



# Managing forests as functional networks: preparing our landscapes for the unexpected

Marco Mina<sup>1</sup>, N. Aquilué<sup>2</sup>, M.-J. Fortin<sup>3</sup>, M. Duveneck<sup>4</sup>, C. Messier<sup>5</sup>

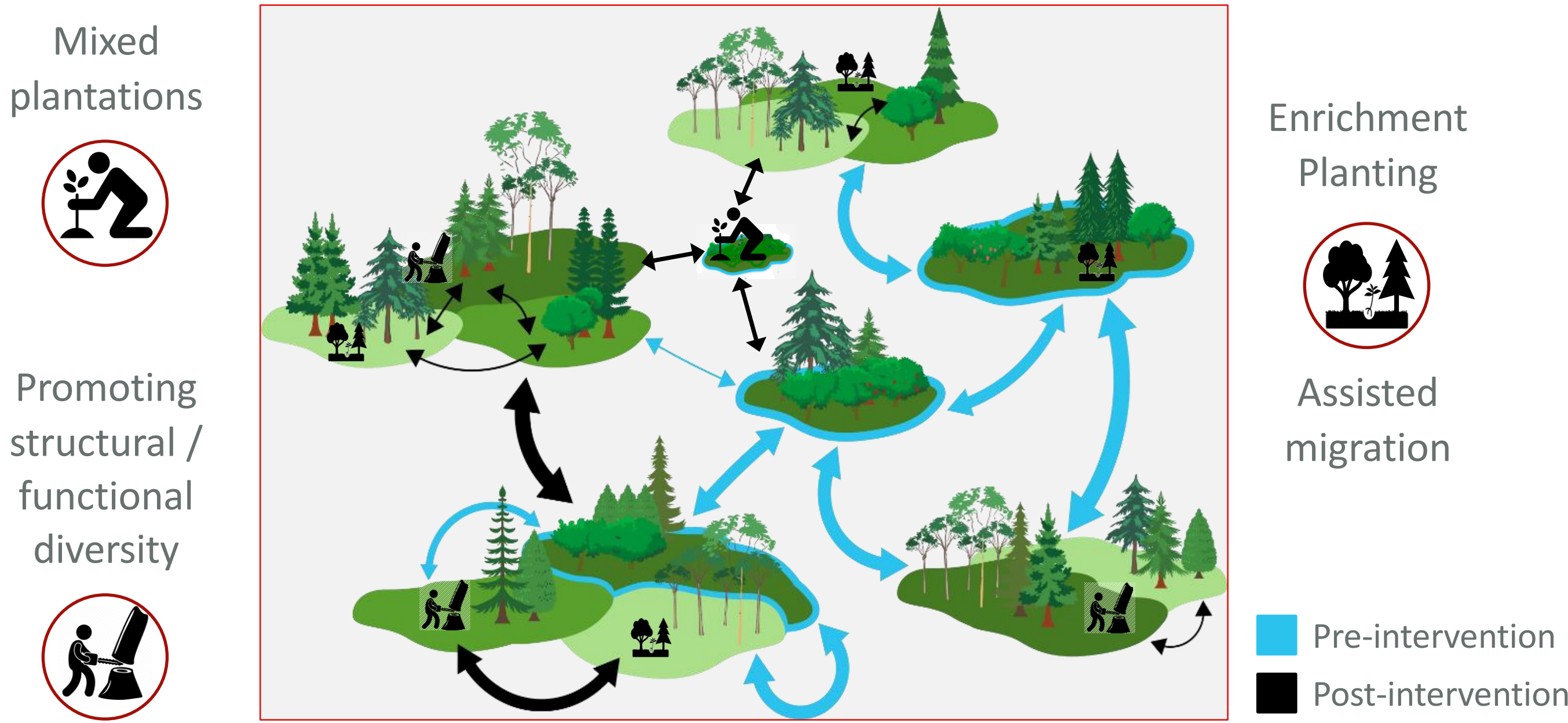
<sup>1</sup>Eurac Research, <sup>2</sup>CTFC Solsona, Spain, <sup>3</sup>University of Toronto, <sup>4</sup>Harvard Forest, <sup>5</sup>Centre d'étude de la forêt - Université du Québec à Montréal UQAM

## The concept

Messier et al. 2019 For. Ecosyst., 6, 21

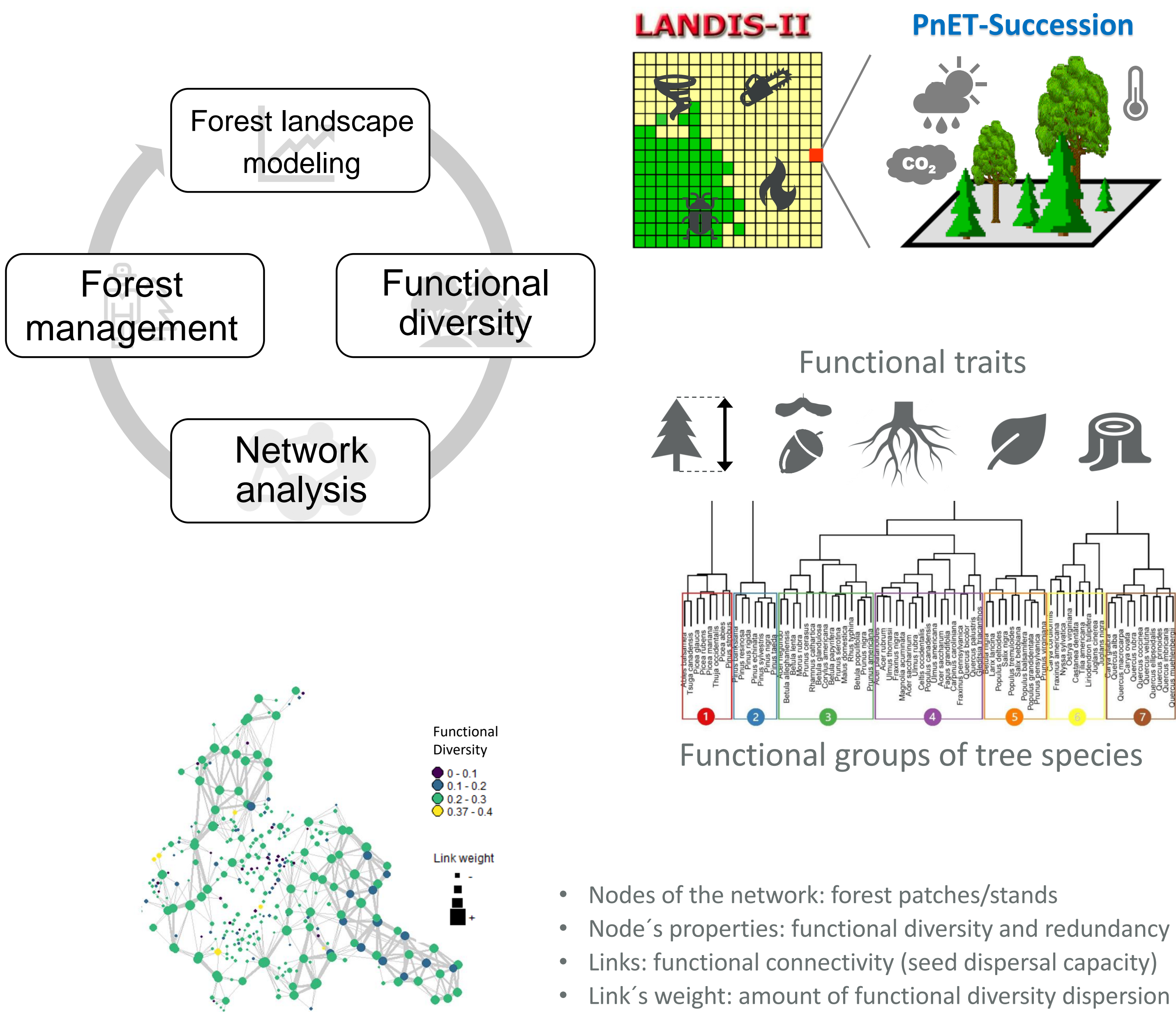
- High level of uncertainty to face future environmental and global changes
- The functional complex network approach: increasing ecological resilience by integrating past and novel approaches in forest management at multiple spatial scales
- Resilient forest landscape → maximizes functional diversity and functional redundancy (at stand-scale); functional connectivity, centrality and modularity (at landscape-scale)

### Management interventions to enhance ecological resilience



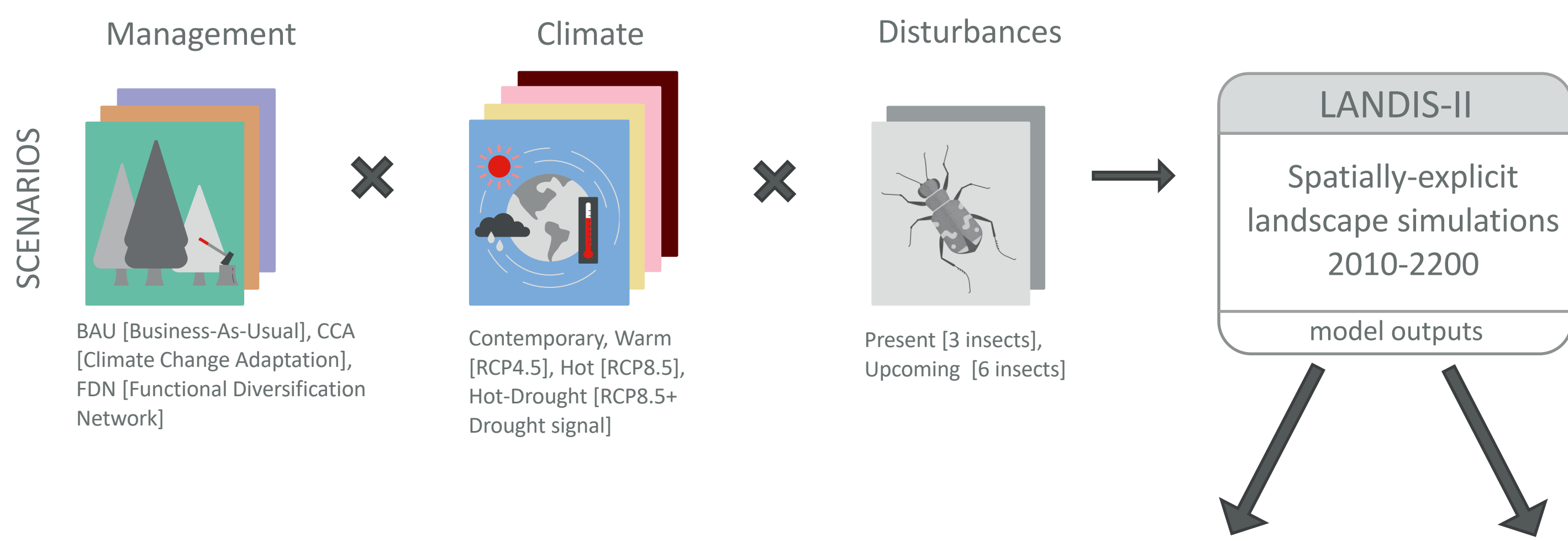
## The methods

Mina et al. 2021 Ecol. Appl., 31, e2221



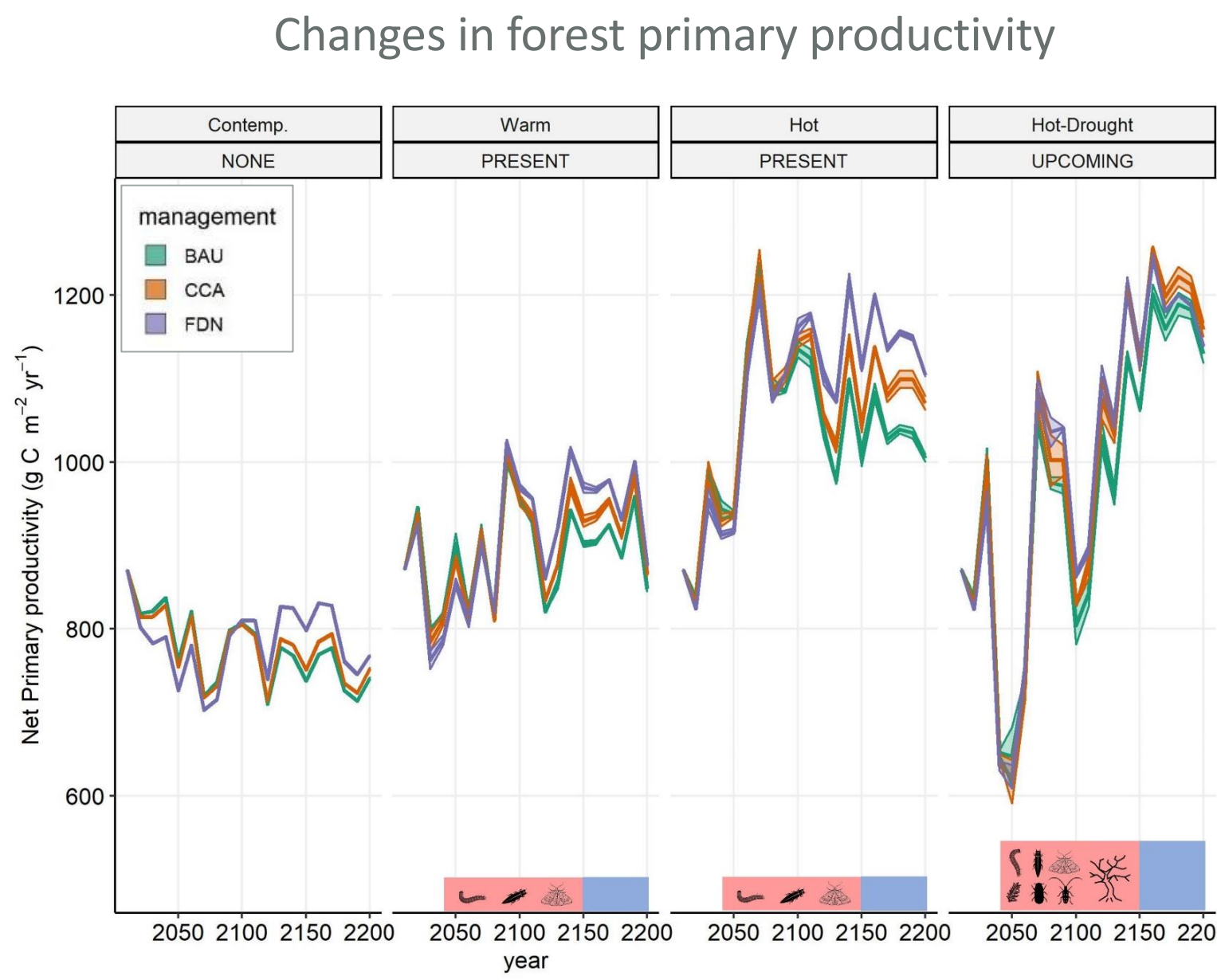
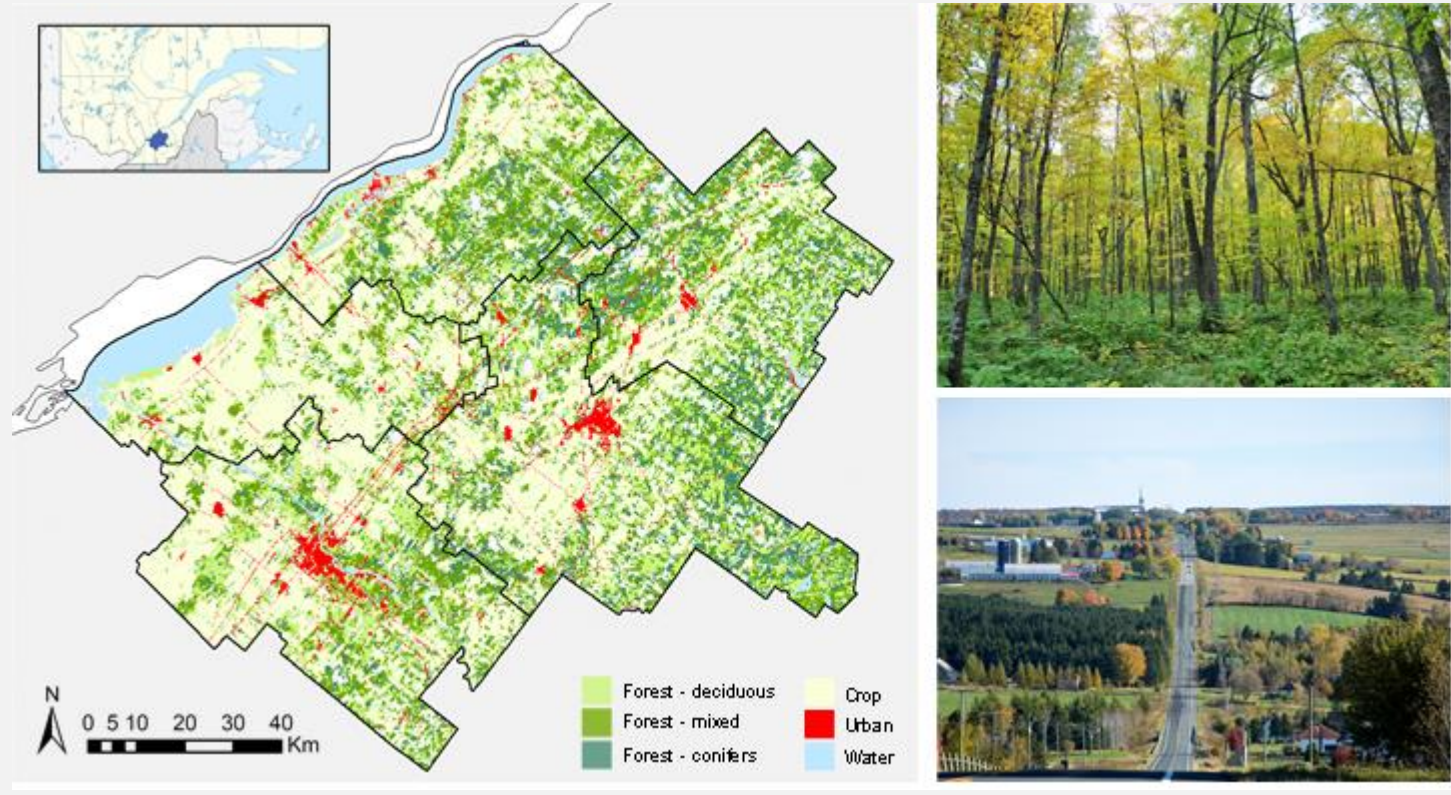
## The simulation study

Mina et al. 2022 Glob Chang Biol, 28, 4323– 4241

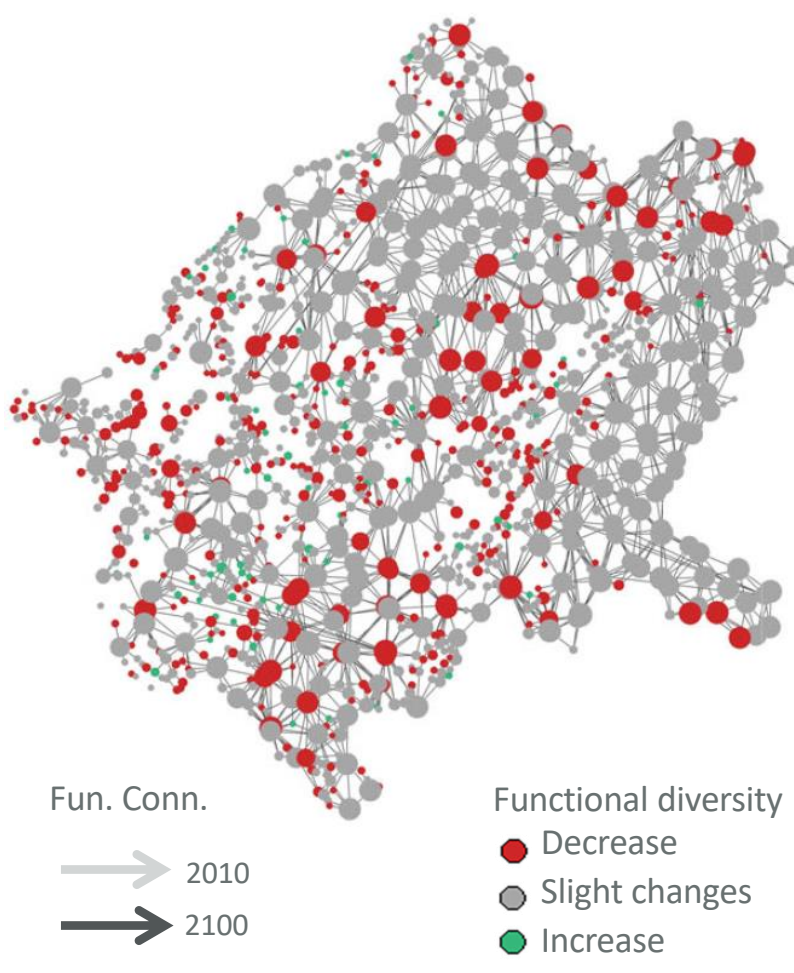


### The study area

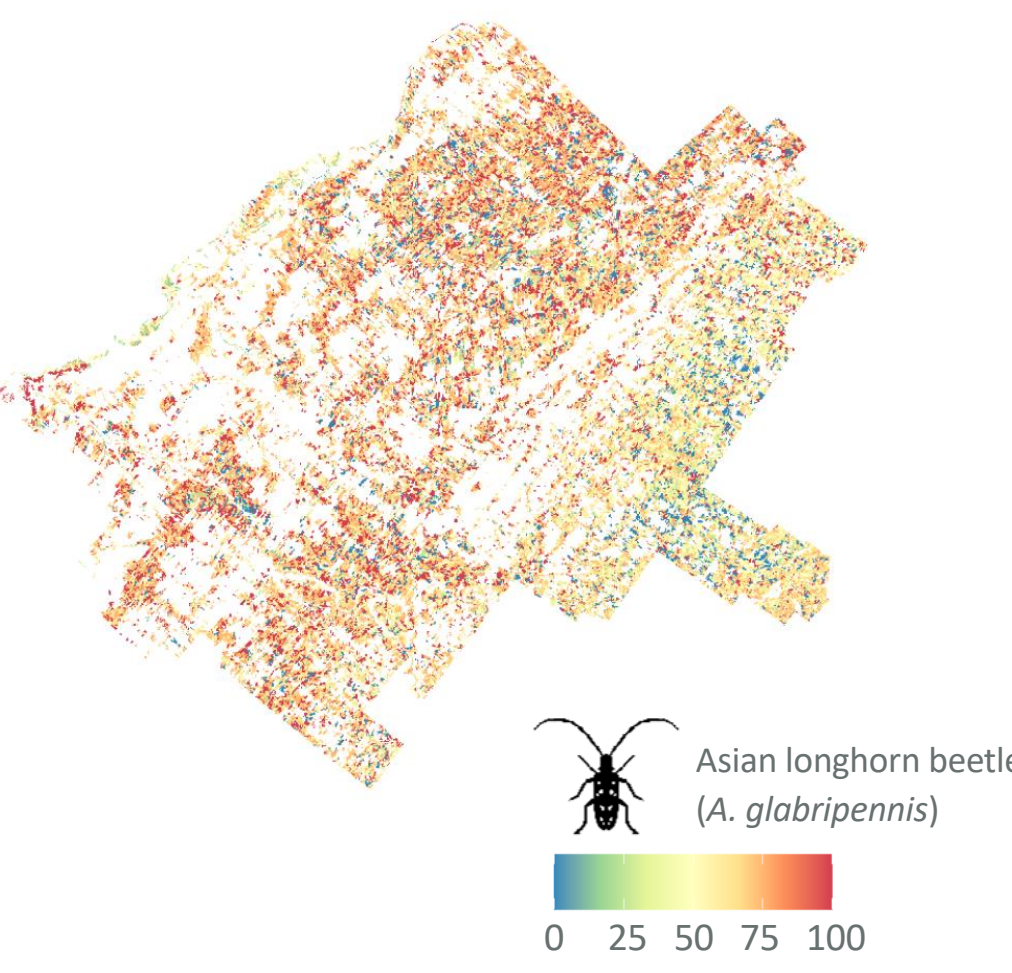
- Central Quebec, 692.600 ha
- Northern hardwoods/mixedwood (maples, birch, fir, spruce)
- Fragmented – mosaic of forest patches, crop, urban
- Timber production, maple syrup, biodiversity conservation



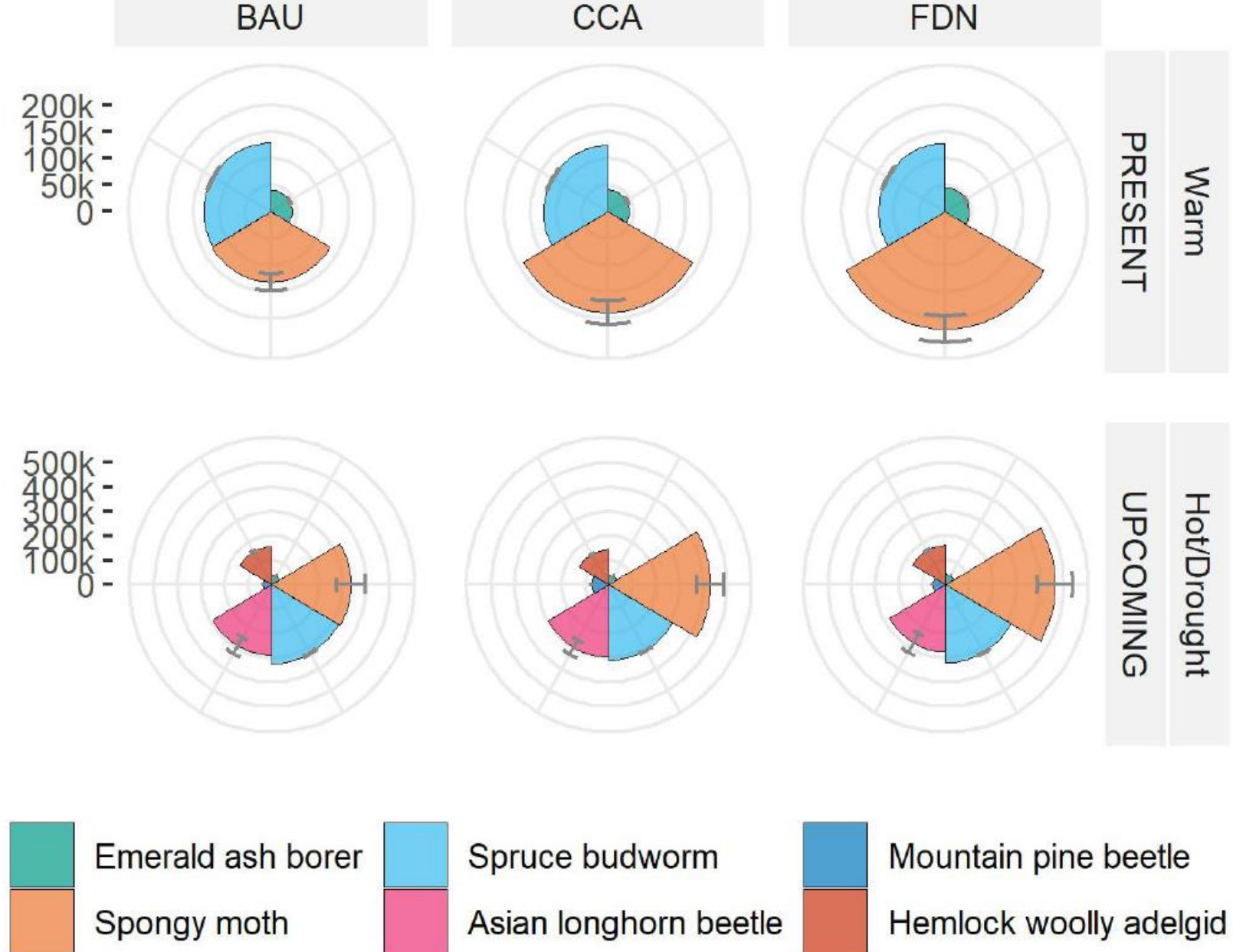
### Functional Network Properties



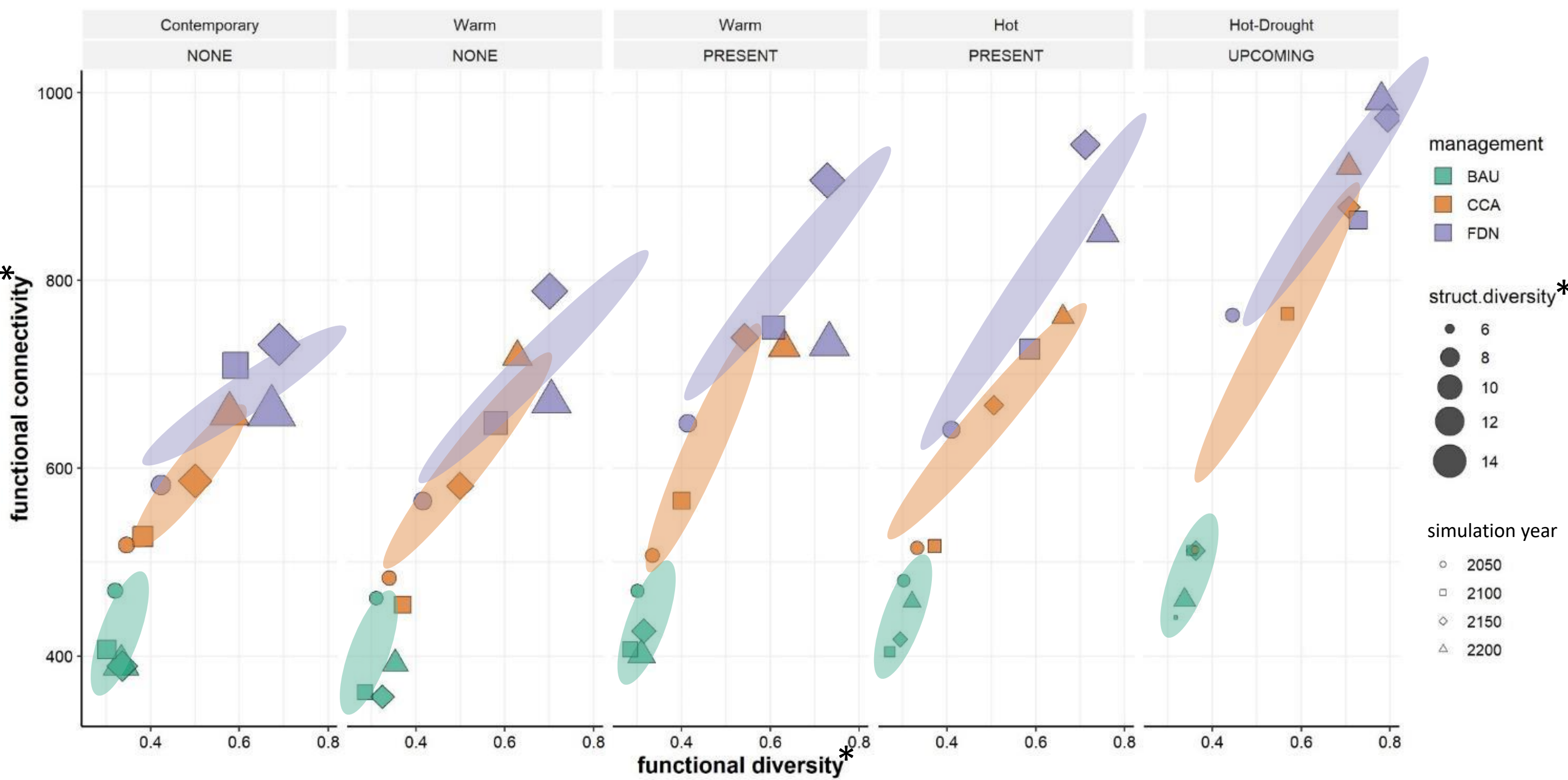
### Susceptibility to different biotic agents



### Total number of hectares damaged by biotic agents



### Landscape-level resilience indicators\*



## Conclusion

- Forest management plans based on functional diversification and network analysis (FDN) provide higher ecological resilience than conventional management
- Positive interactions between management and biotic disturbance can influence the magnitude of potential insect outbreaks
- The *functional complex network approach* is a promising way to better prepare forest ecosystems against unexpected stressors and disturbance events