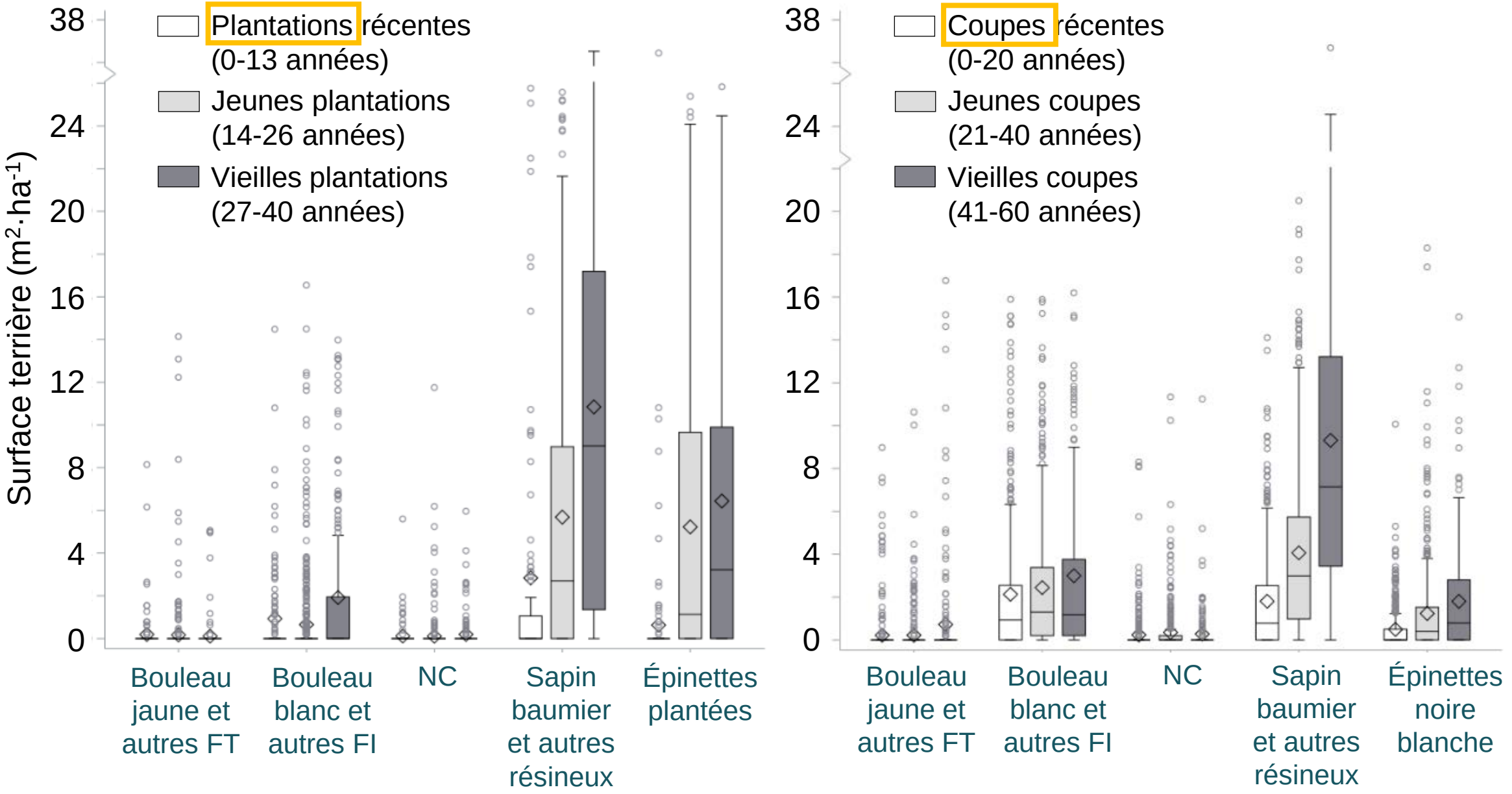
Méthode : Étudier les trajectoires successionnelles sur une période de 40 ans.

Données : Les placettes-échantillons permanentes du MFFP.

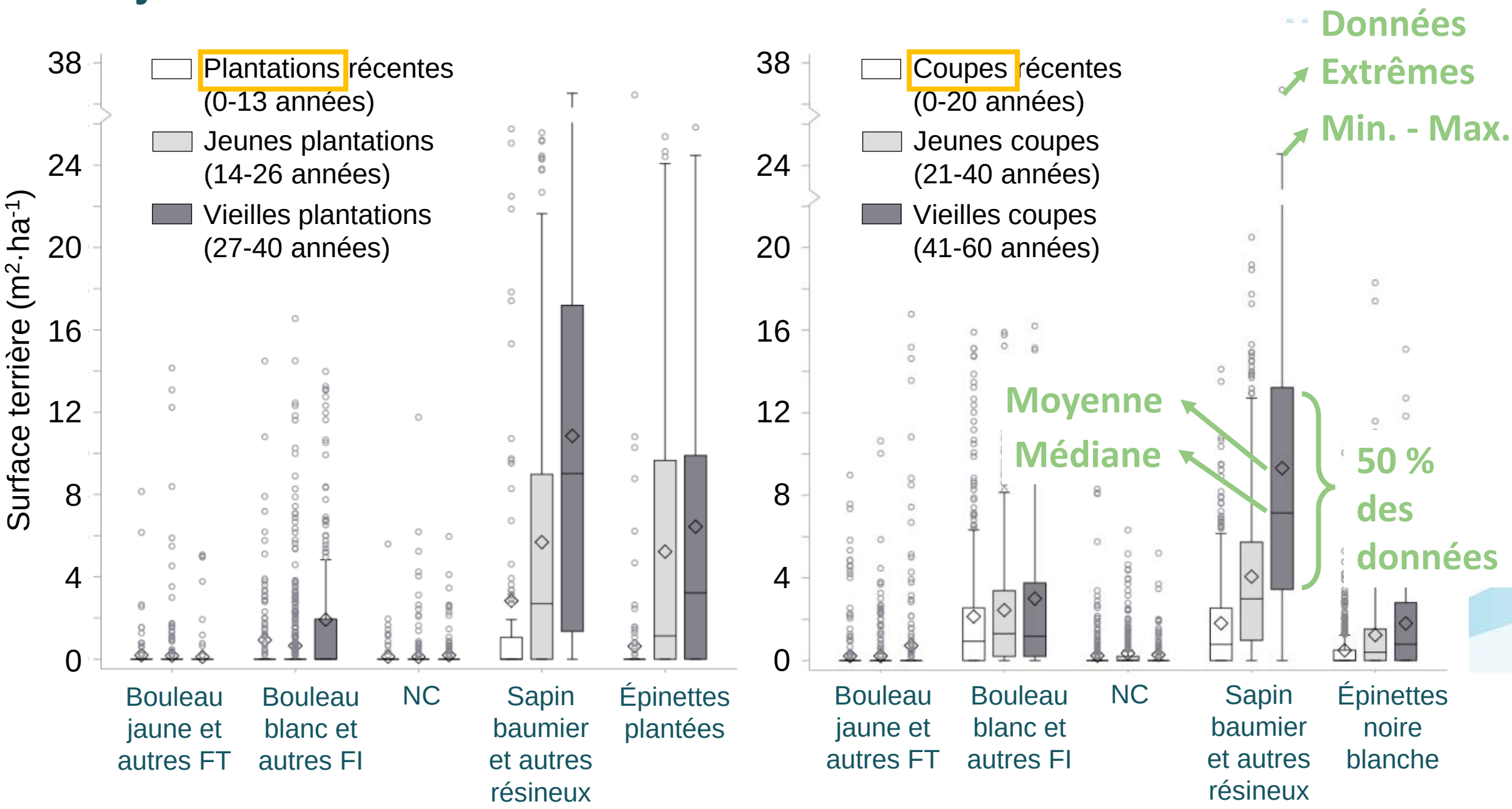


- Plantations d'épinettes sur types écologiques de sapinière (n = 897)
- X Coupes sur types écologiques de sapinière (n = 1123)
- Région écologique de la sapinière

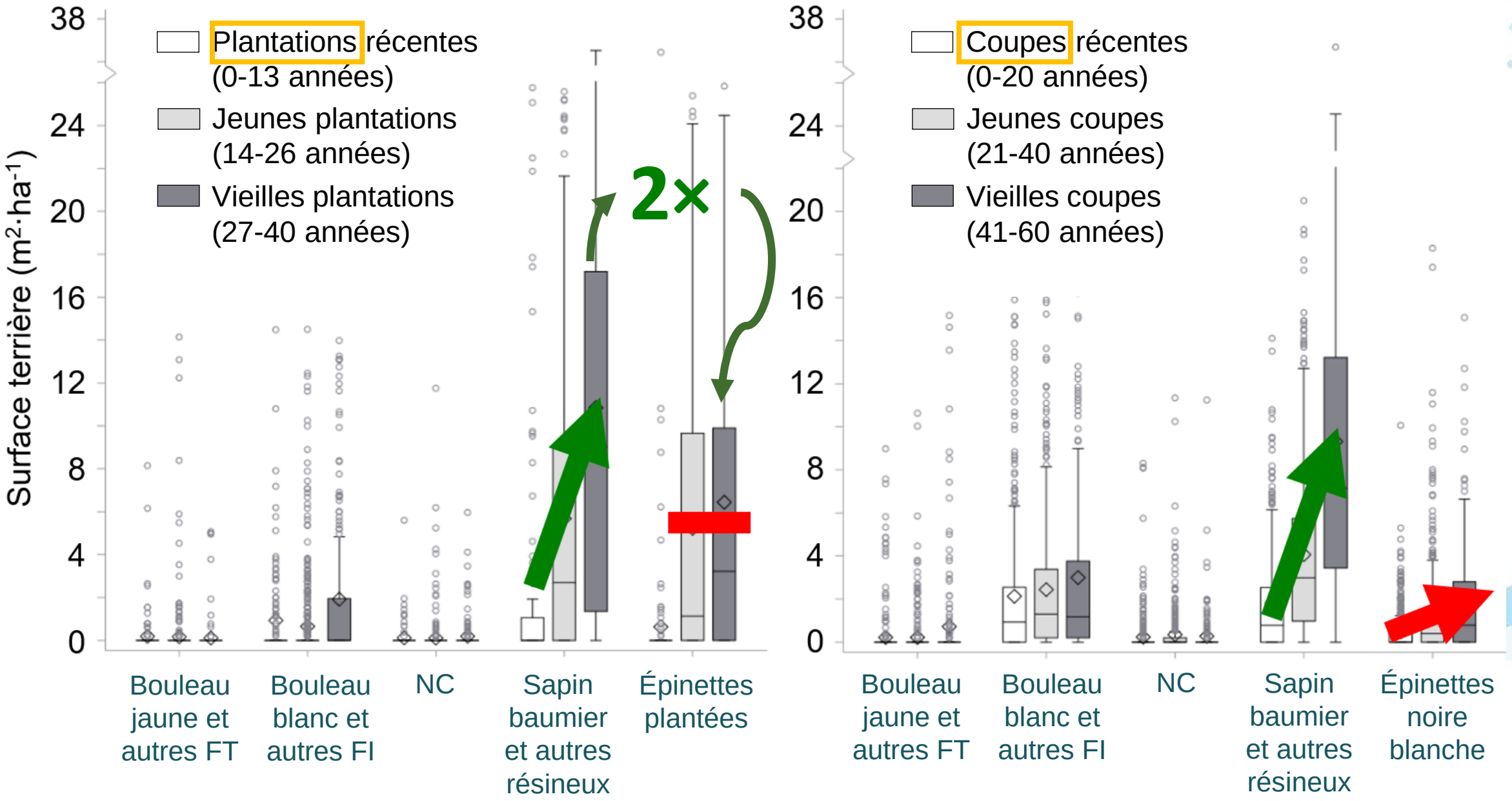
Trajectoires successionnelles des arbres



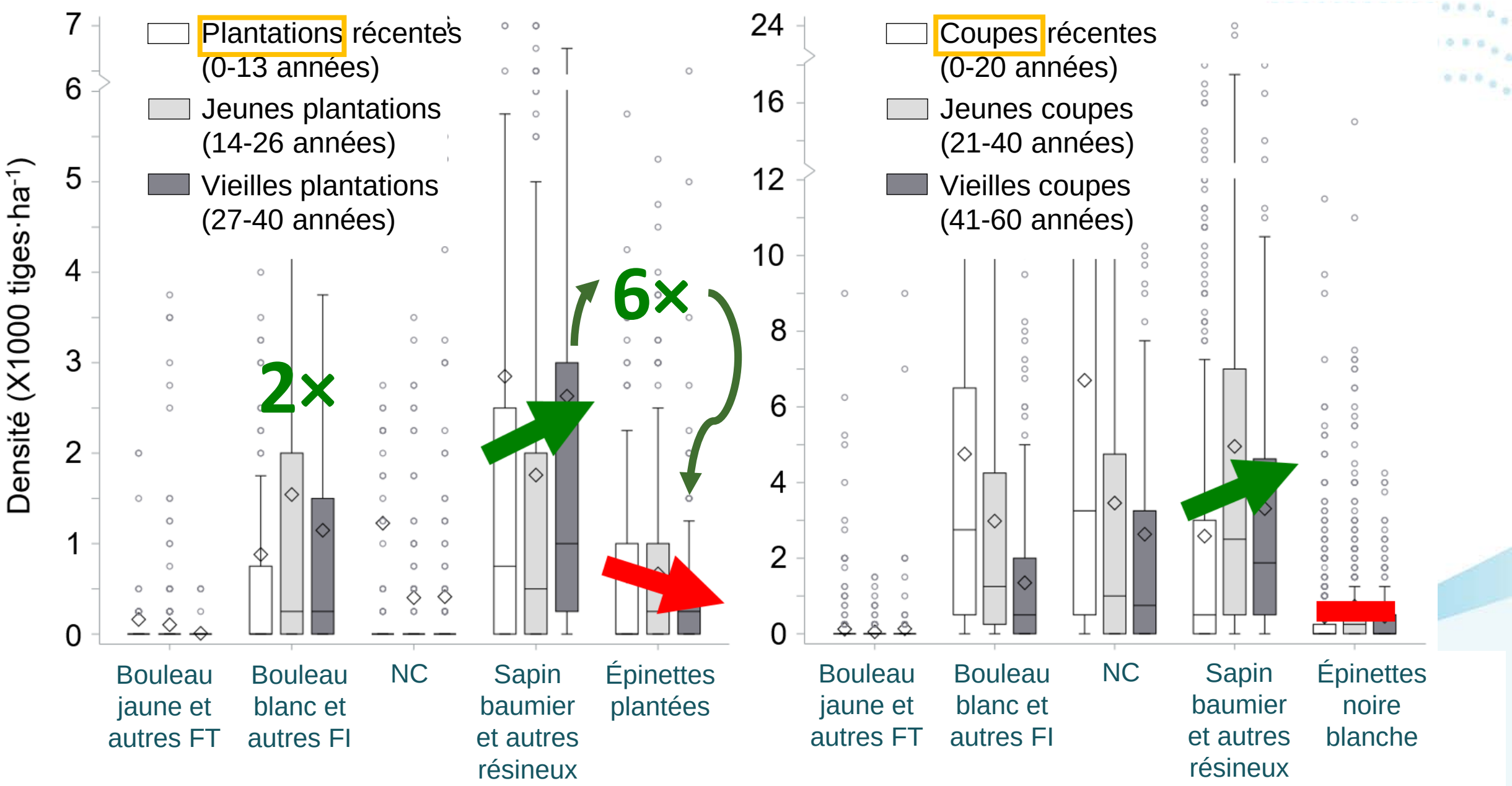
Trajectoires successionnelles des arbres



Trajectoires successionnelles des arbres



Trajectoires successionnelles des gaules



De l'appréhension…

- Les espèces se régénérant naturellement ont récupéré au détriment des épinettes plantées.
- Les sapinières sont résilientes en raison de leur processus de régénération efficace.
- Maintenir des processus de régénération fonctionnels est un moyen de maintenir la résilience.

De l'appréhension… vers une nouvelle perspective

- Reboiser dans une forêt résiliente pourrait compromettre la productivité des plantations et les investissements sylvicoles.
- **Mais la résilience pourrait-elle augmenter la productivité des plantations?**
- Qu'arrive-t-il si les plantations vont dans le sens de la résilience en comparaison avec celles qui, théoriquement, vont contre la résilience?

Votre gouvernement

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Silviculture

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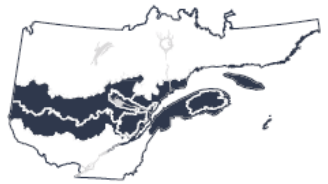
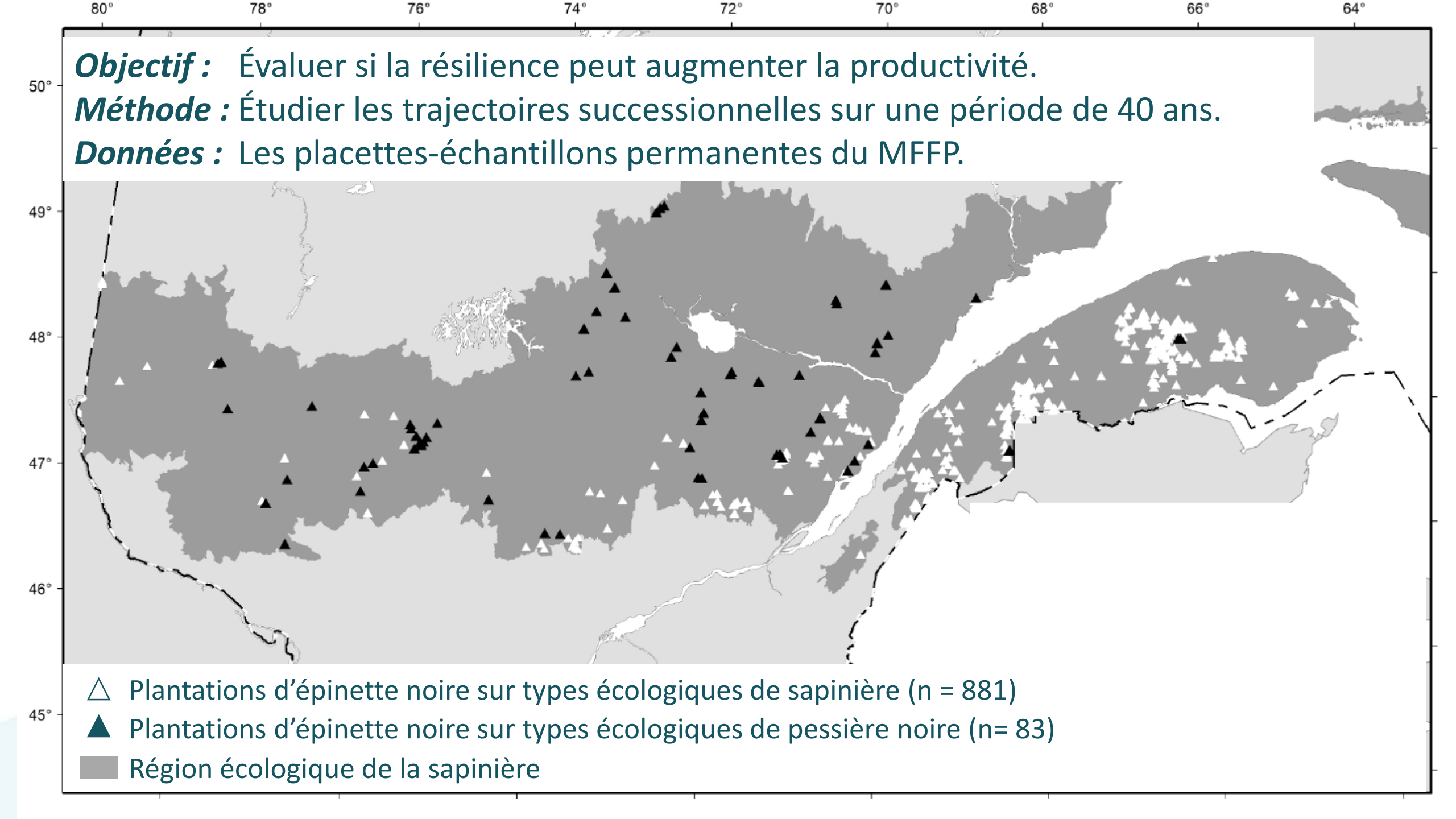
Avis de recherche forestière nº **166**
Direction de la recherche forestière
JUIN 2021

Par *Martin Barrette*[1], ing.f., Ph. D., *Marie-Eve Roy*[1], ing.f., MBA, Nelson Thiffault[2], ing.f., Ph. D. et *Isabelle Auger*[1], stat., M. Sc.



Territoires où les résultats s'appliquent.

La demande mondiale pour les produits du bois est en croissance. D'ici 2050, il est estimé que les plantations, dont la productivité peut être supérieure à celle des forêts naturelles, pourraient fournir jusqu'à 75 % de la matière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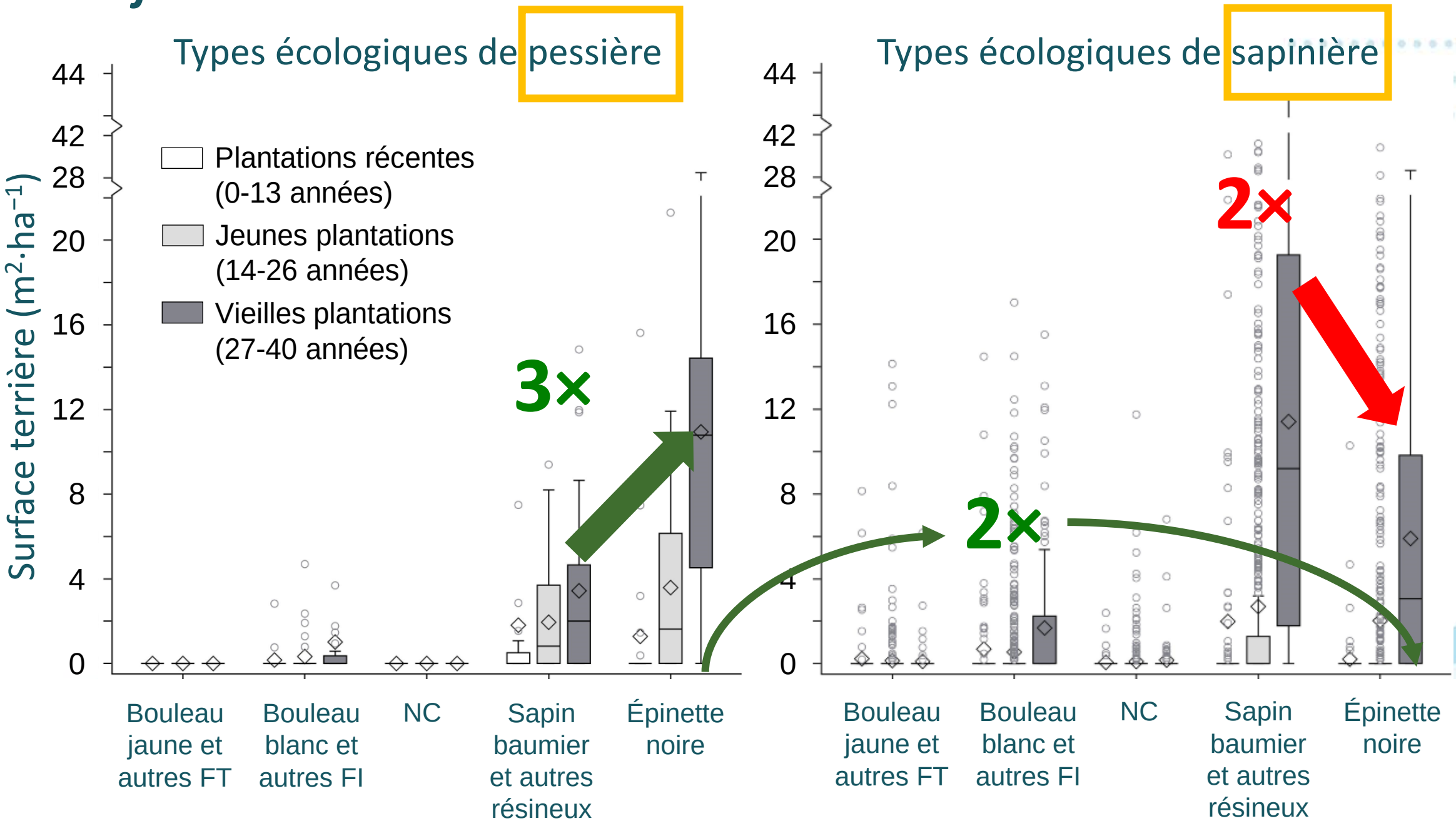
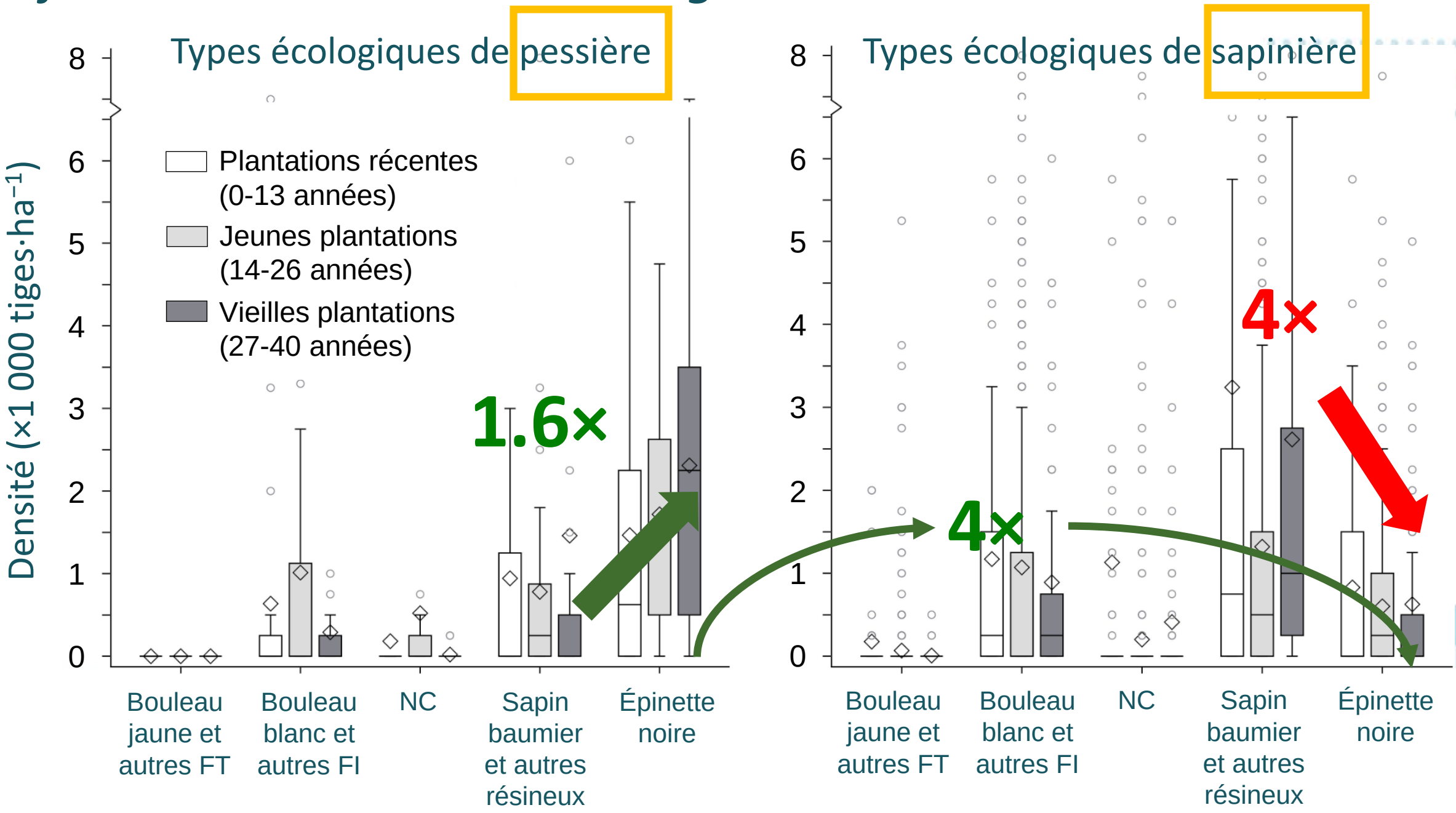
Objectif : Évaluer si la résilience peut augmenter la productivité.
Méthode : Étudier les trajectoires successionnelles sur une période de 40 ans.
Données : Les placettes-échantillons permanentes du MFFP.
Plantations d'épinette noire sur types écologiques de sapinière (n = 881)
Plantations d'épinette noire sur types écologiques de pessière noire (n= 83)
Région écologique de la sapinière

Trajectoires successionnelles des arbres



Trajectoires successionnelles des gaules



Une nouvelle perspective…

- La résilience peut compromettre ou améliorer la productivité.

- Favoriser des scénarios de plantation qui pointent dans la même direction que les trajectoires successionnelles déterminées par la résilience des forêts naturelles.

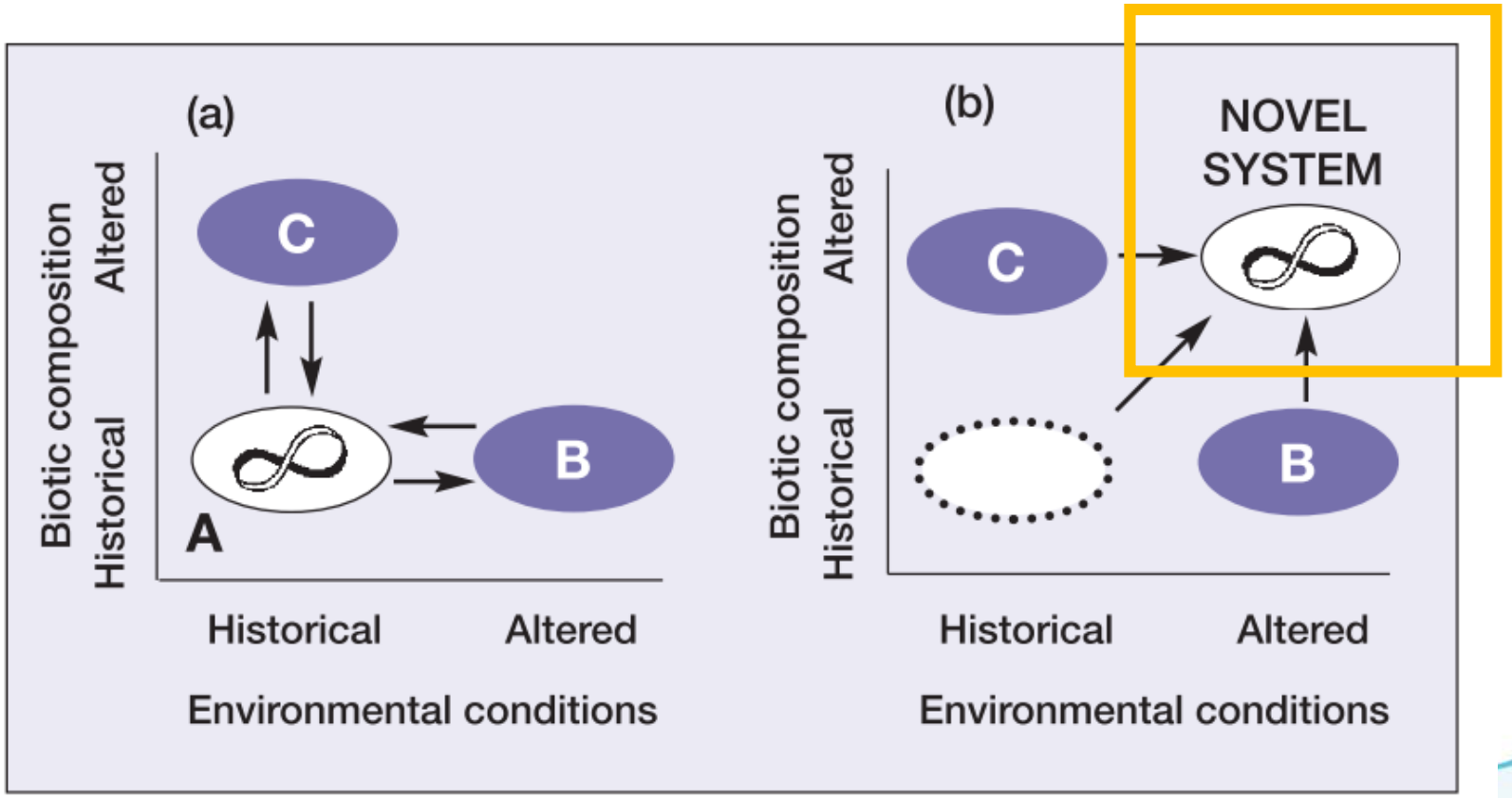
- S’assurer que les plantations sont productives, économiquement viables et favorisent ainsi la durabilité.

Questions en suspens…

- Où faire les plantations d'épinette blanche?
- Quelle est la productivité des regarnis?
- Quelle est la productivité des plantations « envahies » par des espèces compagnes?
- Occurrence de nouveaux écosystèmes ayant une résilience nouvelle?

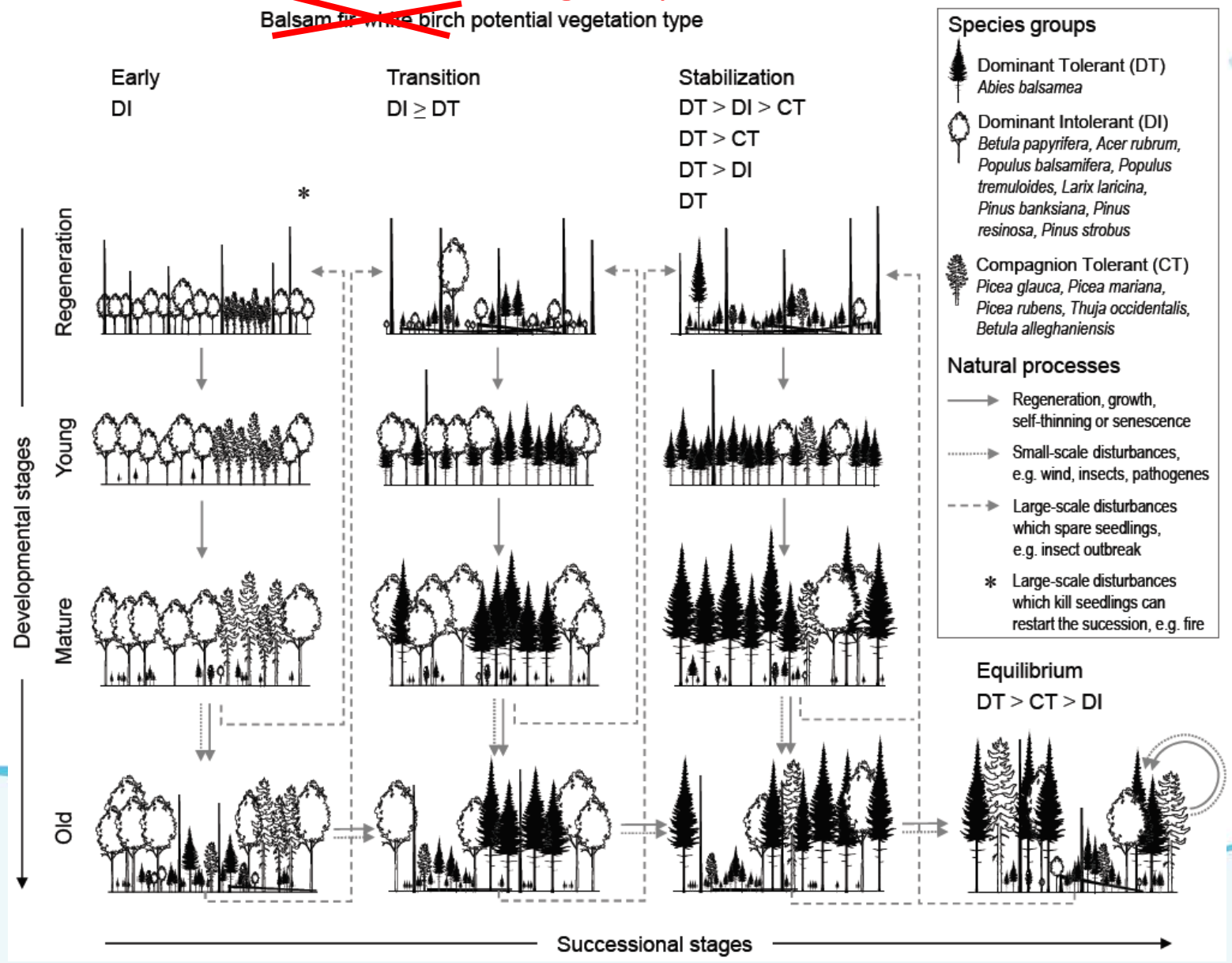
Management of novel ecosystems: are novel approaches required?

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



Développer des modèles de dynamiques successionnelles pour ces nouveaux écosystèmes

Érablière rouge à épinette blanche?



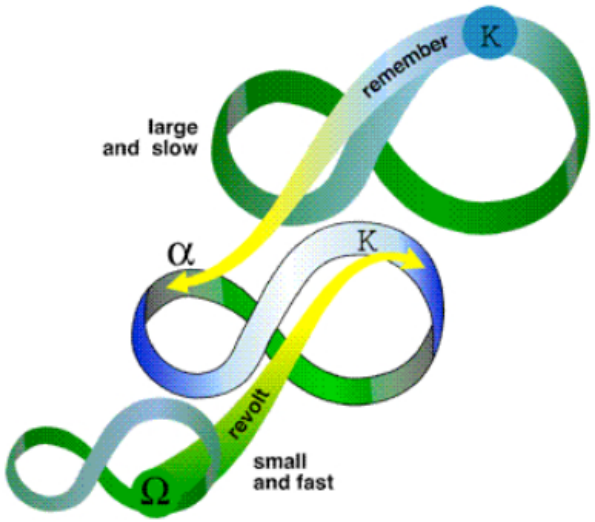
Barrette et al. 2020 Ecol. Ind.

Questions?

Québec

No system can be understood or managed by focusing on it at a single scale. All systems (and SESs especially) exist and function at multiple scales of space, time and social organization, and the interactions across scales are fundamentally important in determining the dynamics of the system at any particular focal scale. This interacting set of hierarchically structured scales has been termed a "panarchy" (Gunderson and Holling 2003).

Panarchy is a framework of nature's rules, hinted at by the name of the Greek god of nature- Pan - whose persona also evokes an image of unpredictable change. Since the essential focus of Panarchy is to rationalize the interplay between change and persistence, between the predictable and unpredictable, Holling et al. (2002) draw on the notion of hierarchies of influences between embedded scales, that is pan-archies, to represent structures that sustain experiments, test its results and allow adaptive evolution.



The panarchy framework connects adaptive cycles in a nested hierarchy. There are potentially multiple connections between phases of the adaptive cycle at one level and phases at another level. Two significant connections are labeled 'revolt' and 'remember'. The smaller, faster, nested levels invent, experiment and test, while the larger, slower levels stabilize and conserve accumulated memory of system dynamics. In this way, the slower and larger levels set the conditions within which faster and smaller ones function. Thus a forest stand moderates the climate within the stand to narrow the range of temperature variation that the species experience. But missing in this representation, is the dynamic of each level which is organized in the four phase cycle of birth, growth and maturation, death and renewal. That cycle is the engine that periodically generates the variability and novelty upon which experimentation depends. As a consequence of the periodic, but transient phases of destruction (omega stage) and reorganization (alpha stage), a system's structure and processes can be reorganized. This reshuffling allows for the establishment of new system configurations and opportunities for the incorporation of exotic and entirely novel entrants into the system. The adaptive cycle explicitly introduces mutations and rearrangements as a periodic process within each hierarchical level in a way that partially isolates the resulting experiments, reducing the risk to the integrity of the whole structure.

In addition to this creative role, Pan has a destabilizing role that is captured in the word panic, directly derived from one facet of his paradoxical personality. His attributes are described in ways that resonate with the attributes of the four phase adaptive cycle; as the creative and motive power of universal nature, the controller and arranger of the four elements- earth, water, air and fire (or perhaps, of K, alpha, r and omega!). He therefore represents the inherent features of the synthesis that has emerged in this comparison of ecological and social systems.

Figure (above)- Panarchy connections. Linked adaptive cycles at multiple scales. *(Originally published in Panarchy: Understanding transformations in human and natural systems, Edited by Lance H. Gunderson and C.S. Holling 2002. Permission Island Press)*

Adaptive Cycle

The model of the adaptive cycle was derived from the comparative study of the dynamics of ecosystems. It is meant to be a tool for thought. It focuses attention upon processes of destruction and reorganization, which are often neglected in favor of growth and conservation. Including these processes provides a more complete view of system dynamics that links together system organization, resilience, and dynamics.

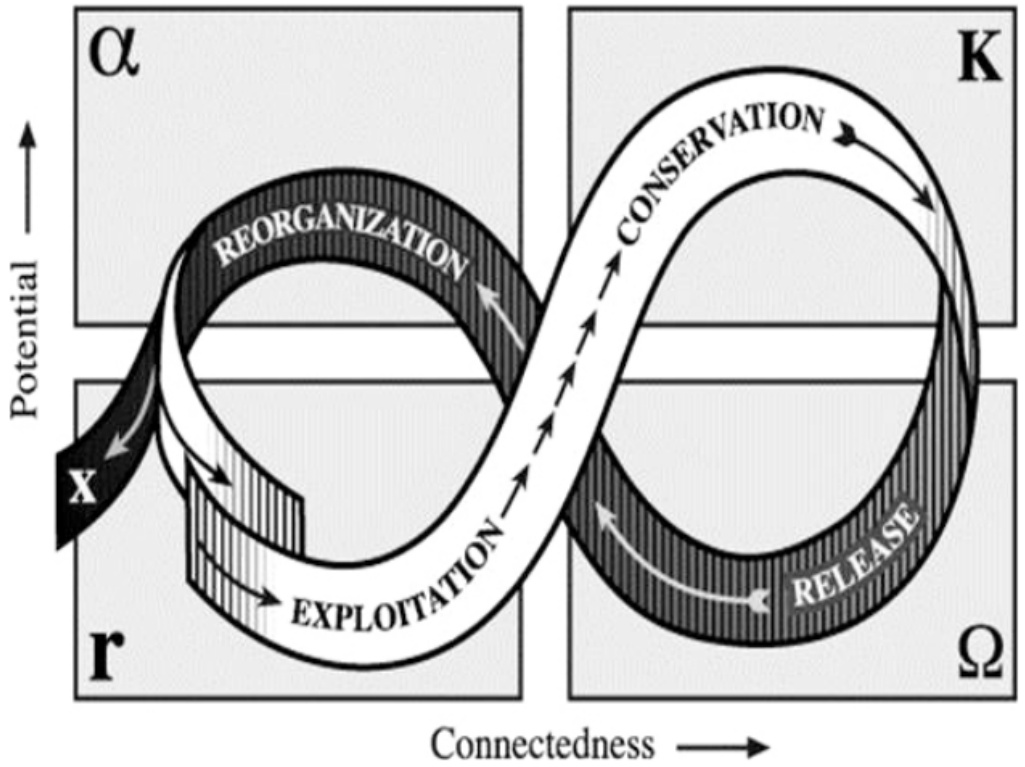
Traditionally ecology has focused on the concept of succession that describes the transition from a time when exploitation (i.e., the rapid colonization of recently disturbed areas) is emphasized to a time when conservation (i.e., the slow accumulation and storage of energy and material) is emphasized.

Our current understanding of ecological dynamics however indicates that two additional functions - release and reorganization - are needed.

An adaptive cycle that alternates between long periods of aggregation and transformation of resources and shorter periods that create opportunities for innovation, is proposed as a fundamental unit for understanding complex systems from cells to ecosystems to societies.

For ecosystem and social-ecological system dynamics that can be represented by an adaptive cycle, four distinct phases have been identified:

1. growth or exploitation (r)
2. conservation (K)
3. collapse or release (omega)
4. reorganization (alpha)



The adaptive cycle exhibits two major phases (or transitions). The first, often referred to as the foreloop, from r to K, is the slow, incremental phase of growth and accumulation. The second, referred to as the backloop, from Omega to Alpha, is the rapid phase of reorganization leading to renewal.

During the slow sequence from exploitation to conservation, connectedness and stability increase and a capital of nutrients and biomass (in ecosystems) is slowly accumulated and sequestered. Competitive processes lead to a few species becoming dominant, with diversity retained in residual pockets preserved in a patchy landscape. While the accumulated capital is sequestered for the growing, maturing ecosystem, it also represents a gradual increase in the potential for other kinds of ecosystems and futures. For an economic or social system, the accumulating potential could as well be from the skills, networks of human relationships, and mutual trust that are incrementally developed and tested during the progression from r to K. Those also represent a potential developed and used in one setting, that could be available in transformed ones.

Adaptive cycles are nested in a hierarchy across time and space which helps explain how adaptive systems can, for brief moments, generate novel recombinations that are tested during longer periods of capital accumulation and storage. These windows of experimentation open briefly, but the results do not trigger cascading instabilities of the whole because of the stabilizing nature of nested hierarchies. In essence, larger and slower components of the hierarchy provide the memory of the past and of the distant to allow recovery of smaller and faster adaptive cycles. A nested hierarchy of adaptive cycles represents a panarchy.

Selected references:

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Naturalness assessment performed using forestry maps to validate forest management sustainability

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Natural forest landscape
Forest alteration
Forestry maps
Ecosystem management

ABSTRACT

One-quarter of forest areas worldwide are managed for forestry purposes. Depending upon the type of practice and intensity of management, forestry may alter forests to various degrees and raise sustainability issues. To mitigate the alteration of natural forests by forestry and to promote sustainability, ecosystem management has been implemented widely over the past quarter century. A need remains for the development of comprehensive and operational assessment approaches to validate its effectiveness. Naturalness assessment could be used to validate effectiveness of ecosystem management since this concept relates to the degree to which a natural state has been altered. We developed an approach that integrates stand- and landscape- scale traits of naturalness into