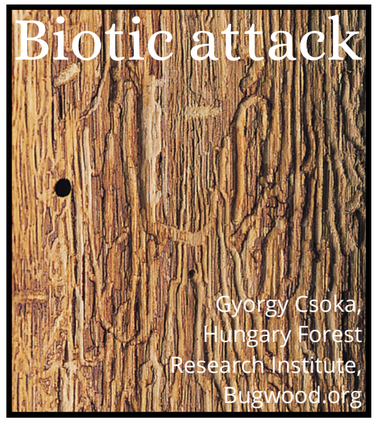
FOREM
01/03/2025

Towards adaptative decision-making tools in forest management: integrating control on regeneration in ForCEEPS.

Alice ROY
supervised by
Marion Jourdan
Jean-Denis Mathias
Jean-Baptiste Pichancourt
Meriem Fournier

Context:

Climate Change



European oak bark beetle
Scolytus intricatus

Heat

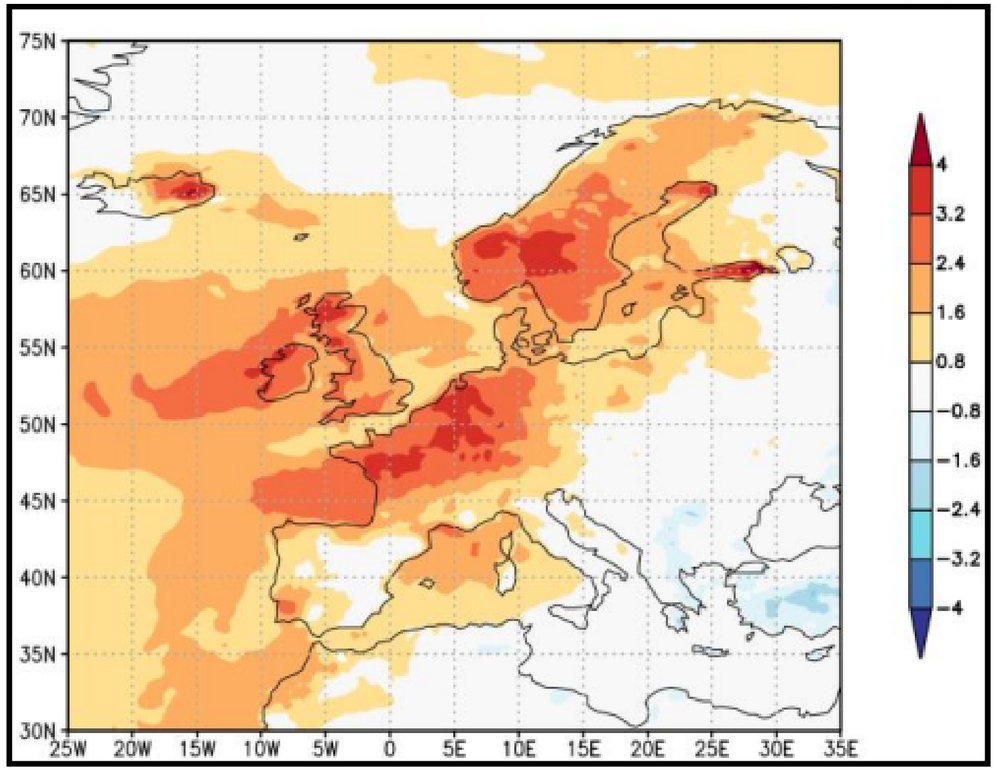


Figure 2: Average temperature anomaly (ERA5, baseline 1991-2020) computed for June 2023 Source: The KNMI Climate Explorer

Drought

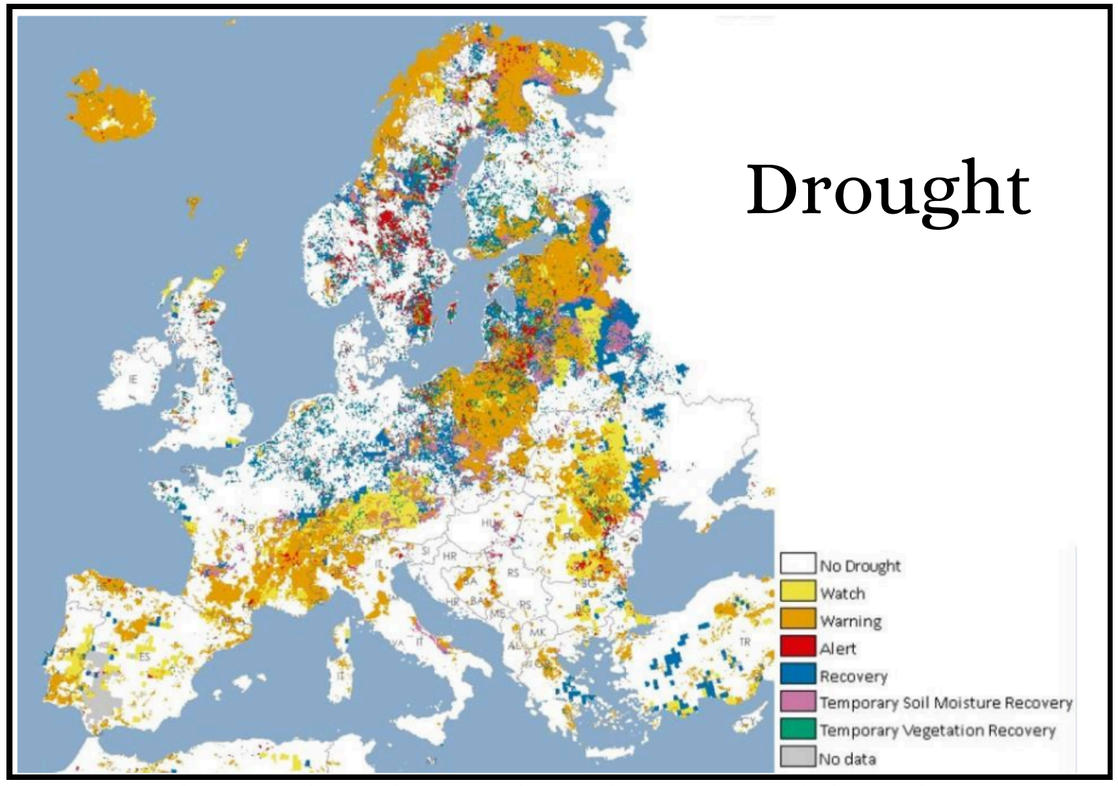


Figure 1: The Combined Drought Indicator (CDI), based on a combination of indicators of precipitation, soil moisture, and vegetation conditions, for mid-August 2023.

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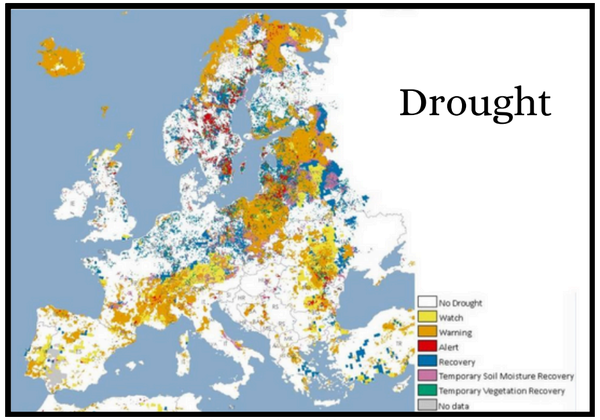

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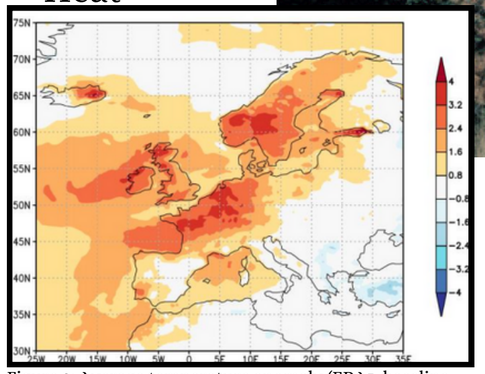

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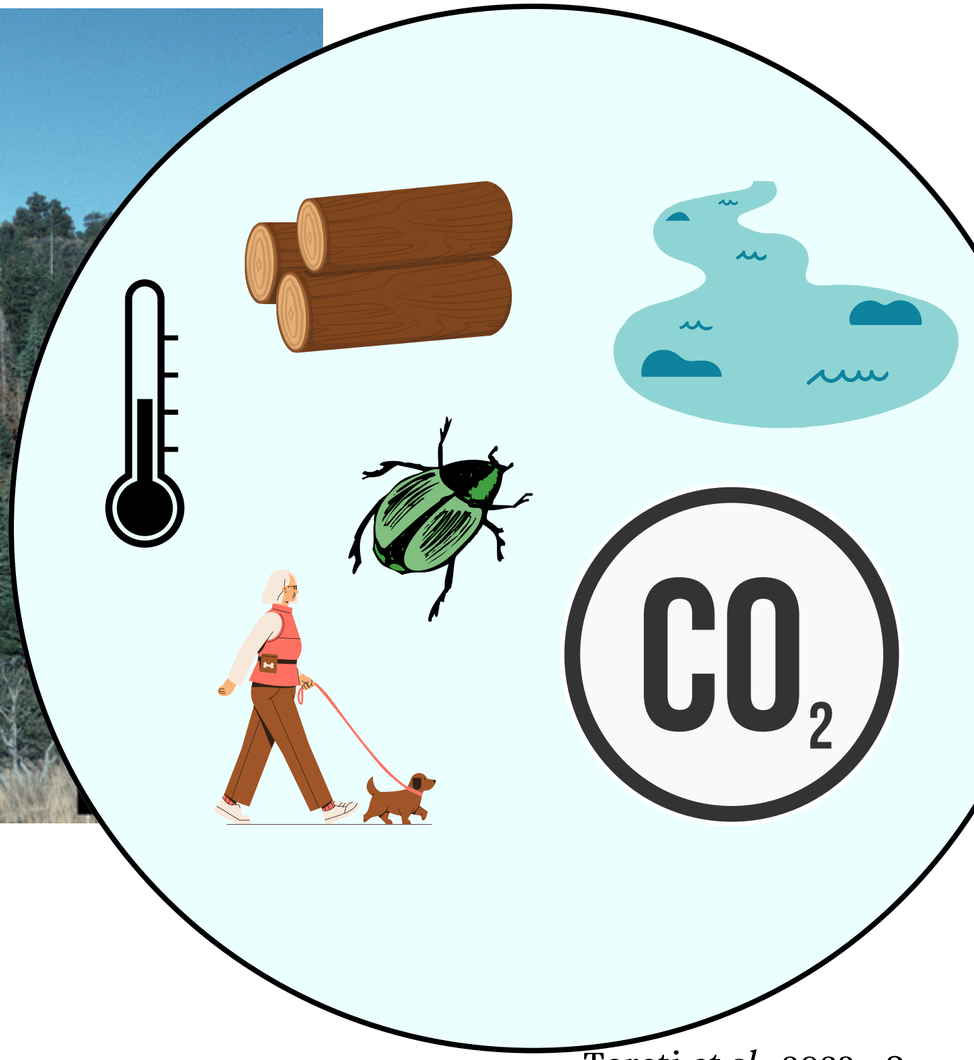
Forest's
Ecosystem services



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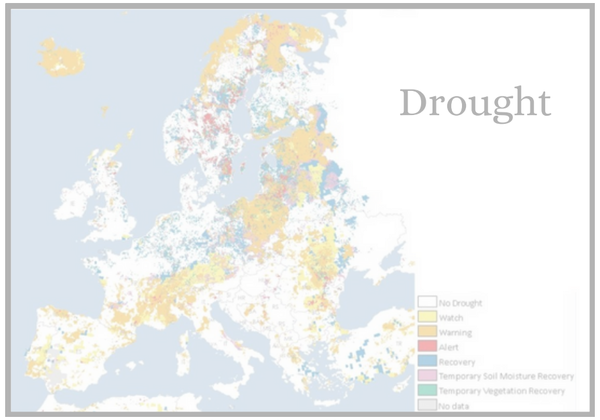

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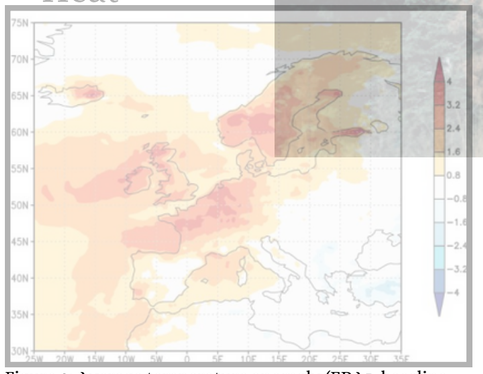

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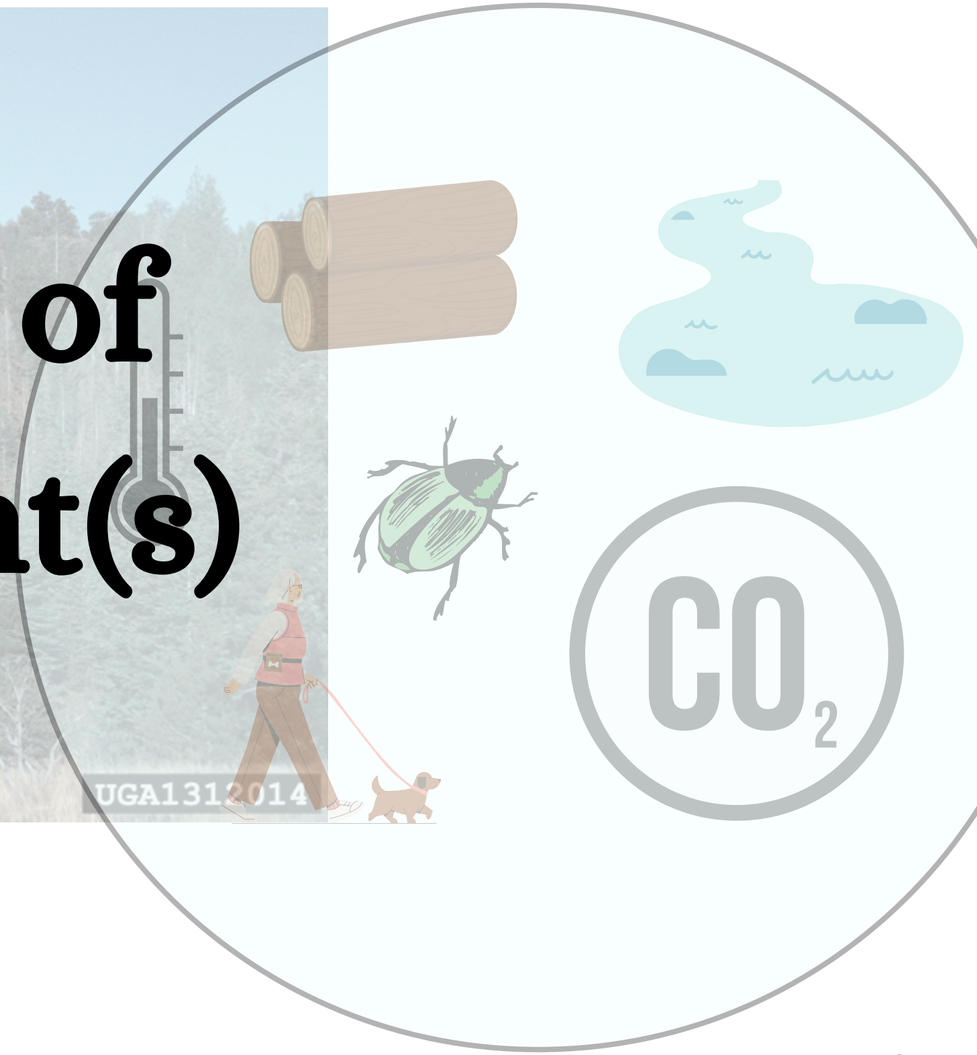
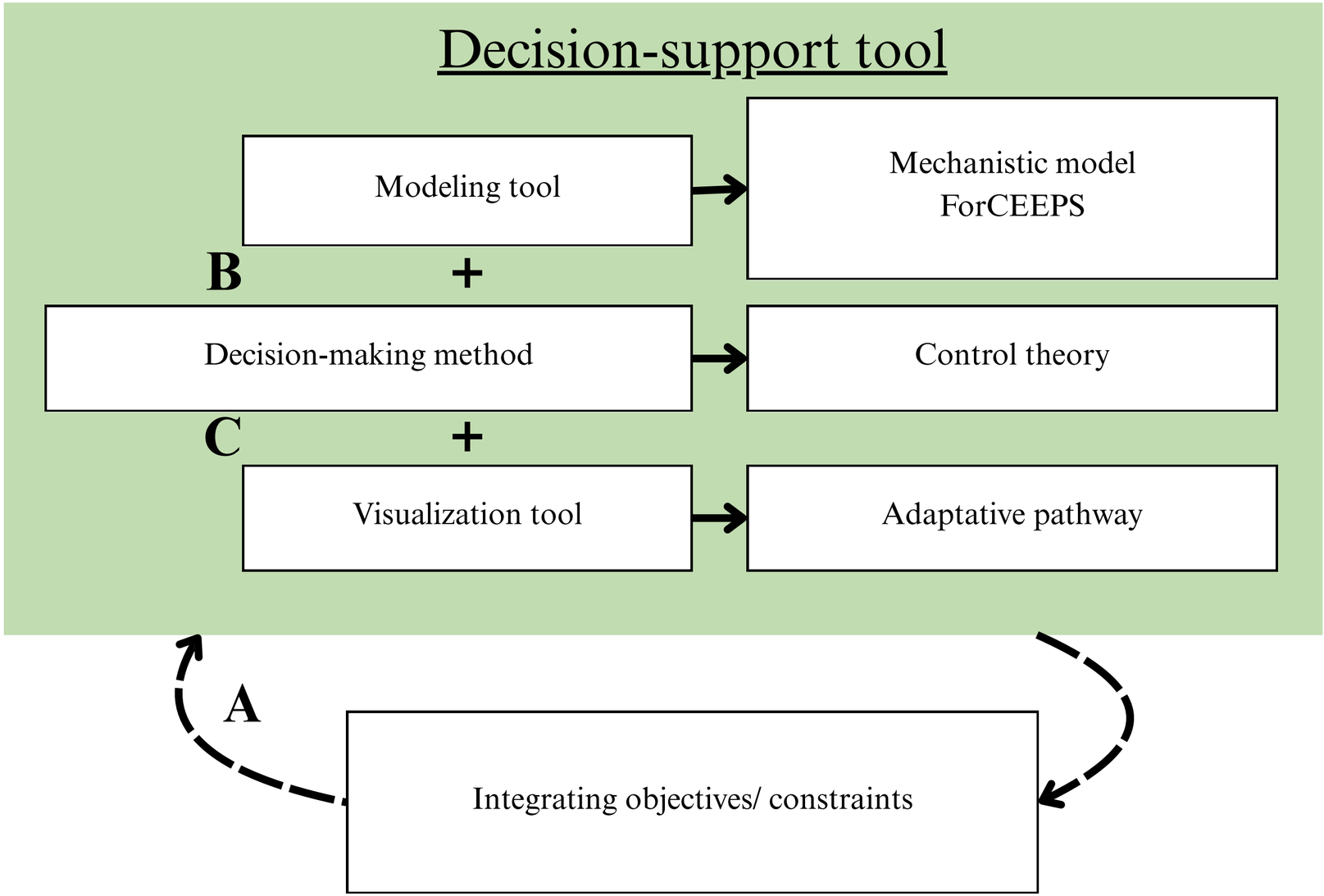
What kind of management(s) ?

Forest's
Ecosystem services



From regeneration to thinning, what sequences of silvicultural choices should be made to meet the needs of multi-objective managements?

Coupling **mechanistic models** with **control theory** in the context of adaptive decision-making in forest management.



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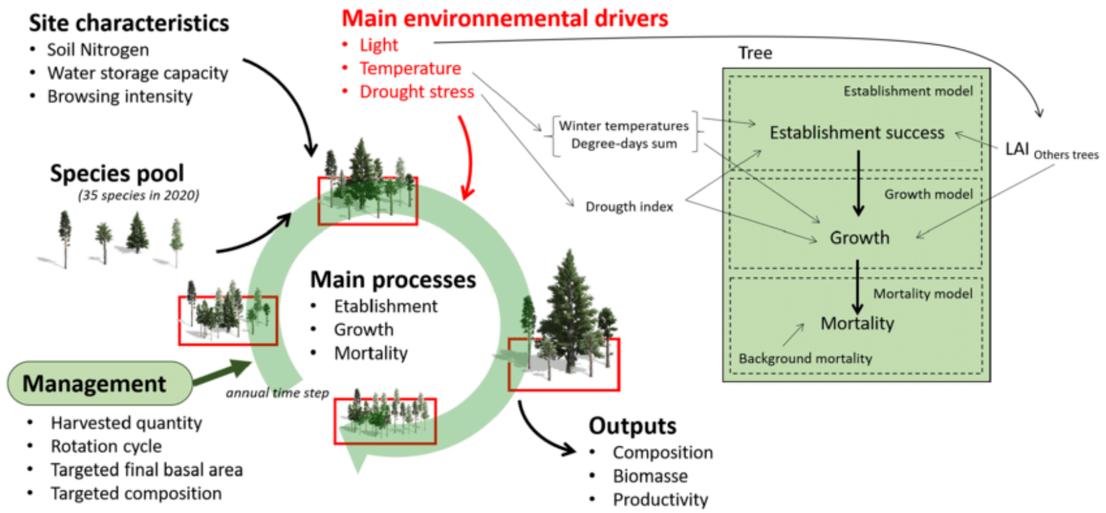
ForCEEPS



Simplified diagram of the ForCEEPS forest dynamics model. The cycle represented by the green arrow shows the forest dynamics that can be observed at patch level: recruitment, growth and mortality. The factors influencing these three stages are biotic (in blue) and abiotic (in red). The central diagram shows changes in stand biomass over time.

Morin *et al*, 2021 & Jourdan *et al*., 2021

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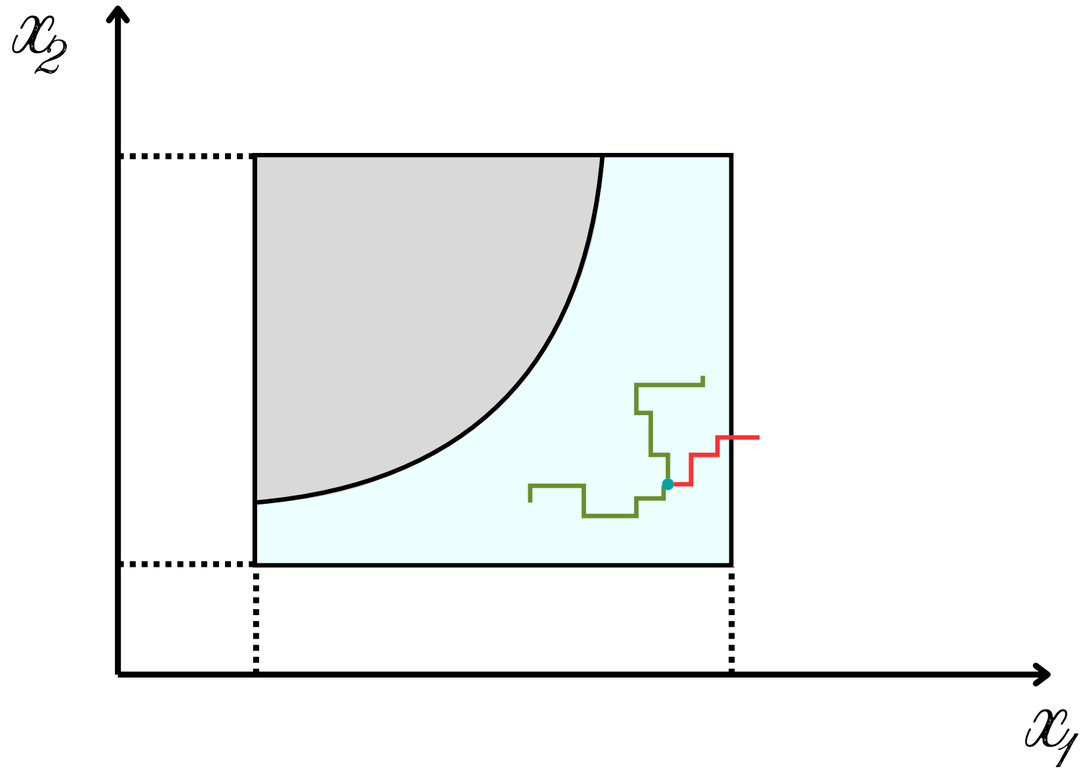
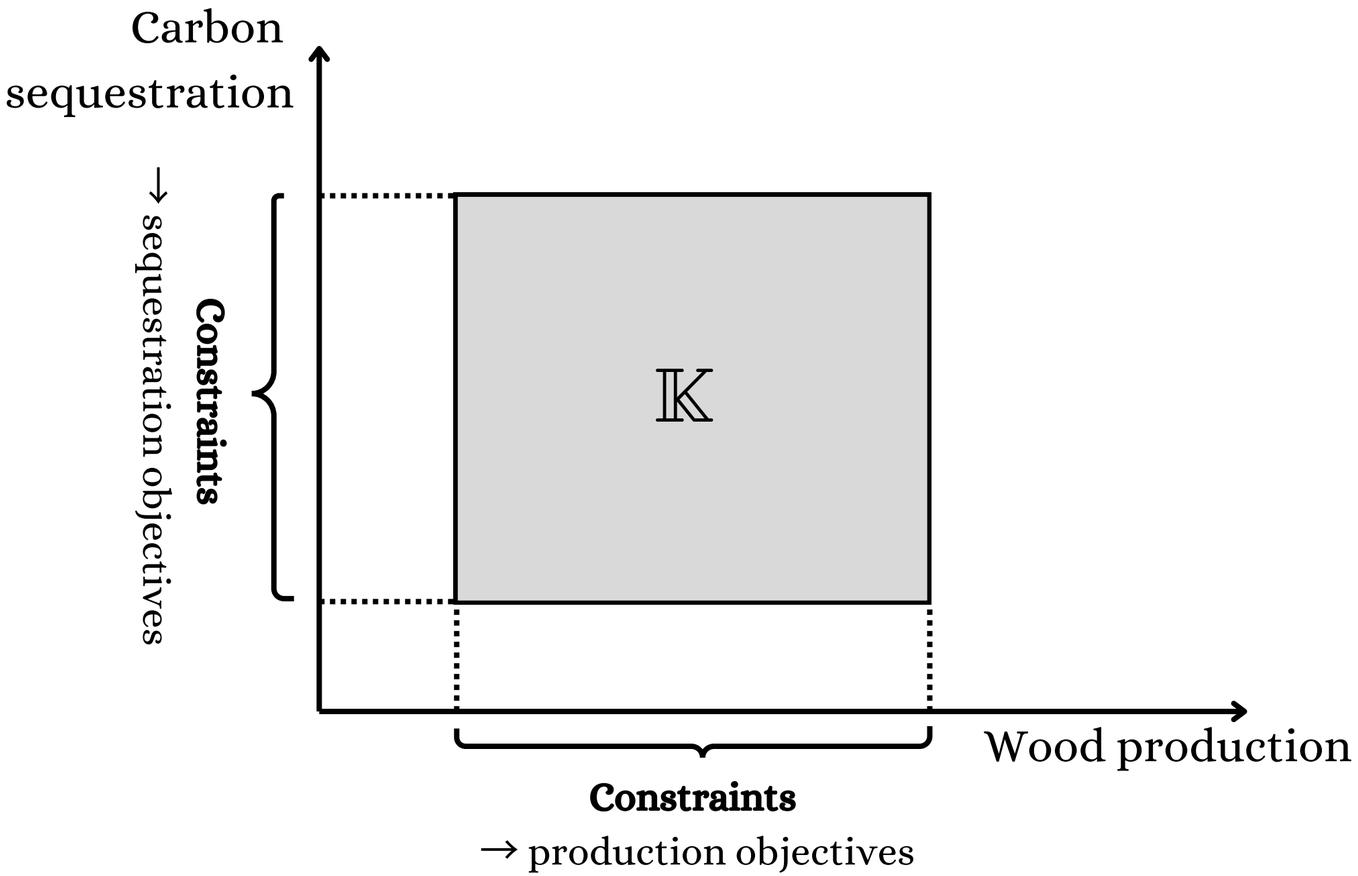


Mathias *et al*, 2015

ForCEEPS + control / viability theory



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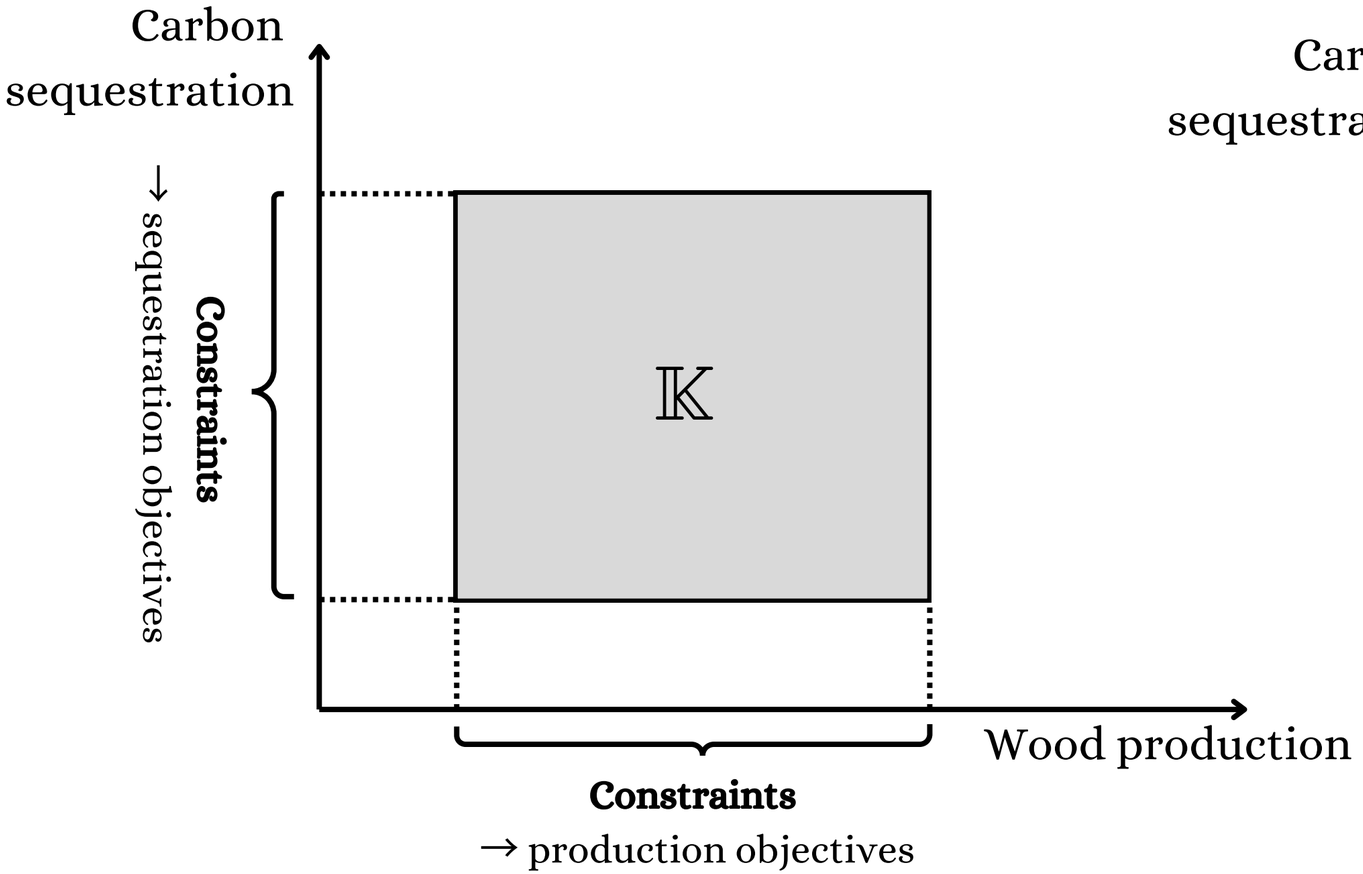
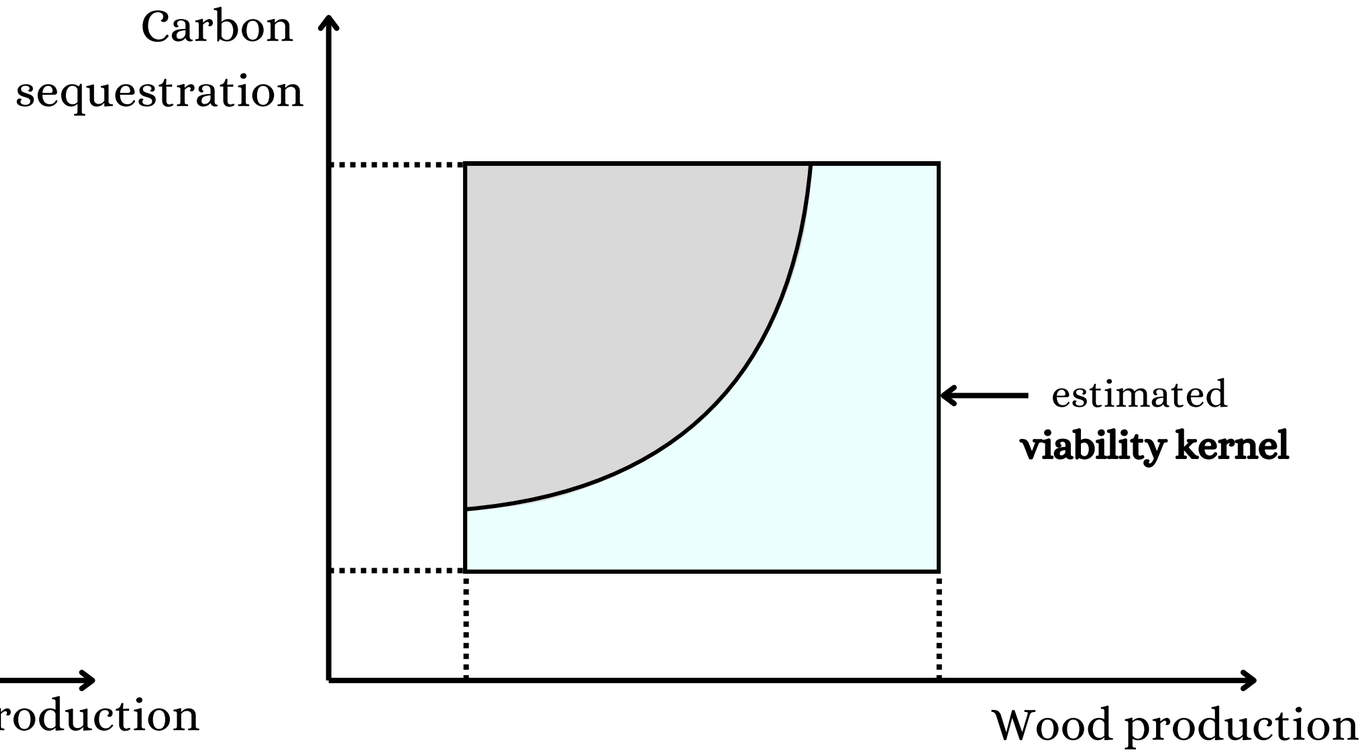
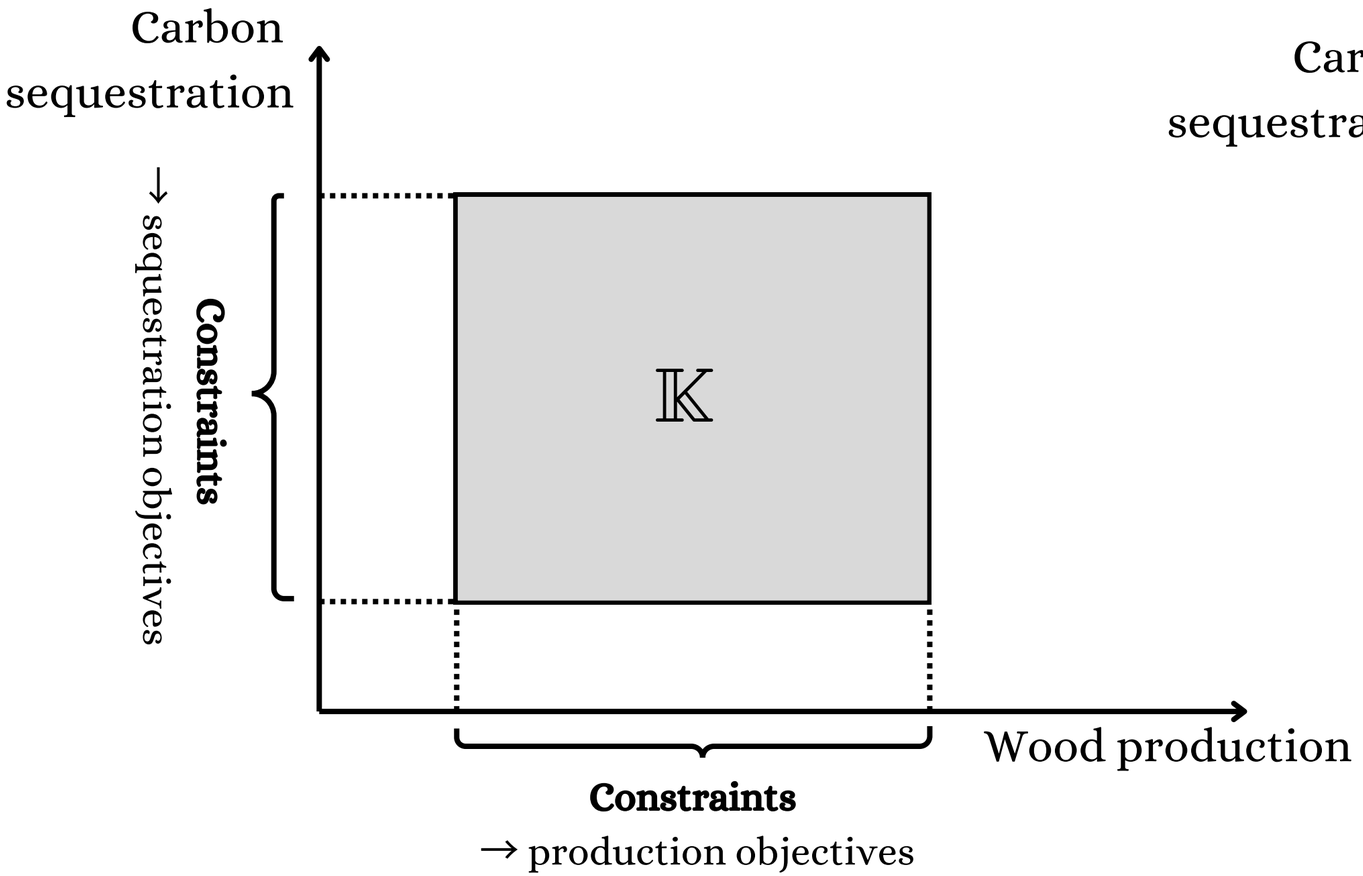
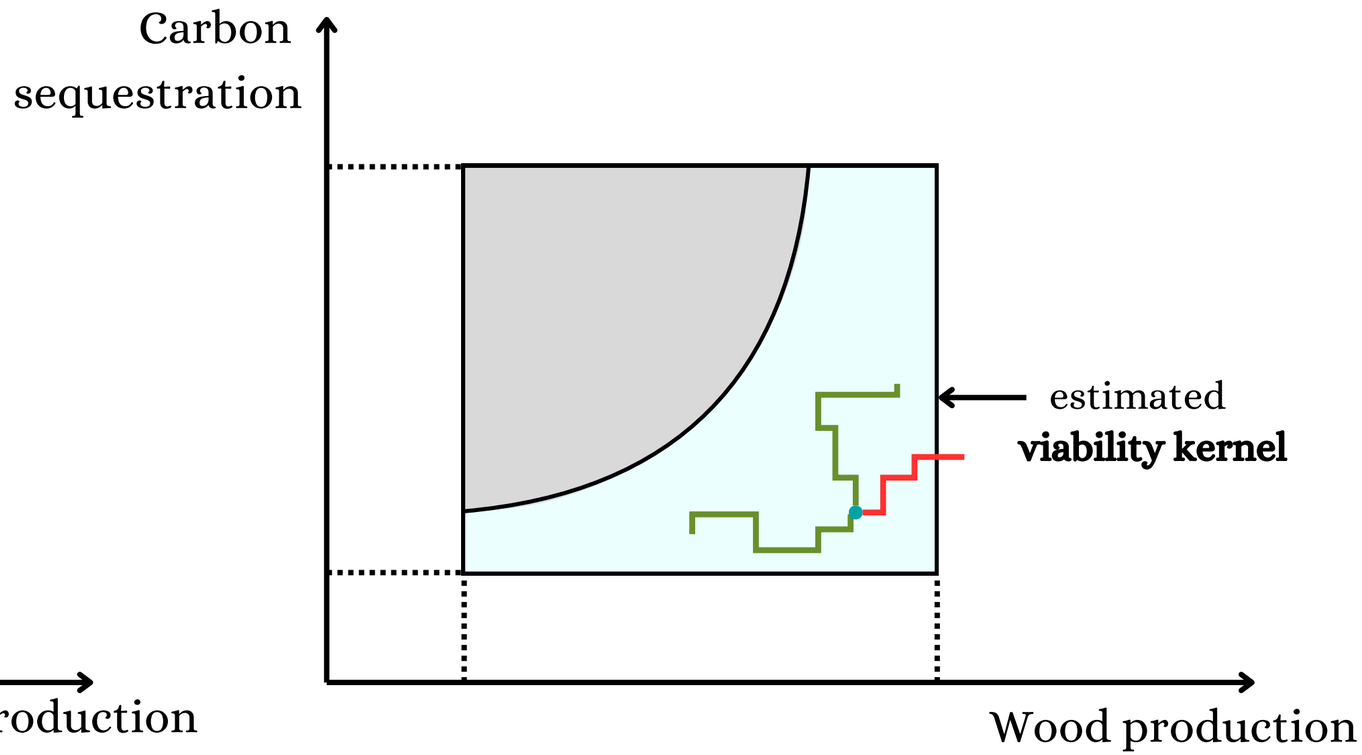




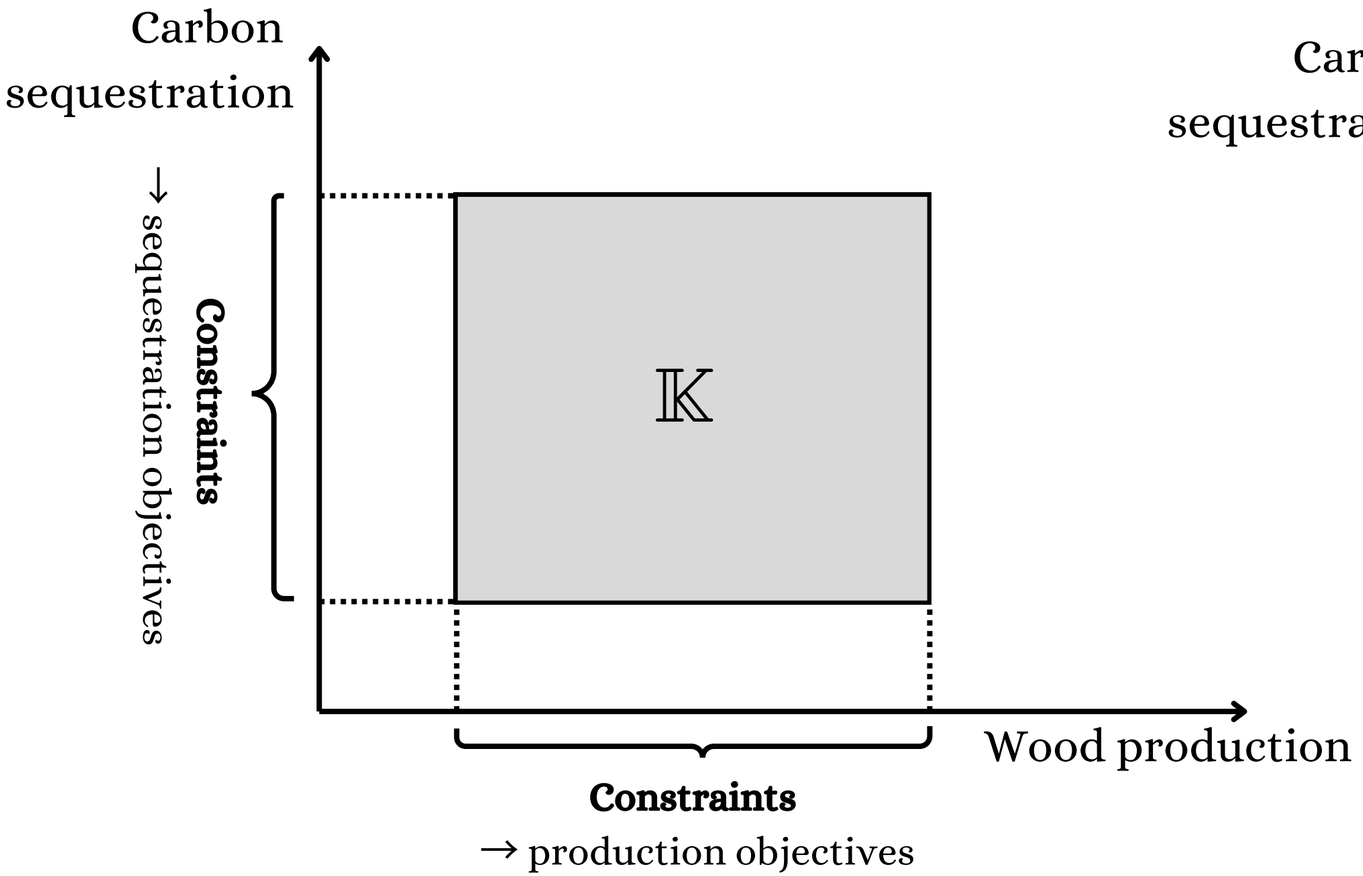
ForCEEPS + control / viability theory

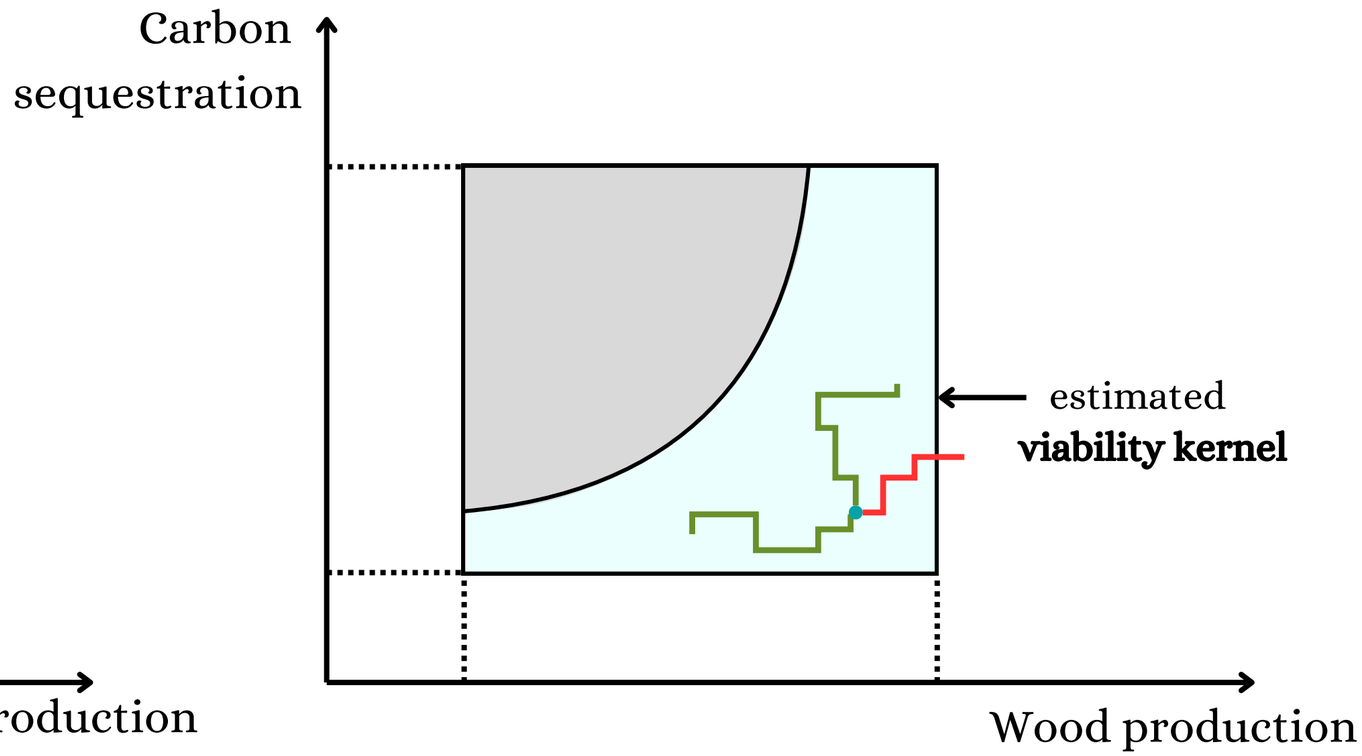




- State: dynamic
- Constraints: objectives
- Control: managements

ForCEEPS + control / viability theory





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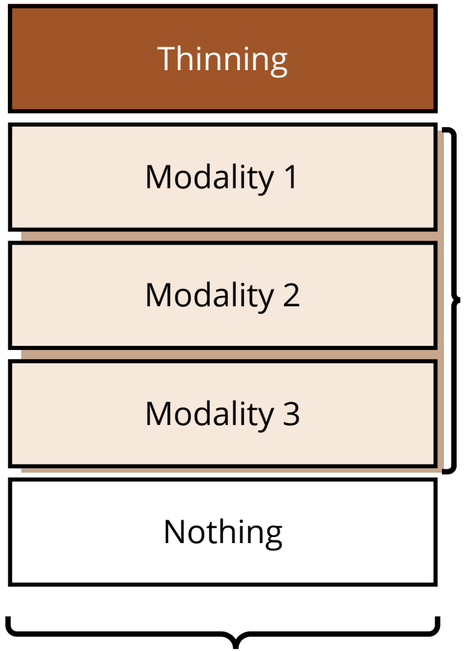
Control: managements



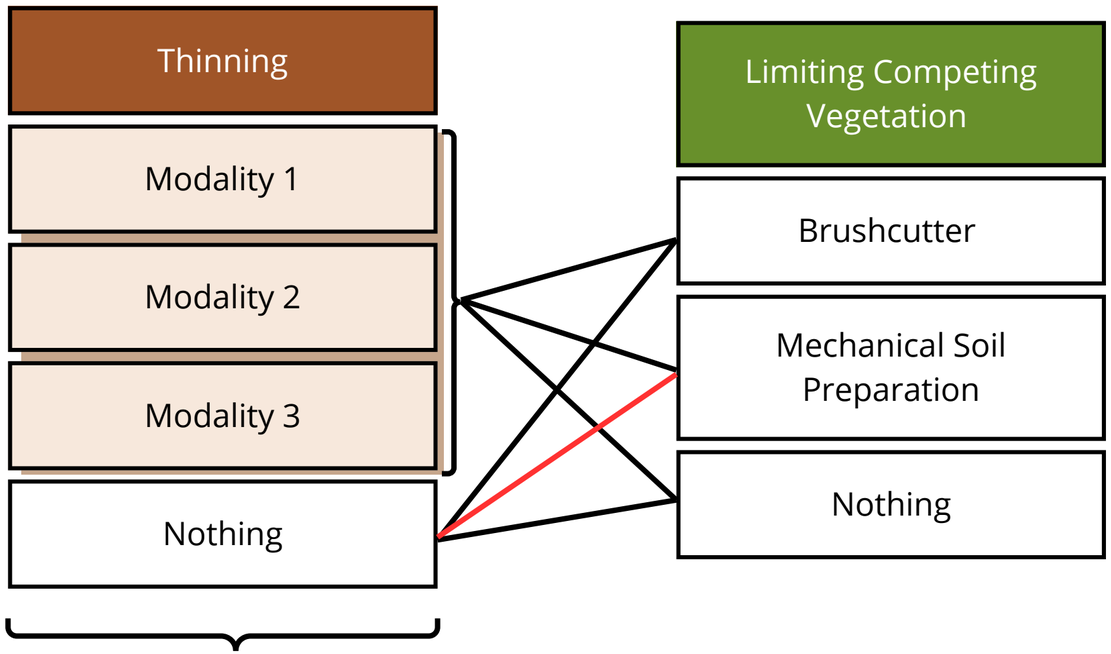
FOREM 2024: Marion Jourdan

→When, How Much, Objective Composition, Type ?

Impossible to combine

Possible to combine

Control: managements



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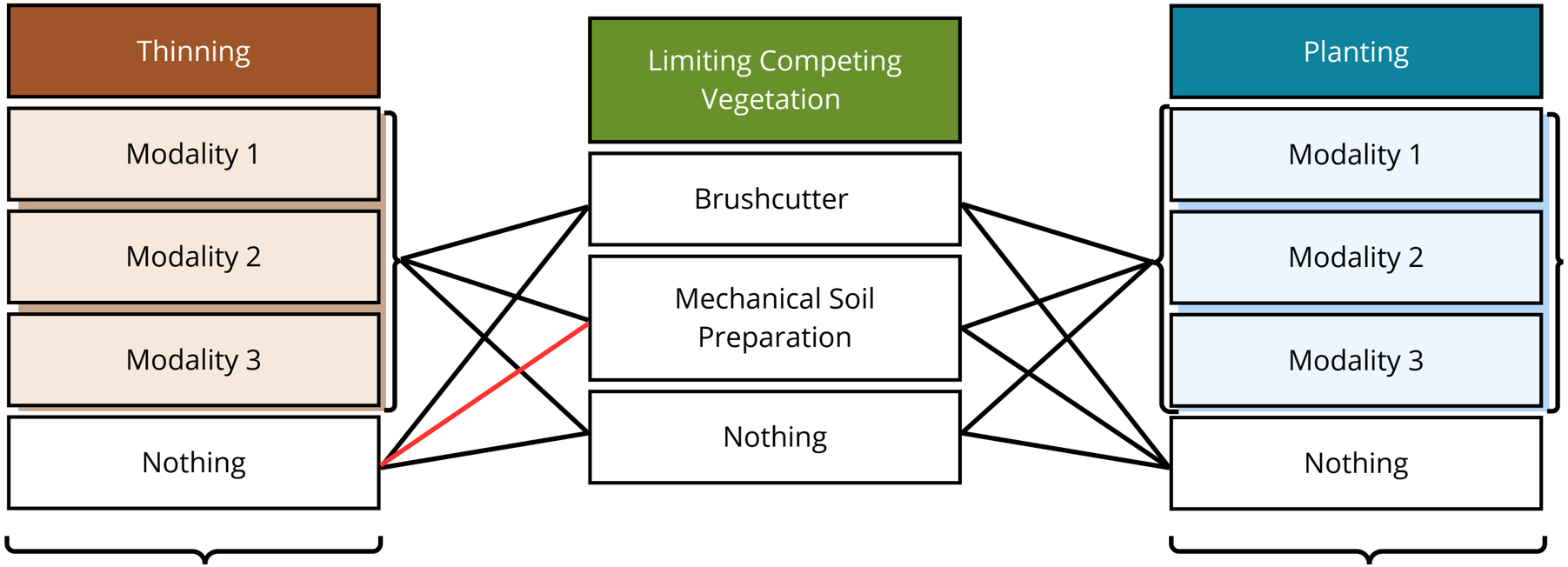


FOREM 2024: Marion Jourdan

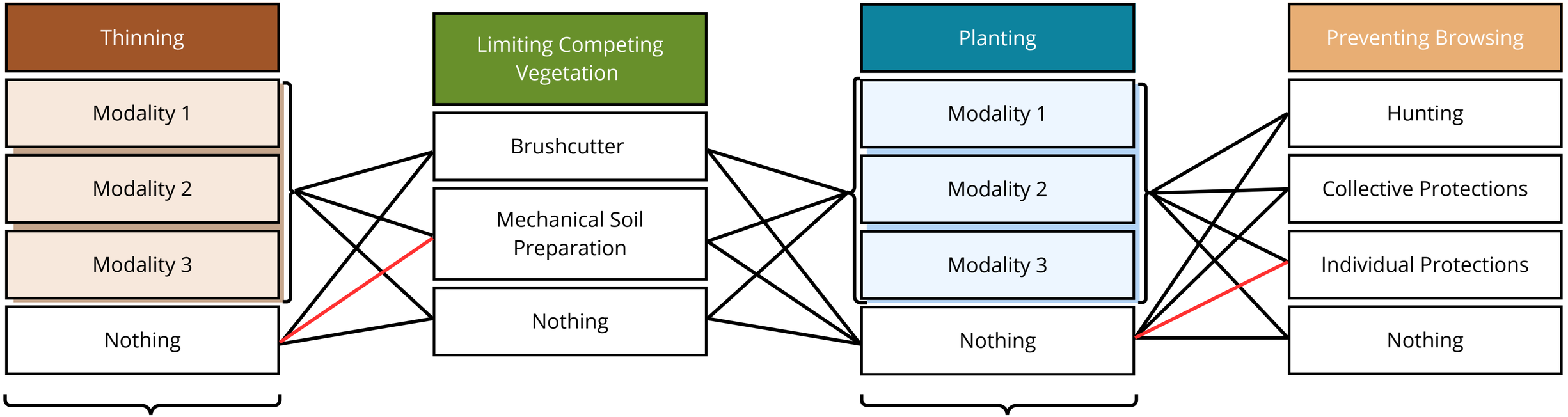
→When, How Much, Objective Composition, Type ?

→Density, Richness ?

Impossible to combine

Possible to combine

Control: managements

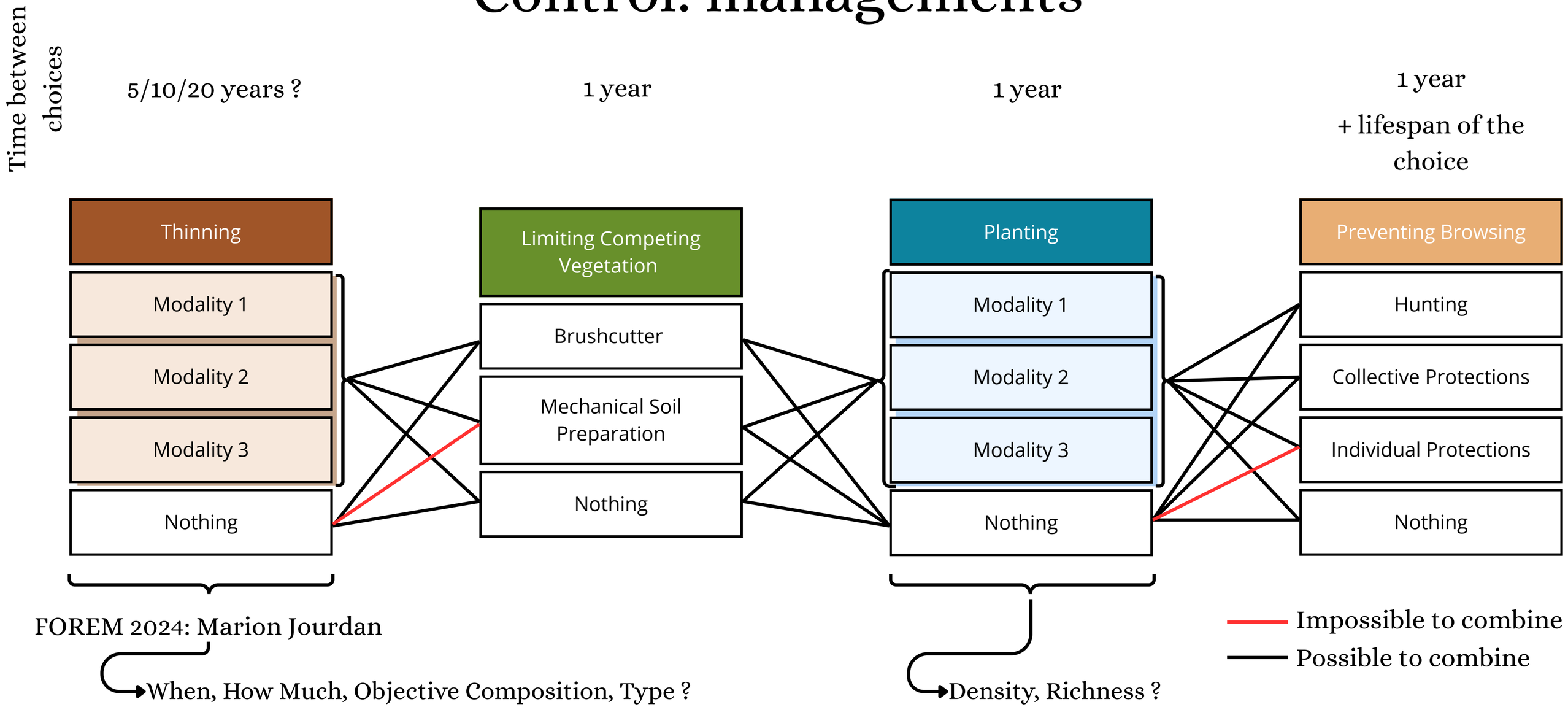


FOREM 2024: Marion Jourdan

→When, How Much, Objective Composition, Type ?

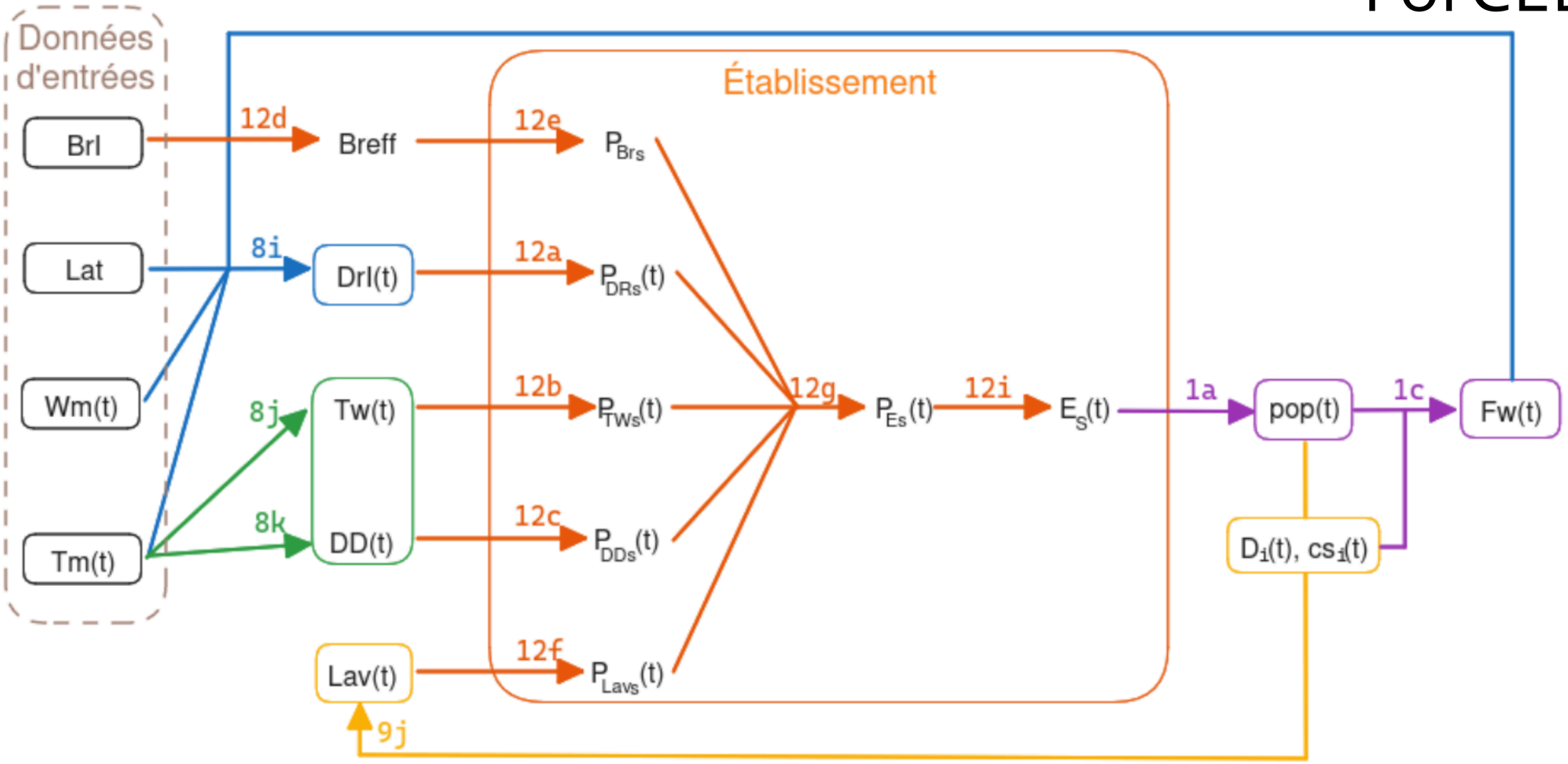
→Density, Richness ?

Control: managements

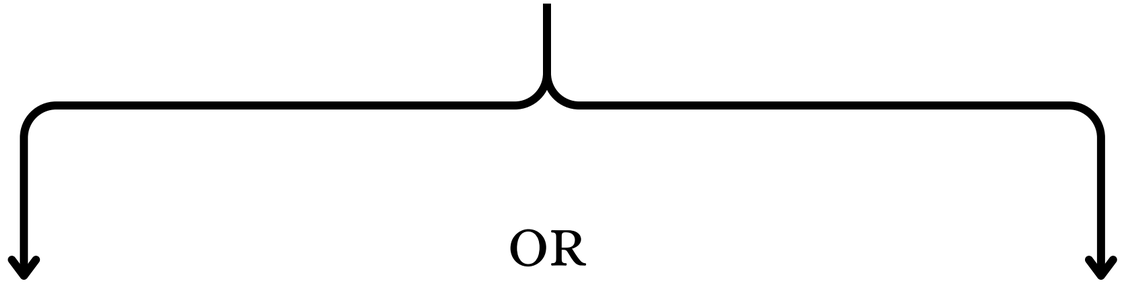


Dynamic of Regeneration

ForCEEPS



Changing the Dynamic of Regeneration to add Control in ForCEEPS

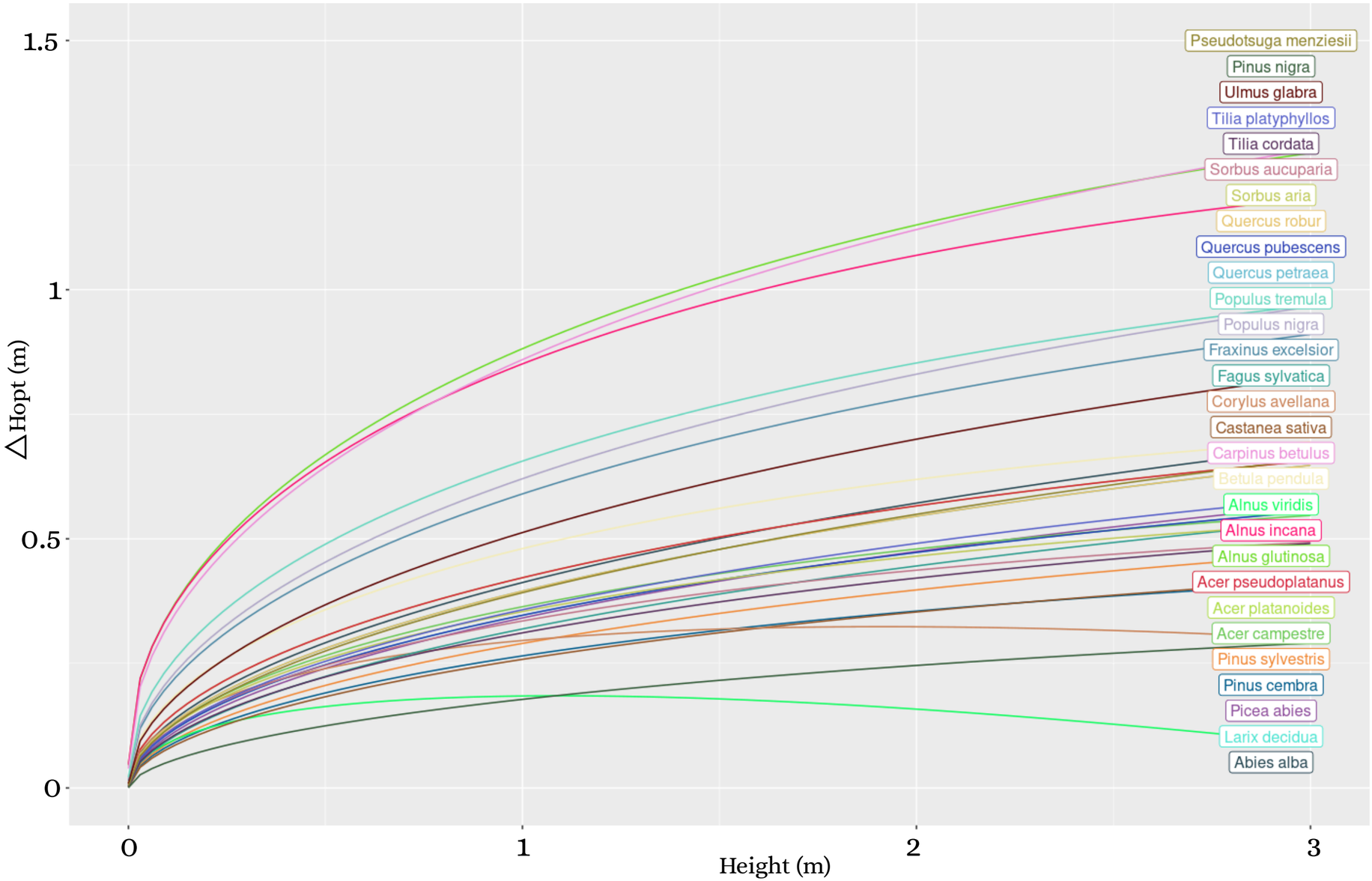


OR

(1) Growth curve

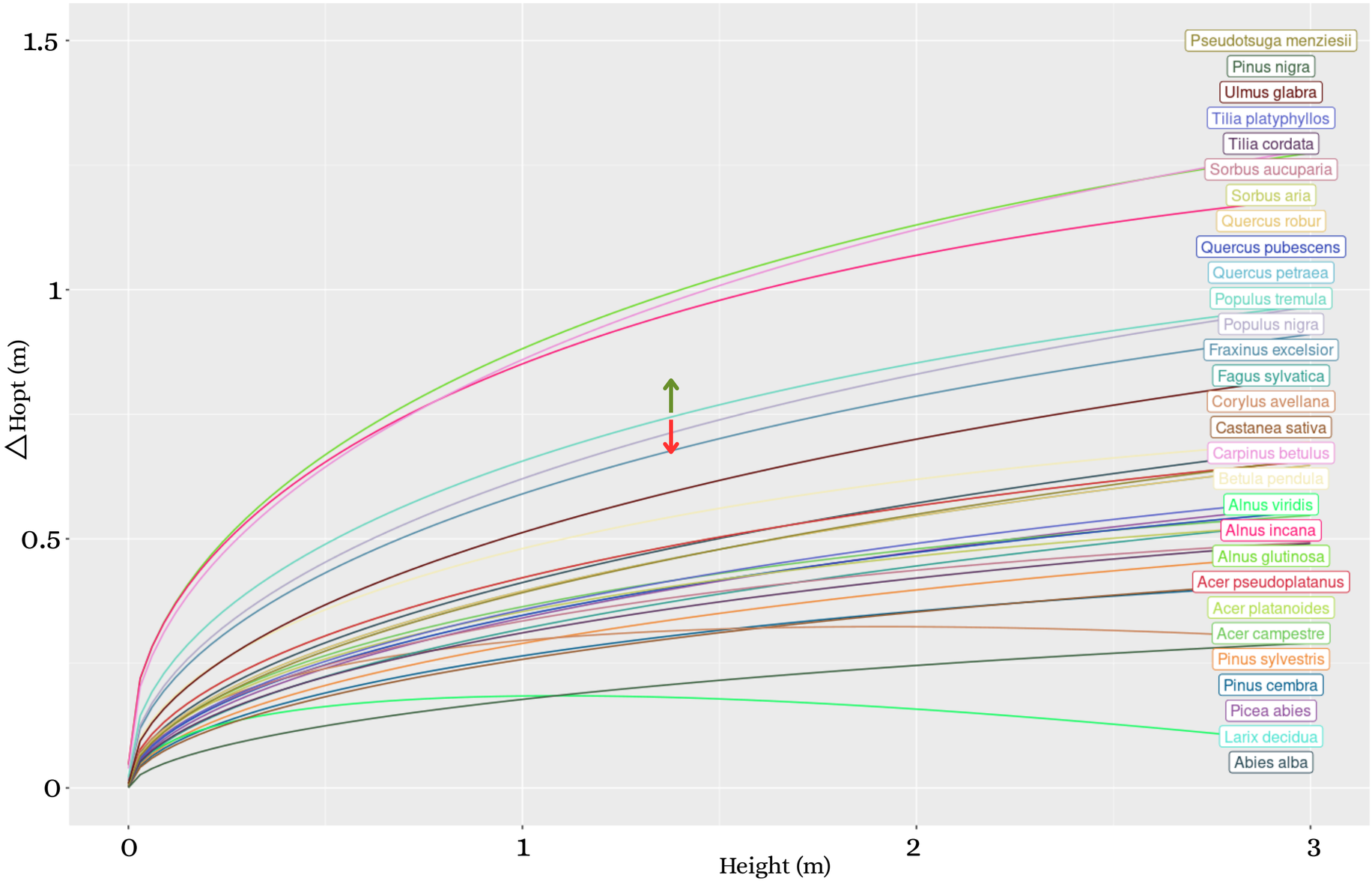
(2) Causal chain

(1) Growth curve - iLand



Seidl *et al.*, 2012

(1) Growth curve - iLand



Real Growth / Mortality

↓

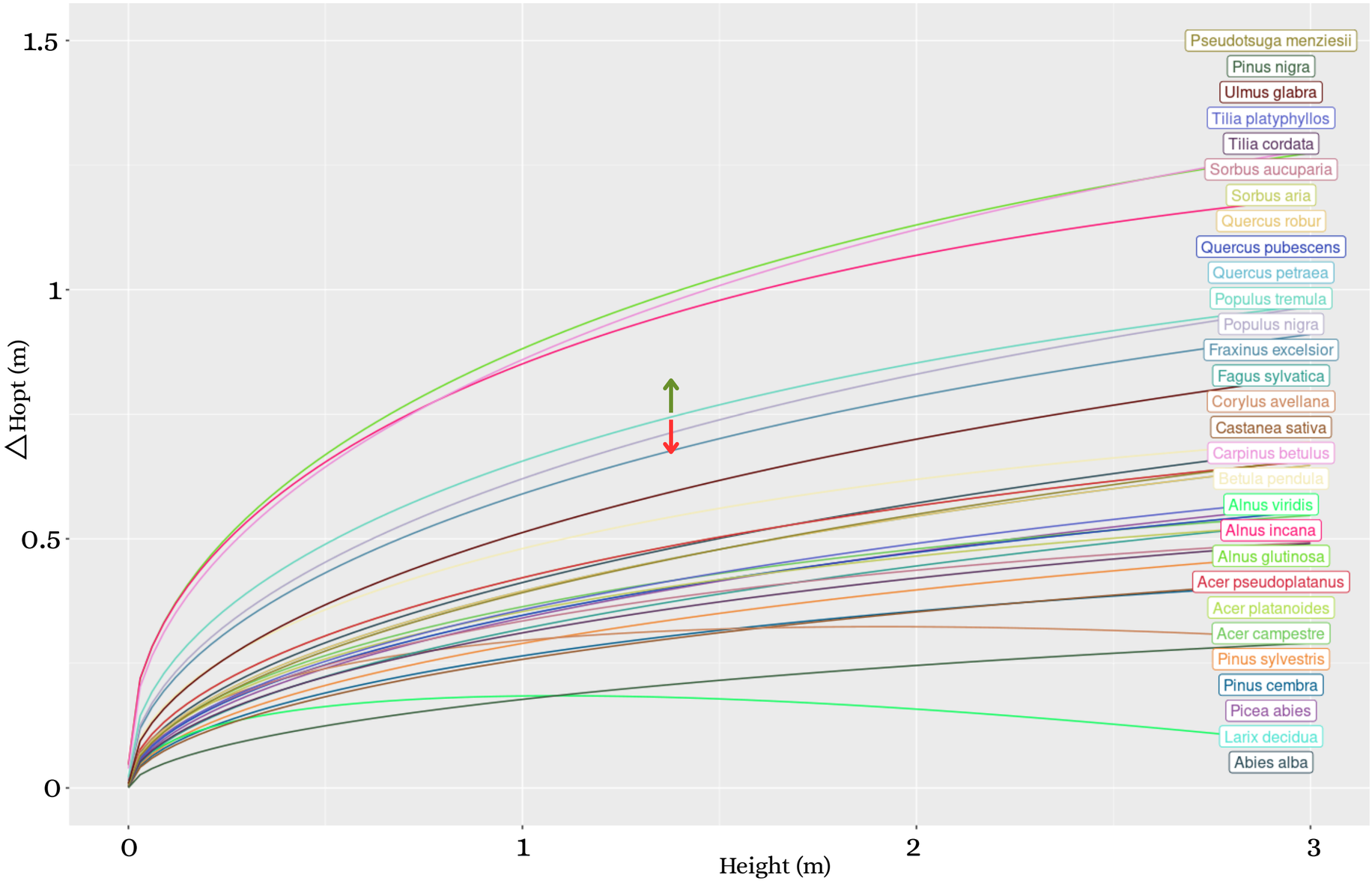
Environmental conditions

+

Control

Seidl *et al.*, 2012

(1) Growth curve - iLand



Real Growth / Mortality

↓

Environmental conditions

+

Control

Seidl *et al.*, 2012

(1) Growth curve

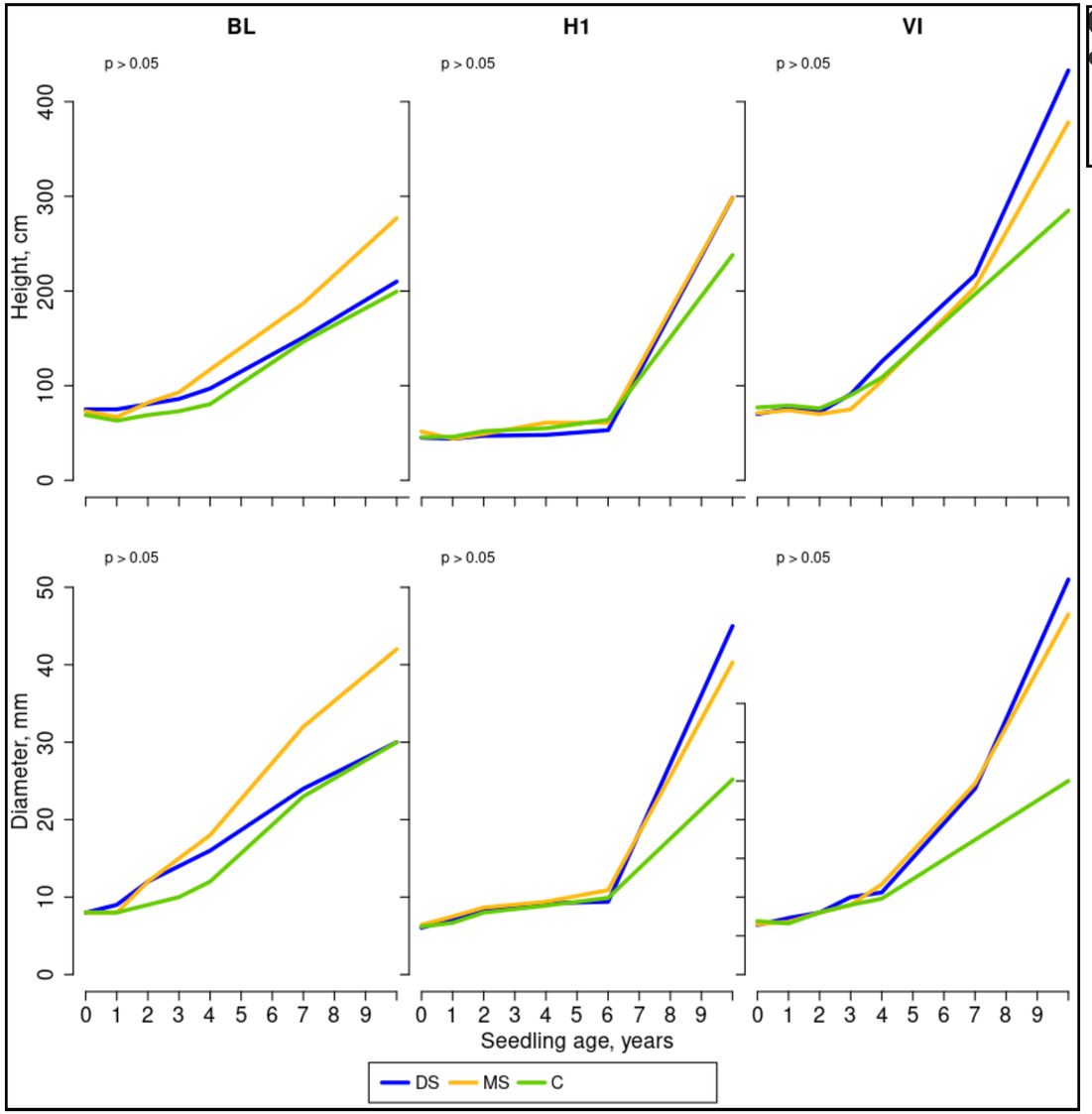
Competitive vegetation

Limiting Competing Vegetation

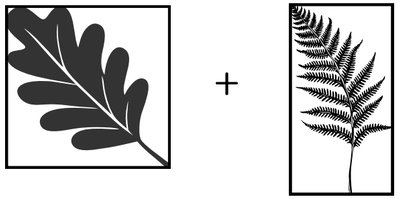
Brushcutter

Mechanical Soil Preparation

Nothing



Oak + Fern



Data:

- **ALTER**
- FCBA
- ONF

From a personal communication

Noé Dumas
Catherine Collet
Thomas Cordonnier
Alain Berthelot

(1) Growth curve

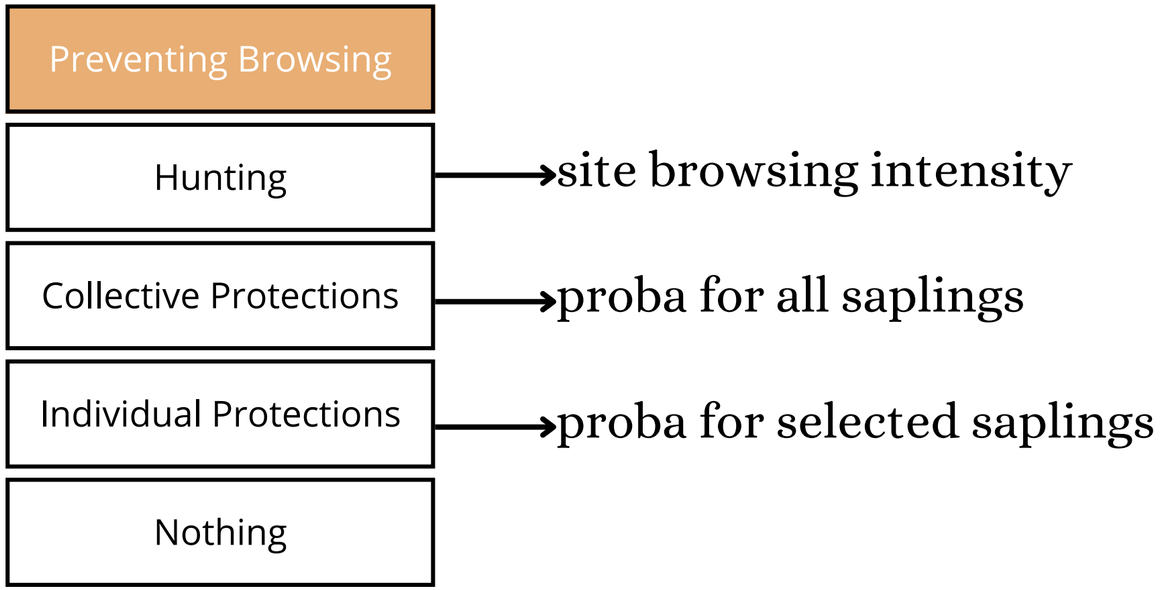
Browsing

Dynamic

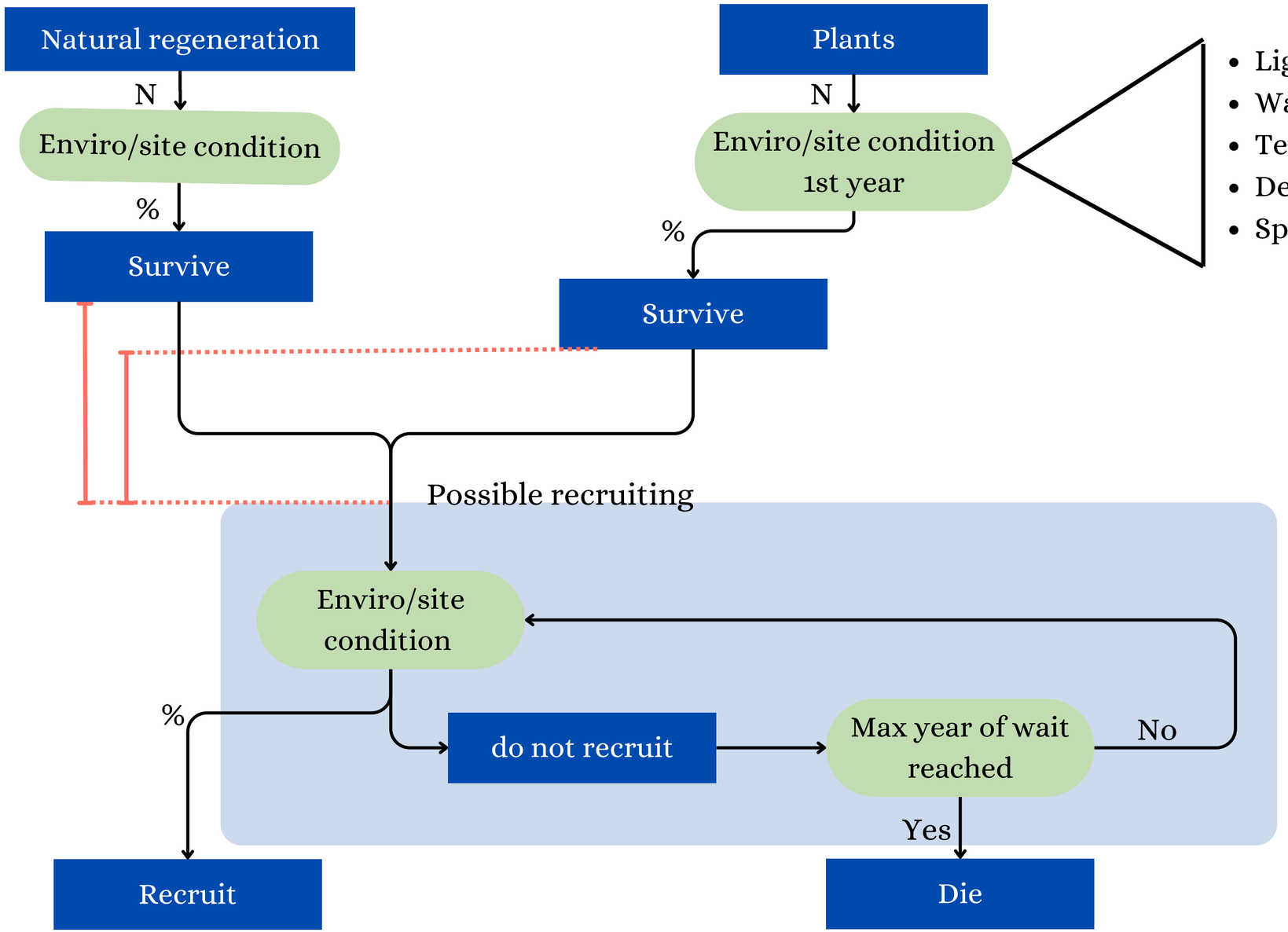
=>**Probability** per seedling depending on **site**, **species, ...**

- If eaten ⟶ no growth that year
- Mortality depending on growth
- Site browsing intensity can evolve with time

Control



(2) Causal chain



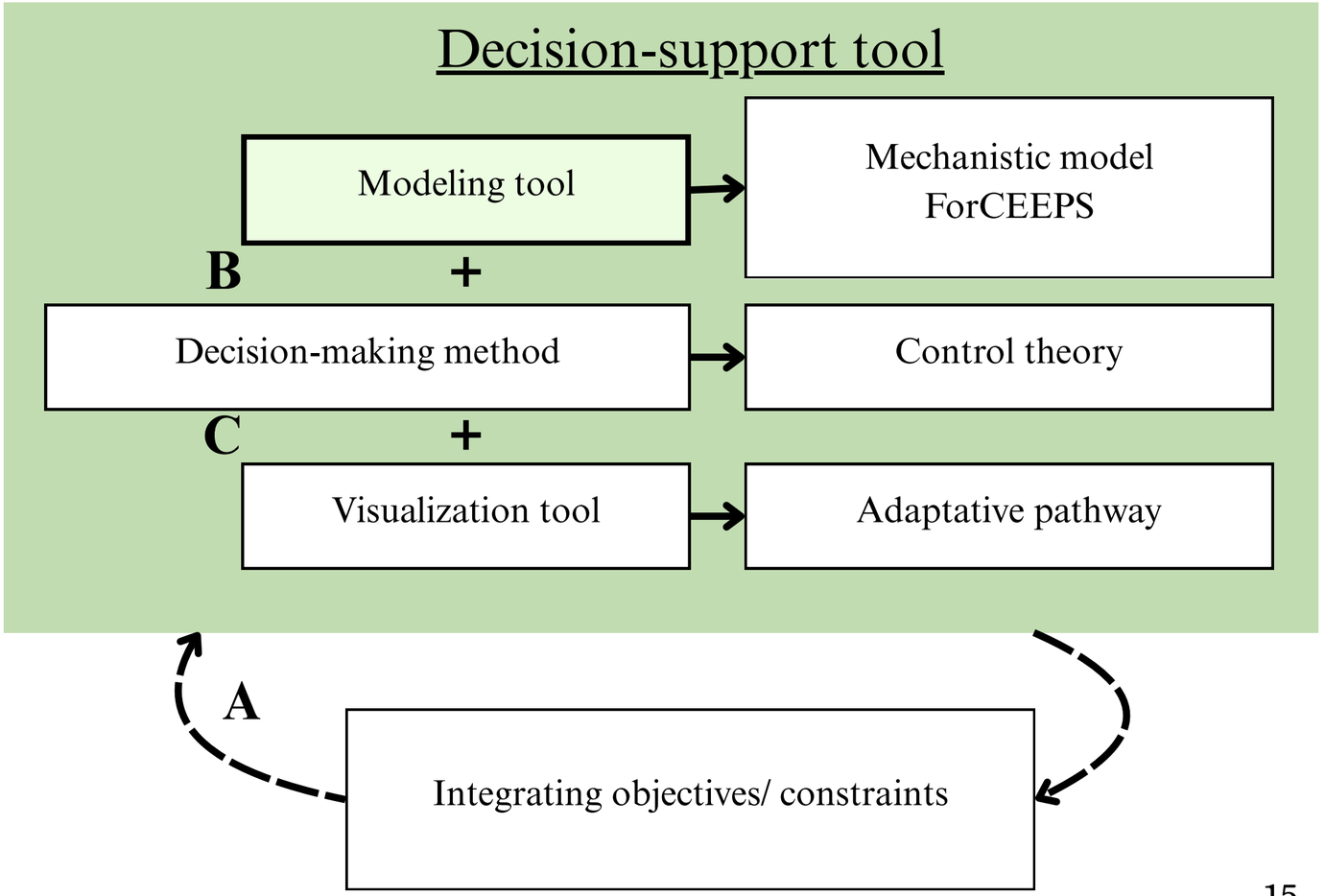
Time for growth in optimal Enviro/site conditions to reach 1.27 cm dbh
-Control on Browsing and Competing vegetation

To conclude

- Regeneration in models

→ Need to improve the representation of the dynamics
→ Need to model adaptative management, including choices on regeneration

- Pivotal point of my PhD, focus on Dst



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Thanks to:

- Catherine Collet
- Noé Dumas
- Samuel Gillet
- François de Coligny
- Xavier Morin

Donald Owen, California Department of Forestry and Fire Protection, Bugwood.org

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(1) Growth curve

Competitive vegetation

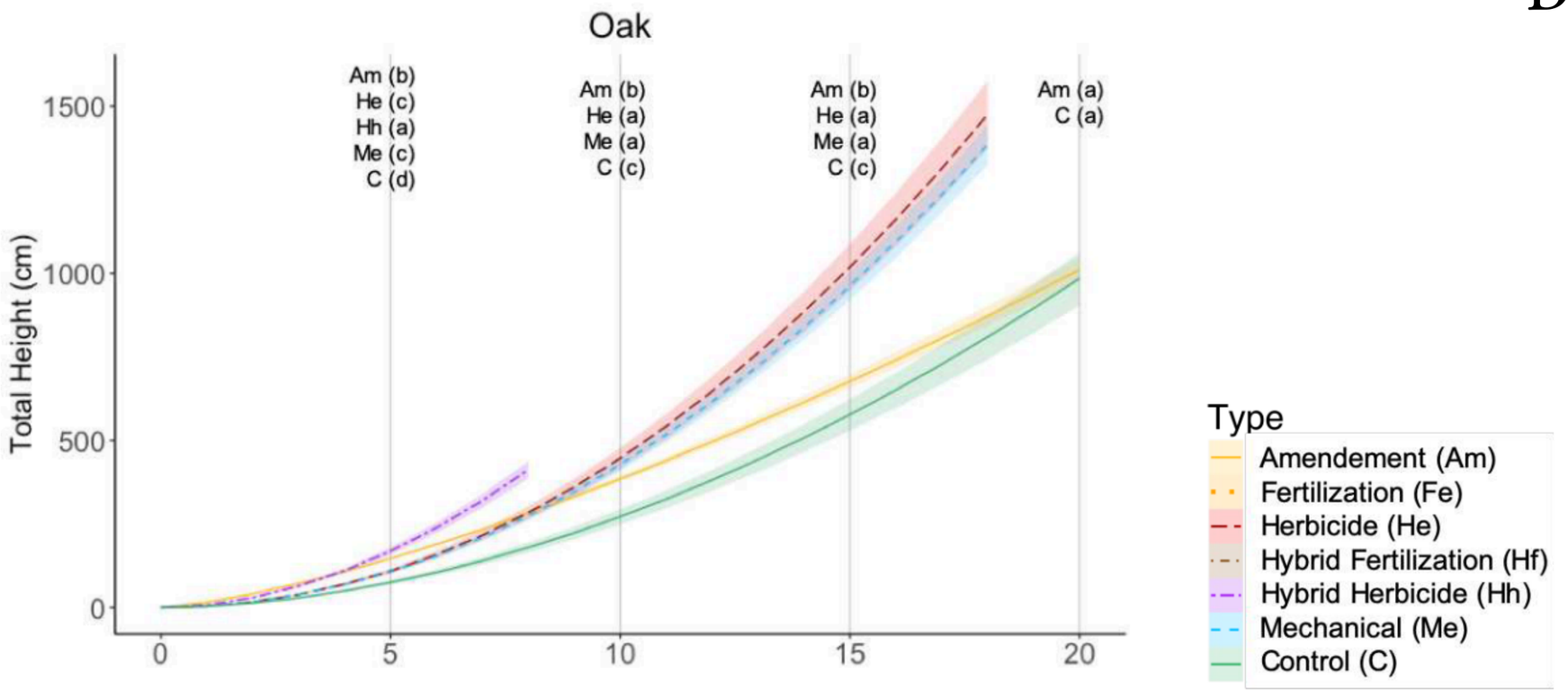

Figure 11. Hauteur totale du Chêne cultivés selon différentes méthodes de préparation du site : valeurs prédites et intervalles de confiance à 95%. Les valeurs moyennes des traitements ont été comparées à 5, 10, 15 et 20 ans à l'aide d'un test Monte-Carlo à intervalles de confiance à 95% : les valeurs moyennes suivies de la même lettre ne diffèrent pas significativement à la date du test. Les échelles X et Y diffèrent selon les graphiques.

Data:

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- FCBA
- ONF

Miquel, 2020. 12 bis