EFFECT OF FOREST MANAGEMENT CHOICES ON CARBON SEQUESTRATION AND BIODIVERSITY AT NATIONAL SCALE – A SIMULATION STUDY

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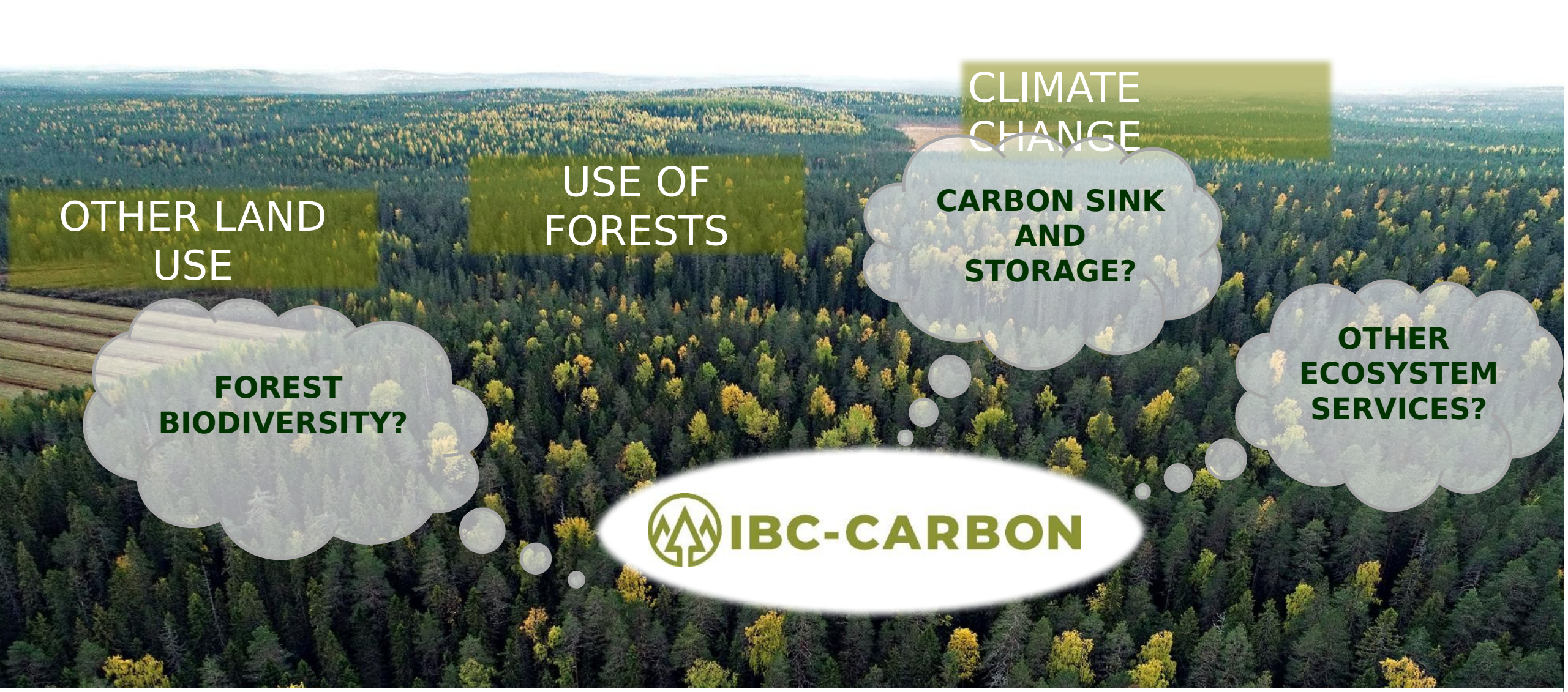
BACKGROUND

- Need to safeguard biodiversity and carbon sequestration in forests
- Is it possible to do this through multipurpose forest management or do we need to increase protected area?
- What kind of forest management is required?
- Implications from Global -> EU -> country?



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OBJECTIVES: THIS STUDY

To study, using large-scale model simulations

How do different management strategies affect national-scale wood production, forest carbon storage and sink, and biodiversity, if

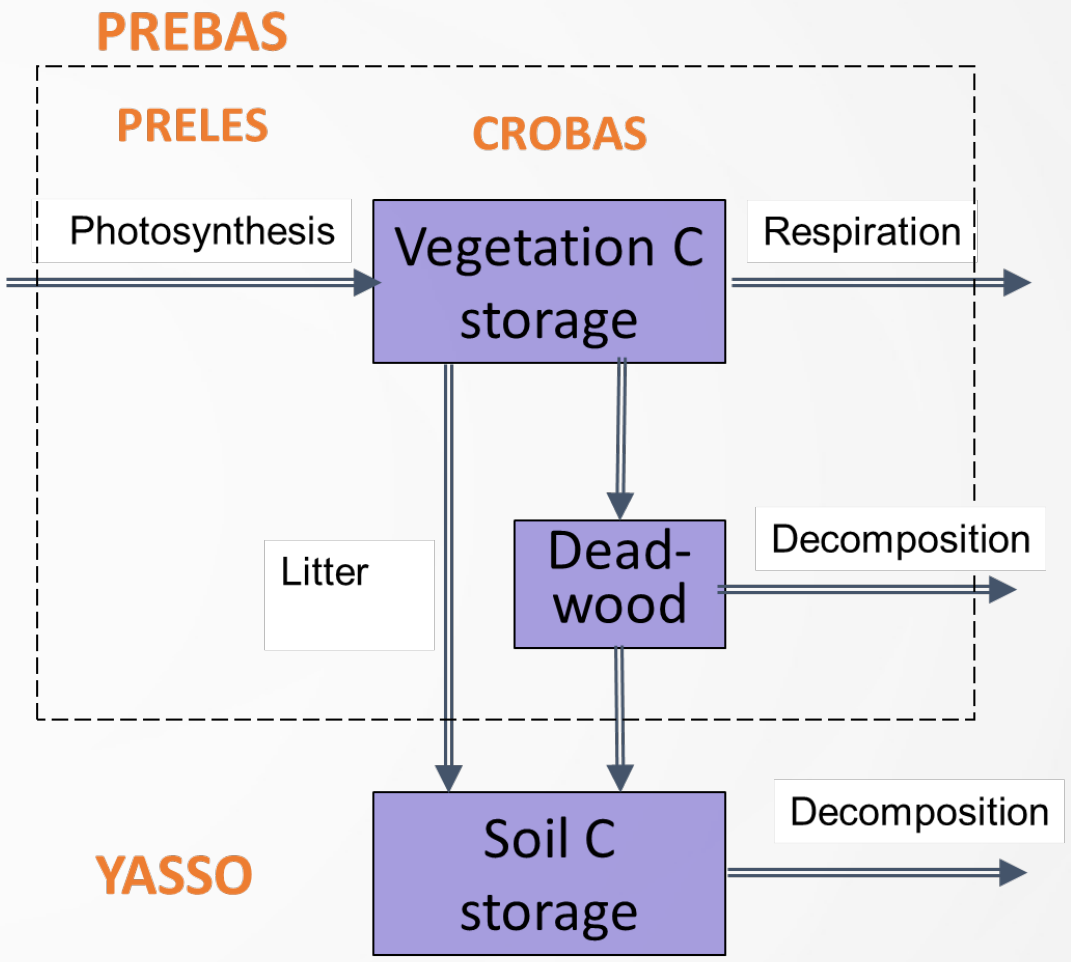
1. MANAGEMENT-DRIVEN (MD): All forests are managed following a given strategy?
2. DEMAND-DRIVEN (DD): As above, but total harvest is constrained by external demand of roundwood and energywood?
3. EXTENDED PROTECTION (E): As above, but set-aside (protected area) is increased?

Accepted for Ambio special issue on IBC-Carbon results

PREBAS: GROWTH AND C BALANCE AT STAND LEVEL

- Intermediate complexity process-based model
- Runs with NFI type forest data & daily weather data

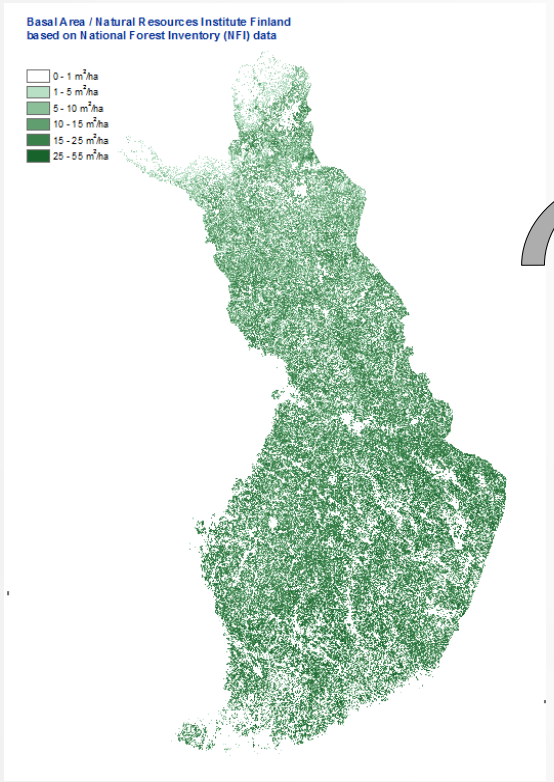
- VALENTINE & MÄKELÄ 2005 TREE PHYS
- PELTONIEMI ET AL. 2015 BER
- MINUNNO ET AL. 2016 ECOMOD, 2019 FORECO



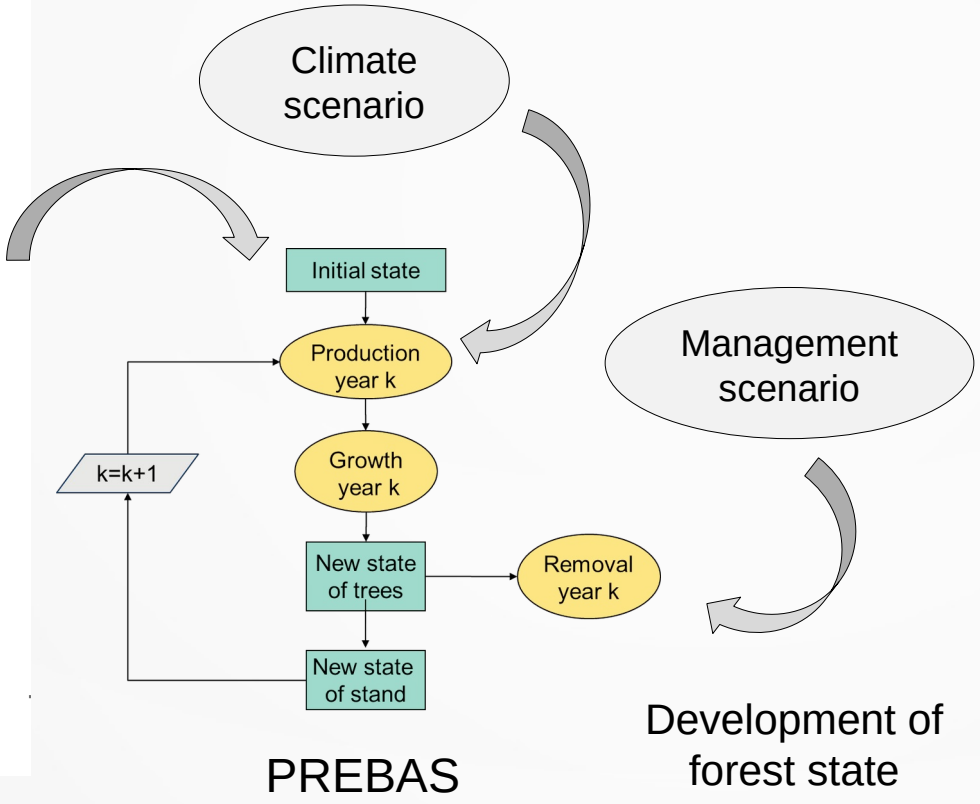
PREBAS: SIMULATIONS COUNTRY LEVEL

Multisource NFI

16m x 16m segmented

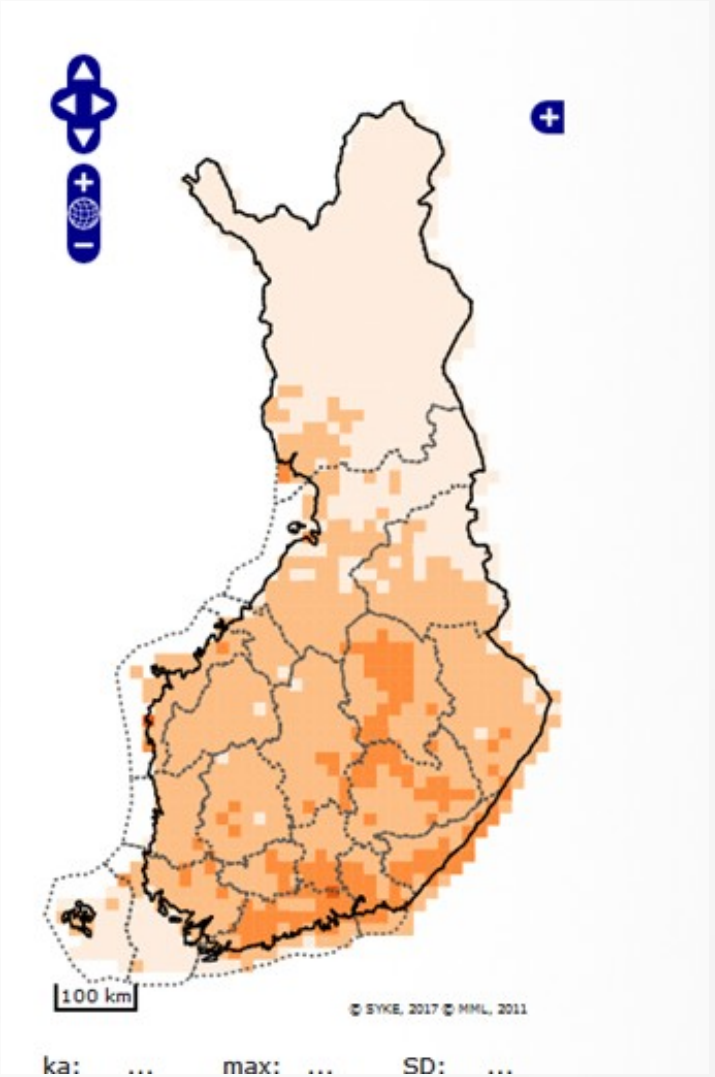


1 km x 1 km daily



PREBAS

Development of forest state

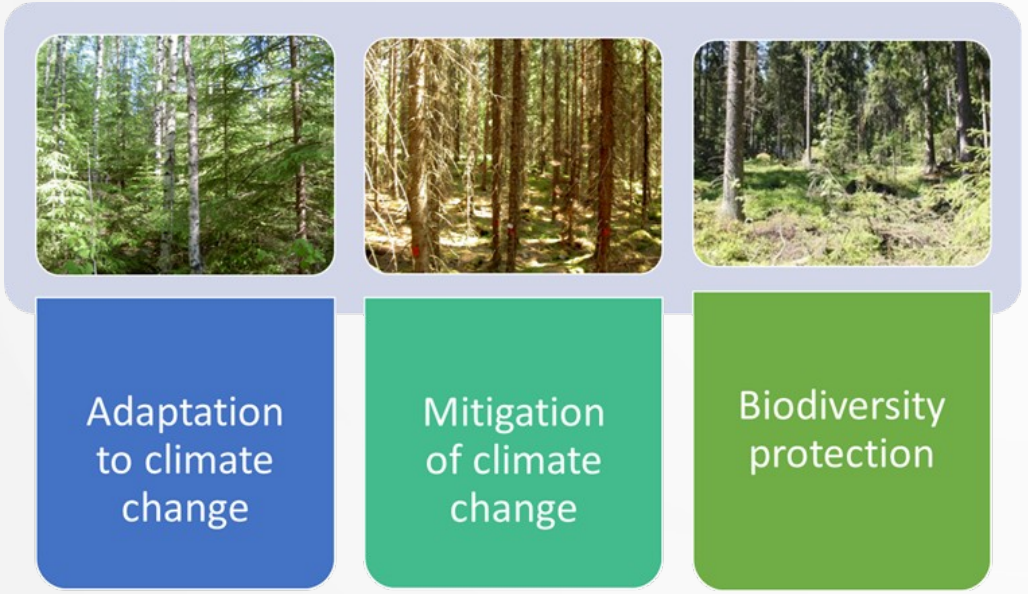


CALCULATING BIODIVERSITY INDICATORS

- Average mortality => deadwood
- Deciduous mixture
- Indicators based on stand structure => species occurrence (Mönkkönen et al. 2014)
  - 5 bird species
  - Flying squirrel

MANAGEMENT SCENARIOS (2021-2050)

- **Management strategies (4)**
  - Base: National recommendations
  - 3 modified strategies



- **Harvest levels (3)**
  - Reference ~80 Mm^3 v^{-1} (BAU)
  - High ~ 90
  - Low ~ 50
  - No prescibed harvest level (harvest level follows from management strategy) MD

DD

- **Protection alternatives (2)**
  - Current (~8%)
  - Extended (total 13%)

Measure	Climate change adaptation	Climate change mitigation	Biodiversity protection
Regeneration	Species to fit the site	Same species as before	Same species as before
Species	Favour broad-leaf mixtures (+ 20% birch at plantation).		Birch mixture with spruce and pine at least 20% of stocking
Rotation	Shortened by 5-10 years	Lengthened by 25%	Lengthened by 25-30%
Thinnings and tending	On time	High thinning at age > 50	
Harvest residues	-	Leave on site	Leave on site
Fertilisation	At sites poorer than mesic heath	-	-
Retention trees	-	-	Leave trees larger than 20 cm as retention trees (incl. broadleaves), 5-10 % of harvest volume in total
Cutting rules if supply greater than demand	-	Cuttings from the most productive sites preferred (site classes 1 and 2) No cuttings from forests older than 120 yr	Cuttings from the most productive sites preferred (site classes 1 and 2) No cuttings from forests older than 120 yr
Protection areas			Buffer zones of 200m around protected areas

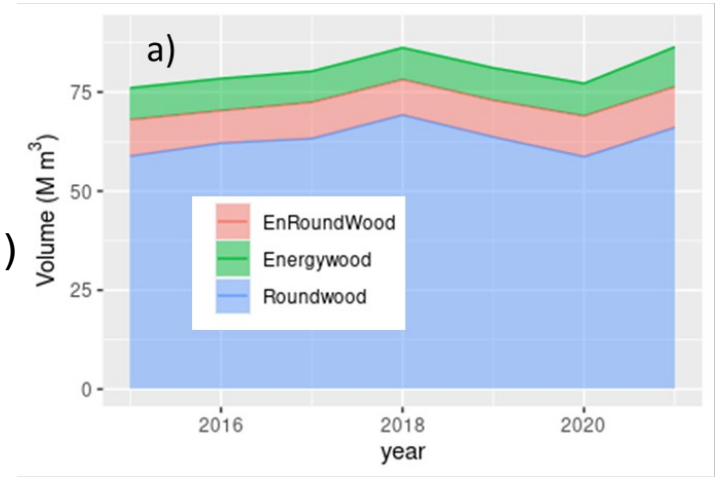
Simulations

- Reference historical cutting levels 2015-2021
- Scenario simulations 2022-2050
- Regional allocation of cuttings
- Sampling by 19 regions (20000 samples)

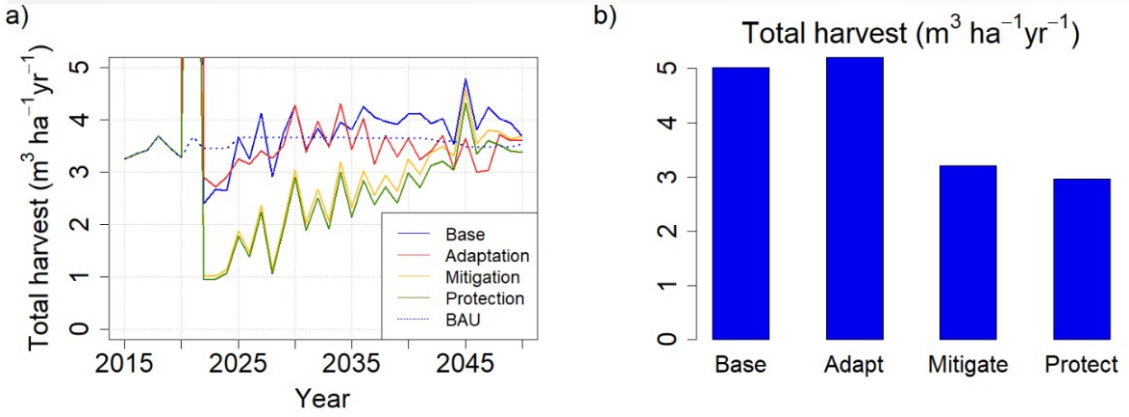
- Current climate (daily)
- (+ climate scenarios, not here)

- RESULTS: 6 C and 8 BD indicators presented as national means / ha (maps available)

- Tested against national statistics for consistency



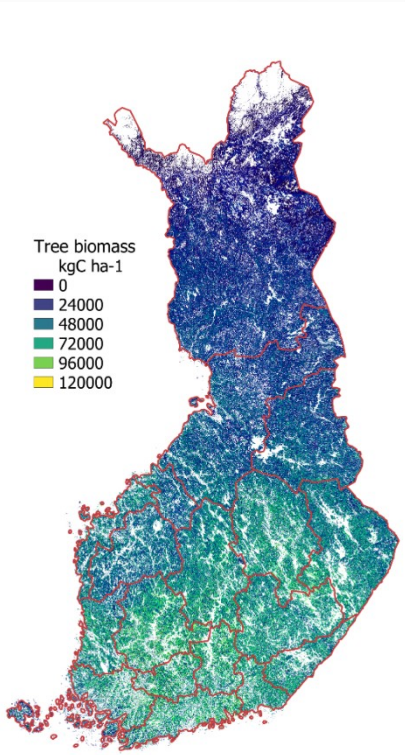
RESULTS: MANAGEMENT-DRIVEN



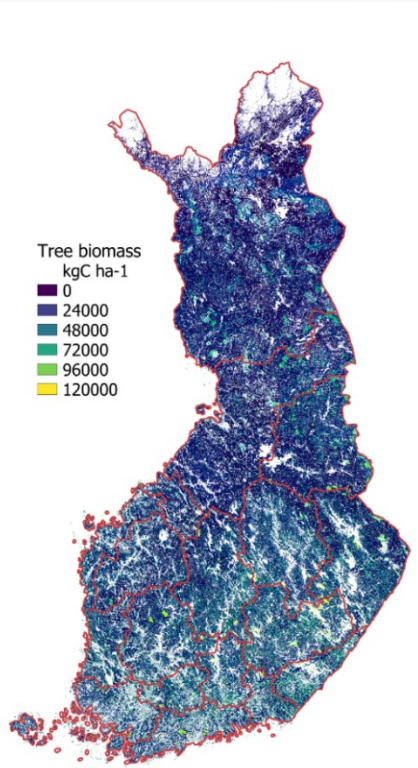
Cutting levels determined by rotation length and harvest residues removal

Period 2017-2025

Period 2034-2050



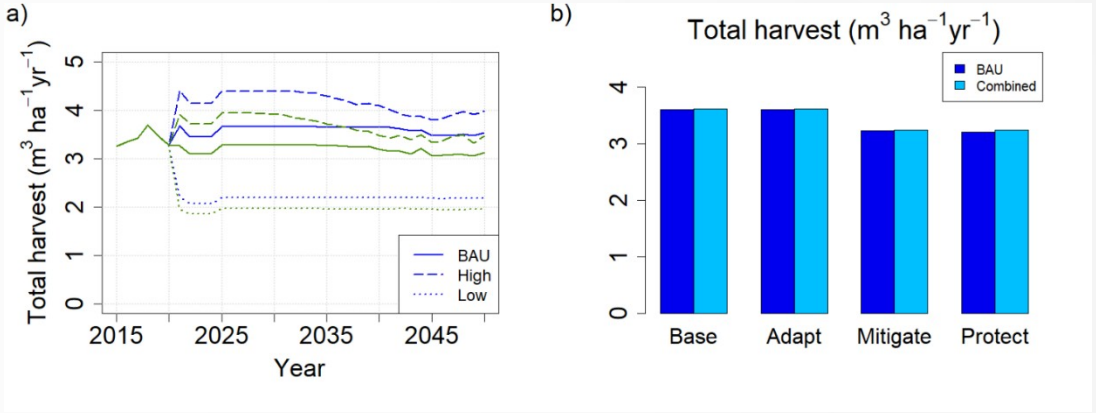
Current regional harvest levels

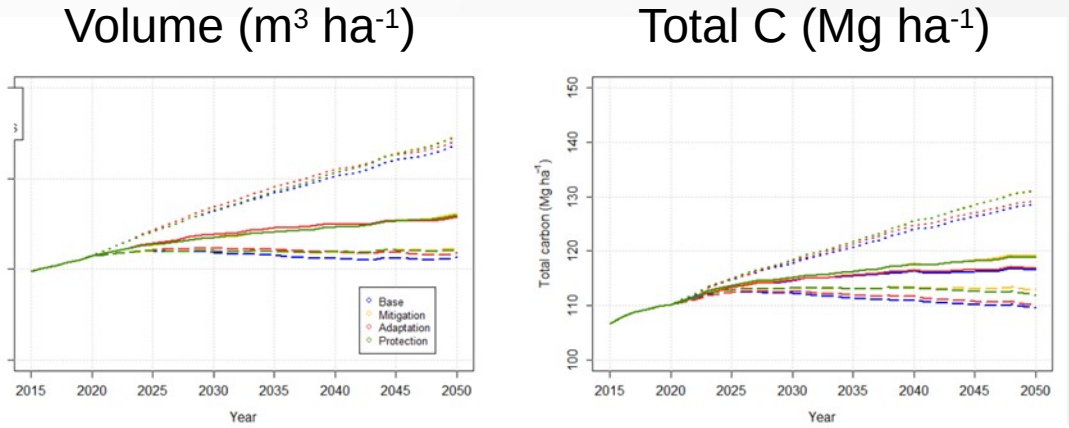


Base strategy

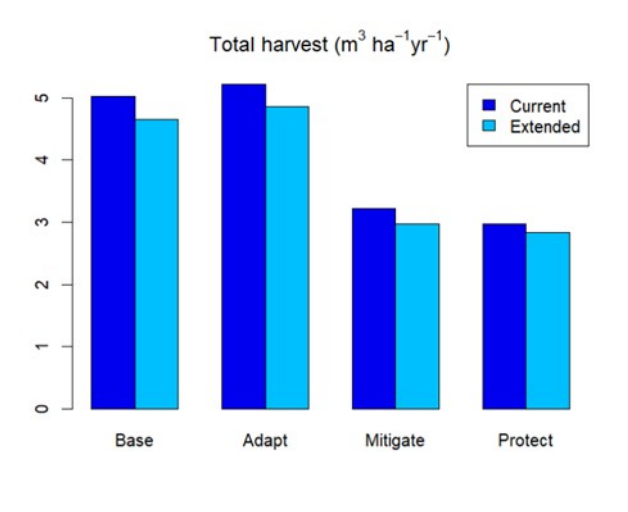
RESULTS: DEMAND DRIVEN

- Harvest levels pre-determined
- Management strategies limit harvests in high harvest scenarios
- Can be fixed by regional re-allocation
- All C indicators depend strongly on harvest level, only marginally on strategy





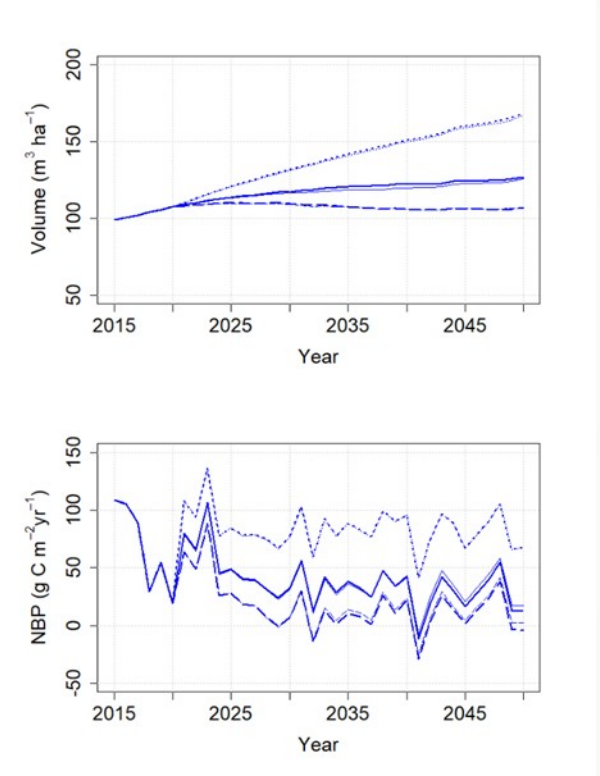
PROTECTED AREA EXTENDED TO MIN 10% IN ALL REGIONS



Management-driven

All C indicators improved

<= cuttings reduced

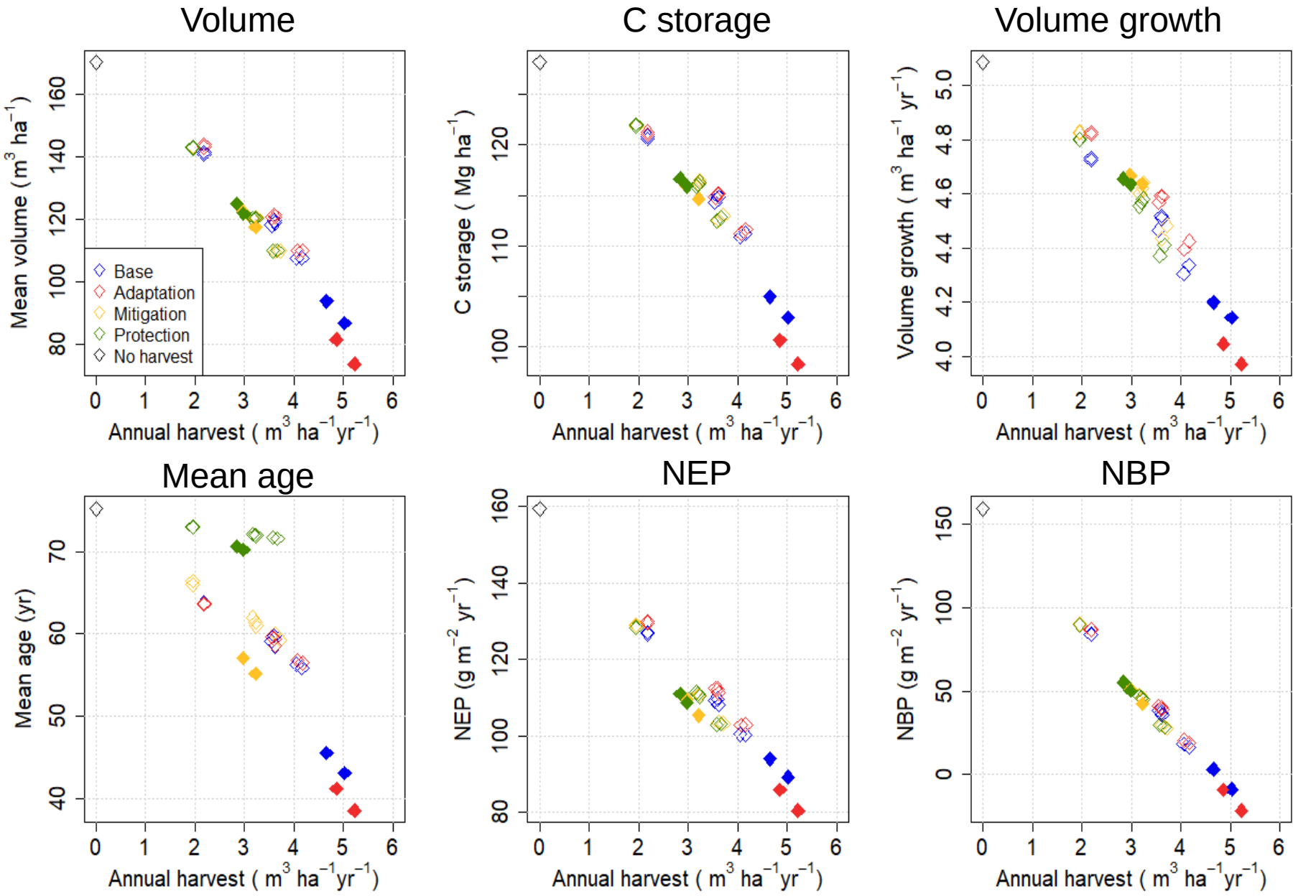


Demand-driven

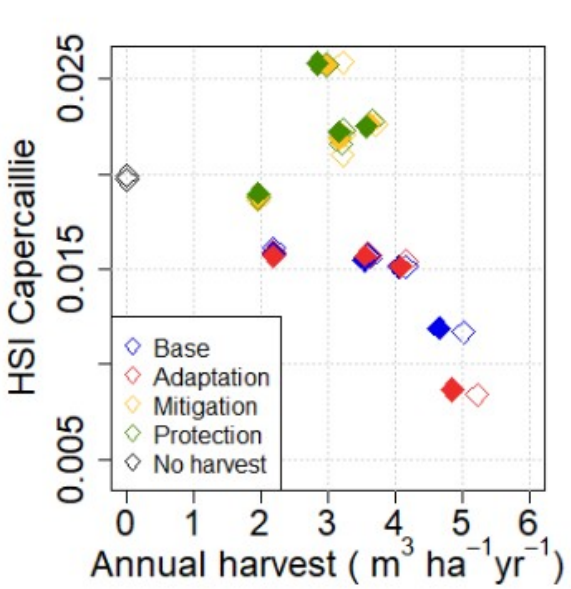
No change in cuttings

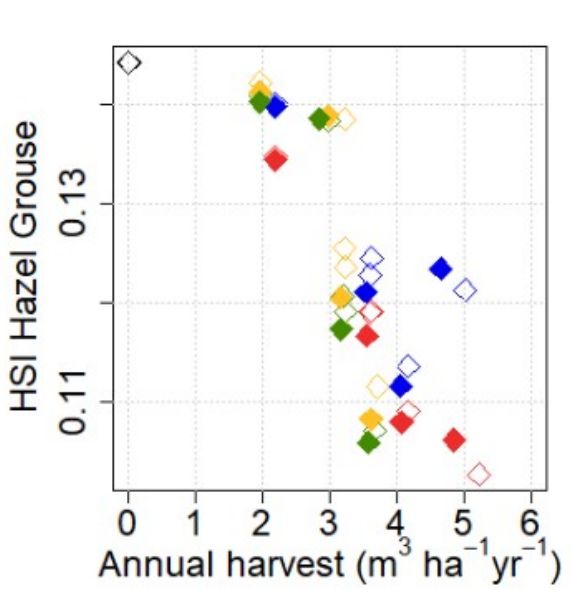
No change in C indicators

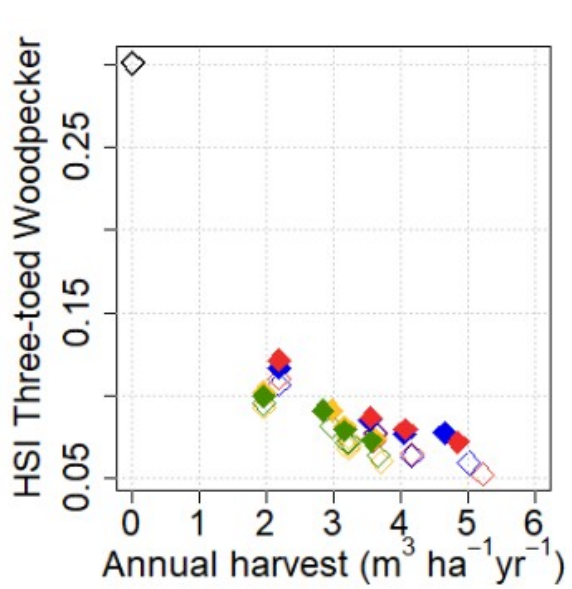
Summary of period mean C balance indicators *vs* harvest level

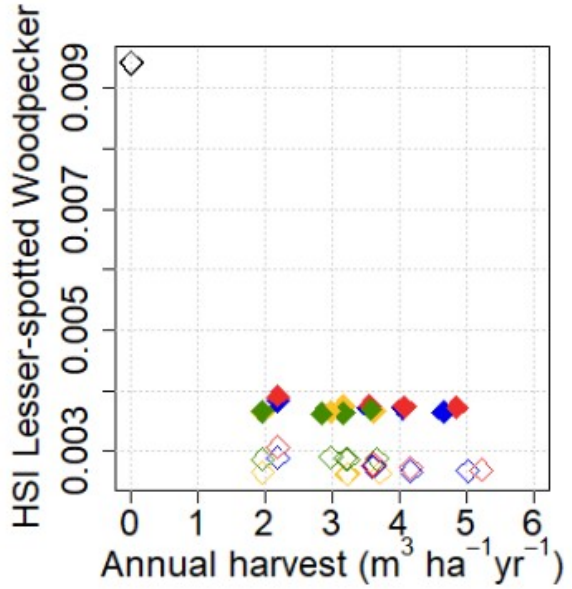


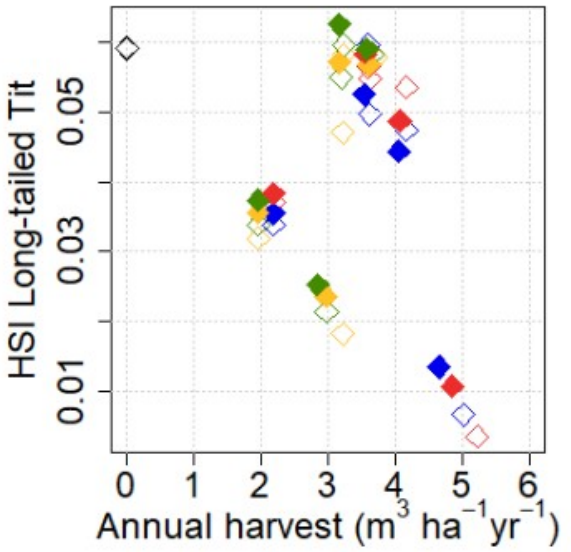
Summary: mean BD indicators

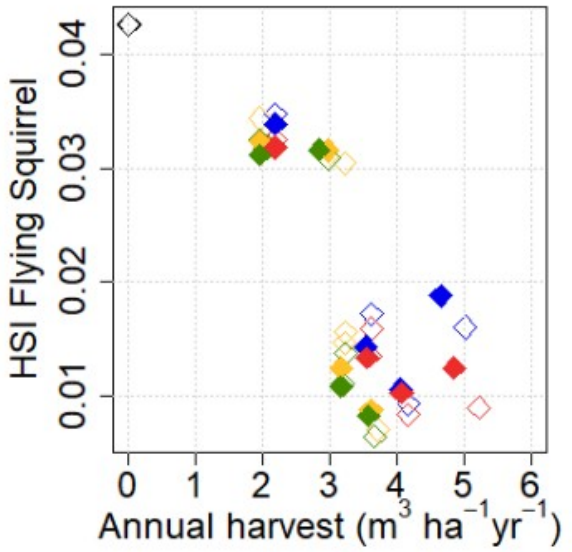


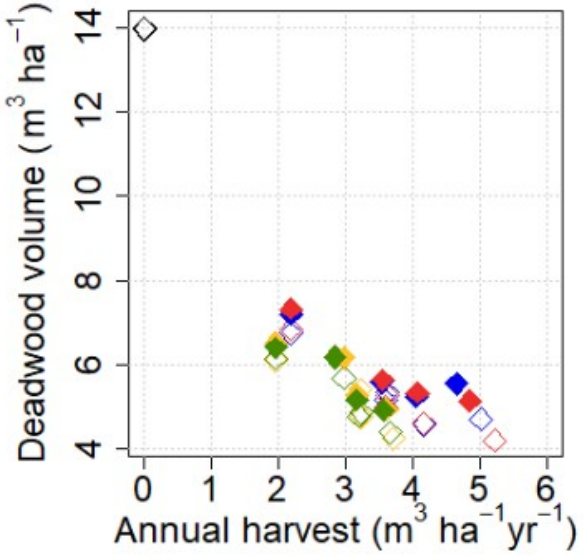


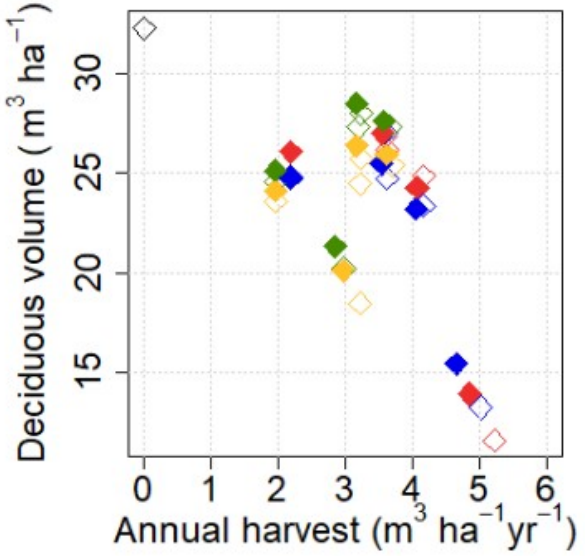












CONCLUSIONS

- Harvest level was key to carbon stocks and fluxes regardless of management actions and moderate changes in proportion of strictly protected forest.
- In contrast, biodiversity was more dependent on other management variables than harvesting levels, and relatively independent of carbon stocks and fluxes.
- Increasing protected area even while maintaining cutting levels can benefit biodiversity conservation

- Model development & application to climate change adaptation under way
- See forthcoming AMBIO special issue!

Thank you!

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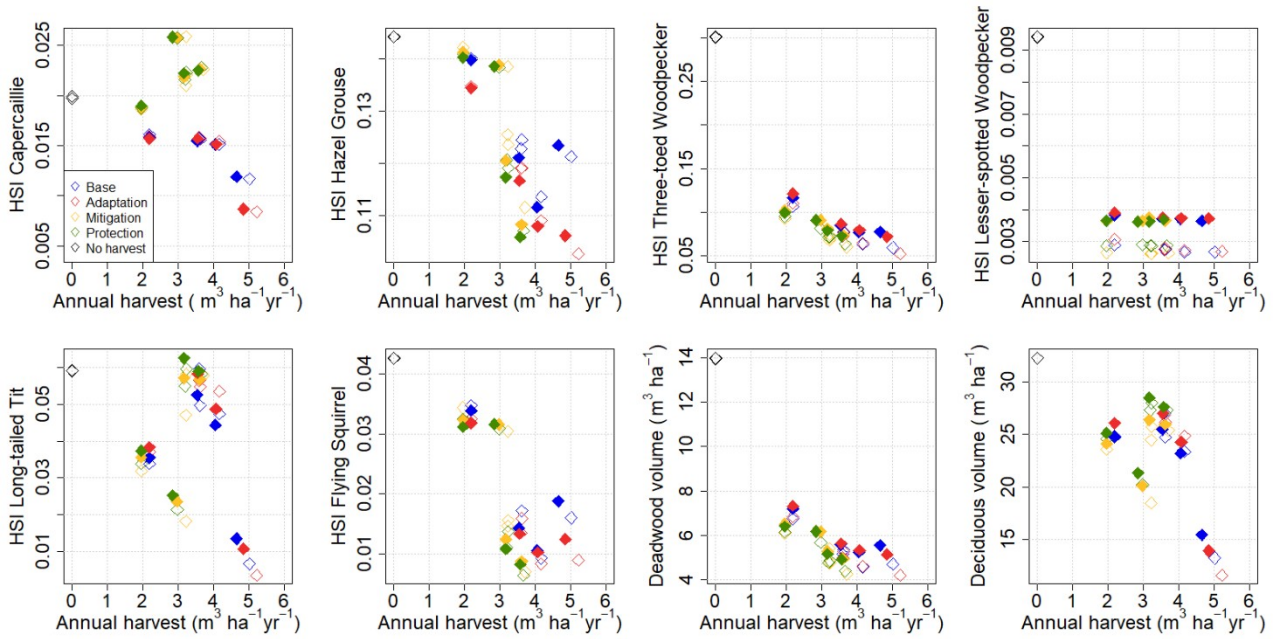
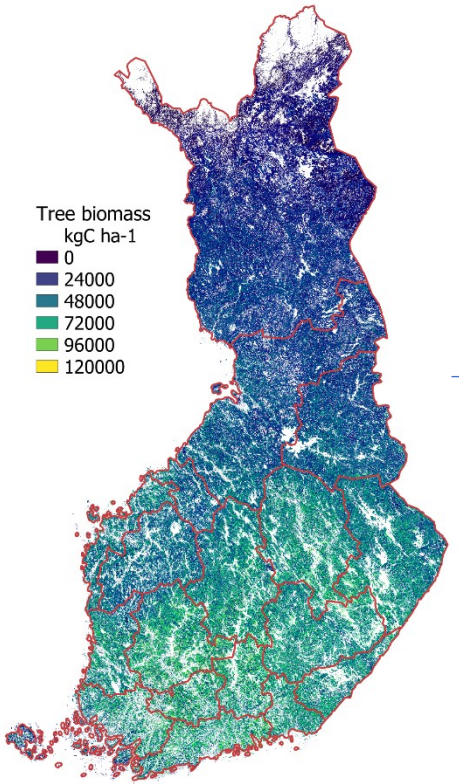
Biodiversity indicators

Temporal mean values (2021-2050) of national mean biodiversity indicators in all management-driven and demand-driven scenarios. Filled symbols are with extended protected area (at least 10% in all regions, 13.7% nationally), open symbols are with current protected area (8.5% nationally). In the symbols, colour indicates management strategy (legend in Figure 10a) and each have one free and three constrained harvest levels.



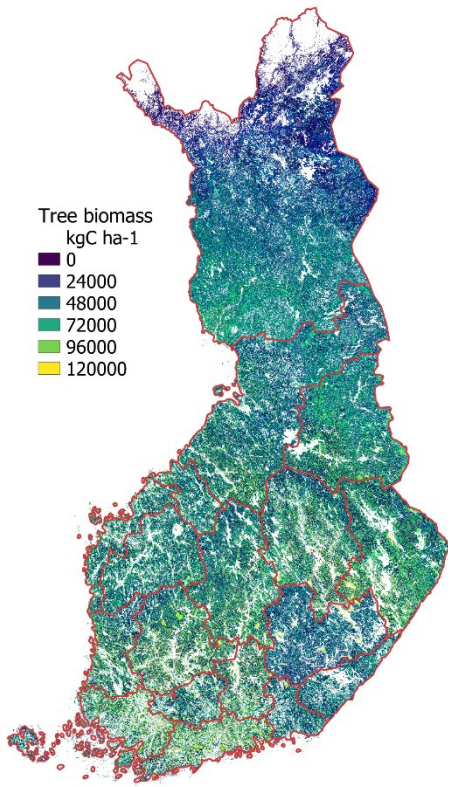
Modelling tree carbon stock changes under different harvest and climate scenarios

Period 2017-2025

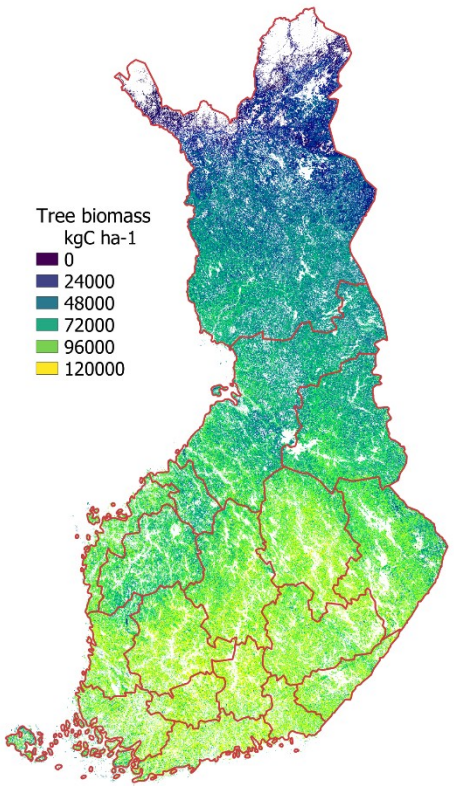


Current climate
current regional harvest levels

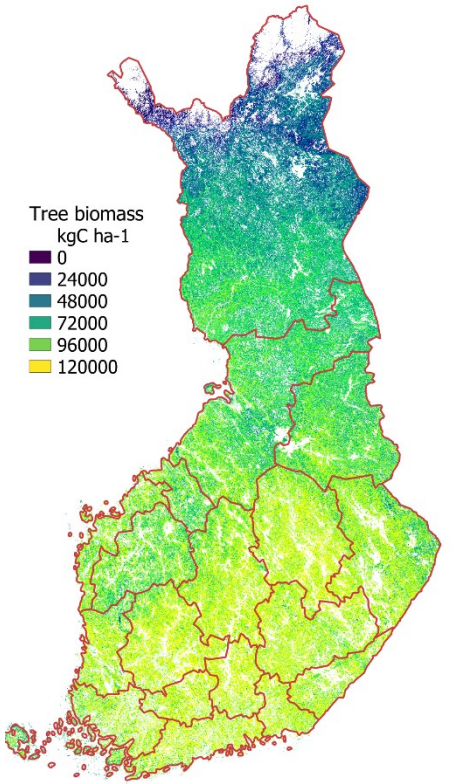
Period 2034-2050



Current climate
current regional harvest levels



Current climate
no harvests after 2015



RCP4.5
no harvests after 2015

Note: No biotic or abiotic disturbances or nitrogen deficiency included! Growth and stocks likely