Natural disturbances – ecological processes as a guideline for multifunctionality –

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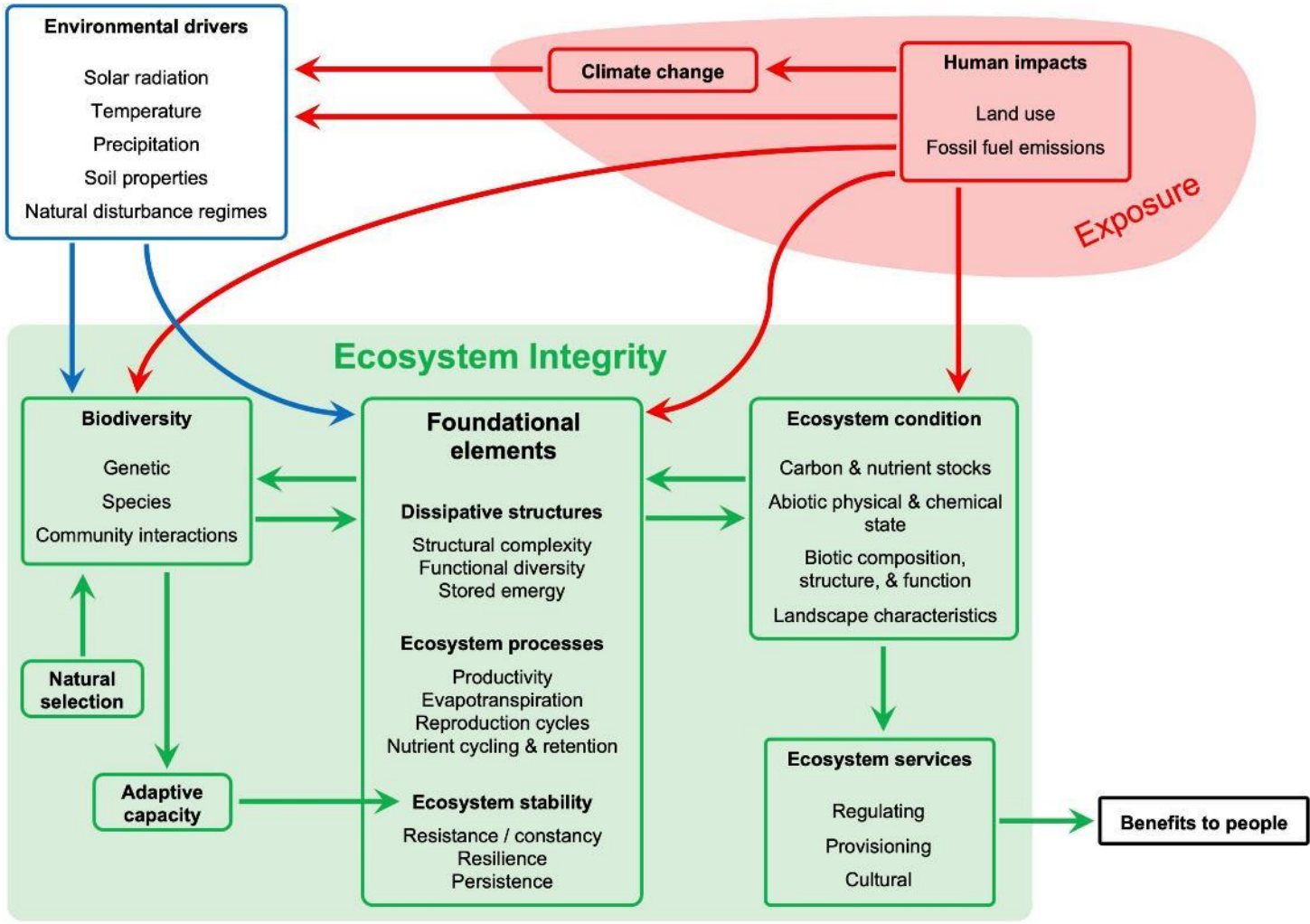
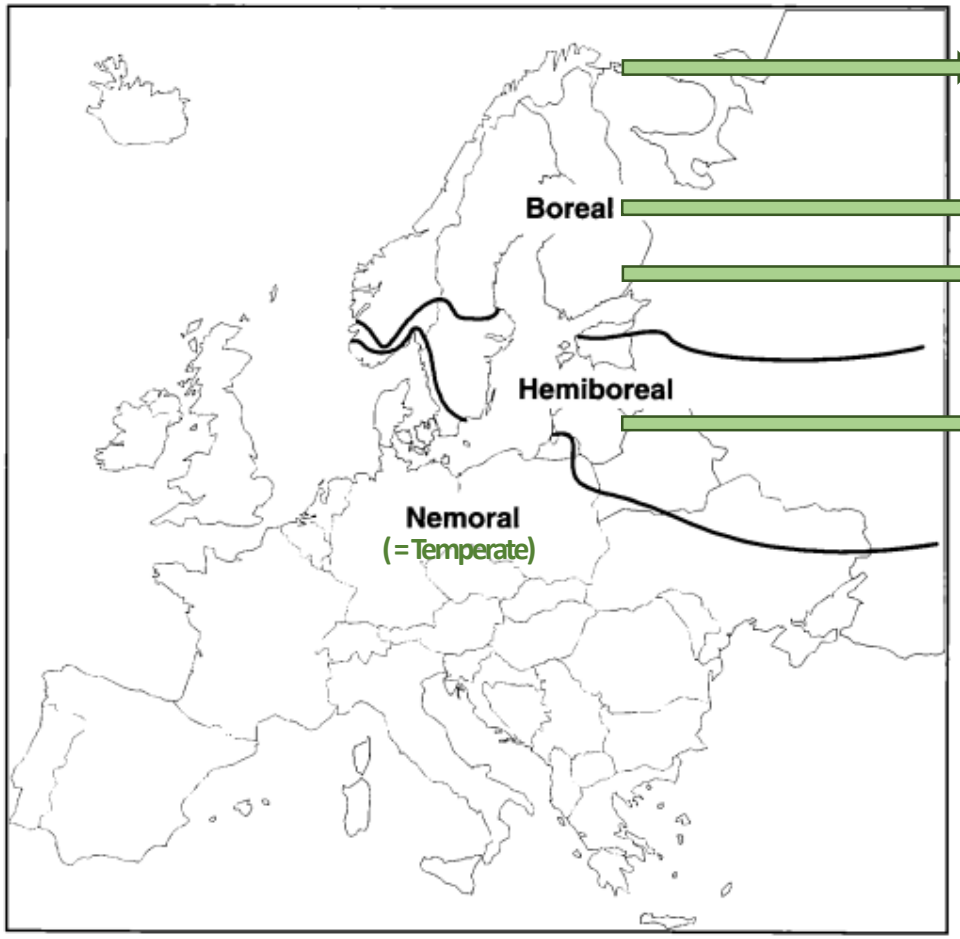
Ecological processes

- Photosynthesis
  + carbon sequestration
- Nutrient cycling
- Food-web interactions
- Succession and competition
- Natural disturbance dynamics
- …



Rogers *et al.* 2022 https://doi.org/10.3389/ffgc.2022.929281

Biomes and tree species in the Nordic-Baltic region



The forest zones of north-west Europe as defined by Ahti *et al.* (1968)

Populus tremula – European aspen
Betula pubescens – downy birch
Alnus incana – grey alder
Pinus sylvestris – Scots pine
Picea abies – Norway spruce
Betula pendula –

+ *Alnus glutinosa* – European black alder
Acer platanoides

+ *Tilia cordata* – small-leaved lime
Fraxinus excelsior – European ash
Ulmus glabra – Wych elm
Quercus robur – pedunculate oak
Ulmus laevis –

+ *Carpinus betulus* – European hornbeam
Fagus sylvatica – European beech

? + *Larix decidua* – European larch
Populus nigra – black poplar
Quercus petraea – sessile oak
Ulmus minor – field elm

Increased tree species diversity

Figure: Bradshaw and Edenius 1998
Forestry Commision Technical Paper 25

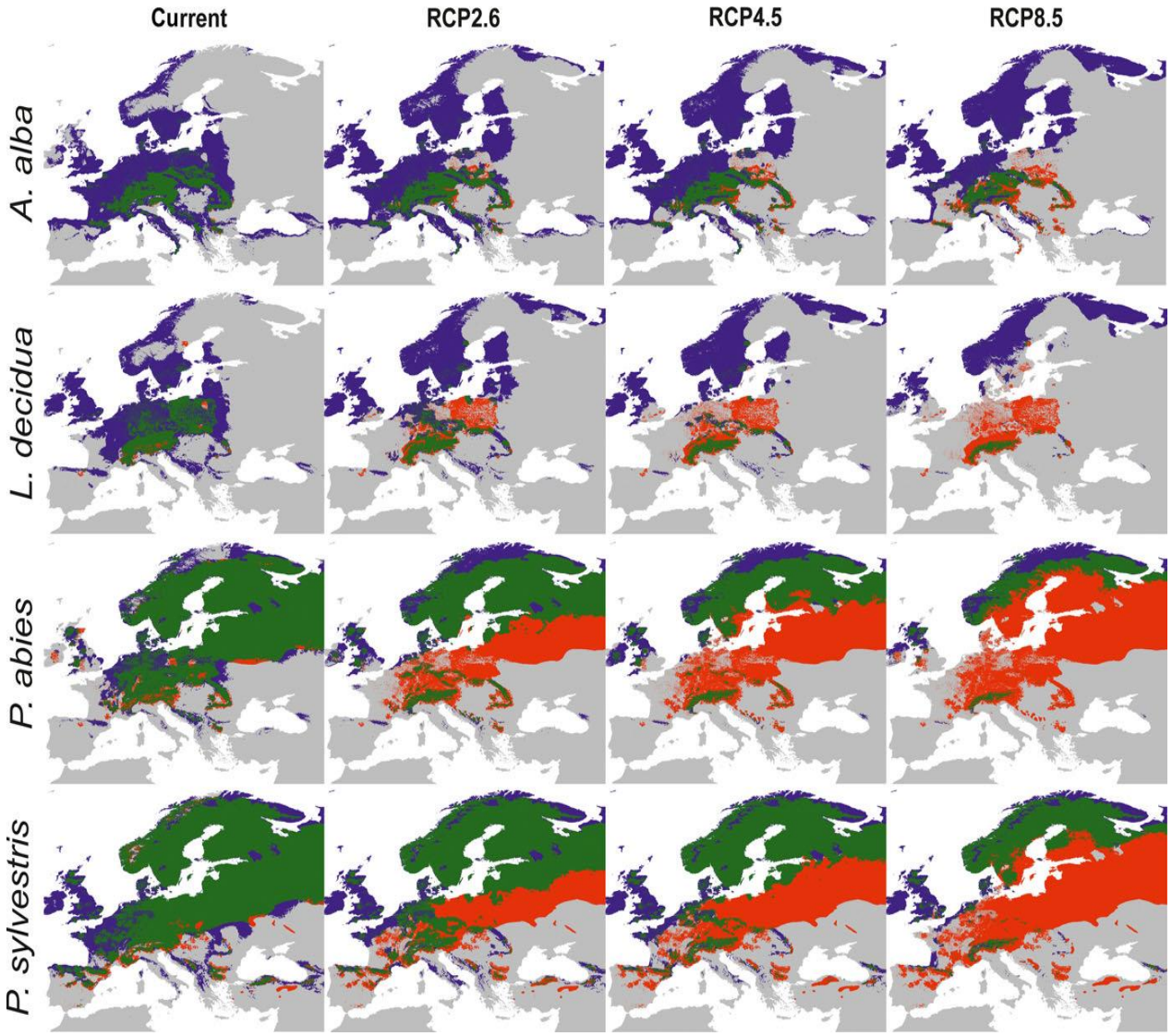
Climate change

Shifts are projected, ongoing, in:

- Species distribution ranges (not only trees, all flora & fauna)
- Biomes (i.e. composition of communities)

Norway spruce

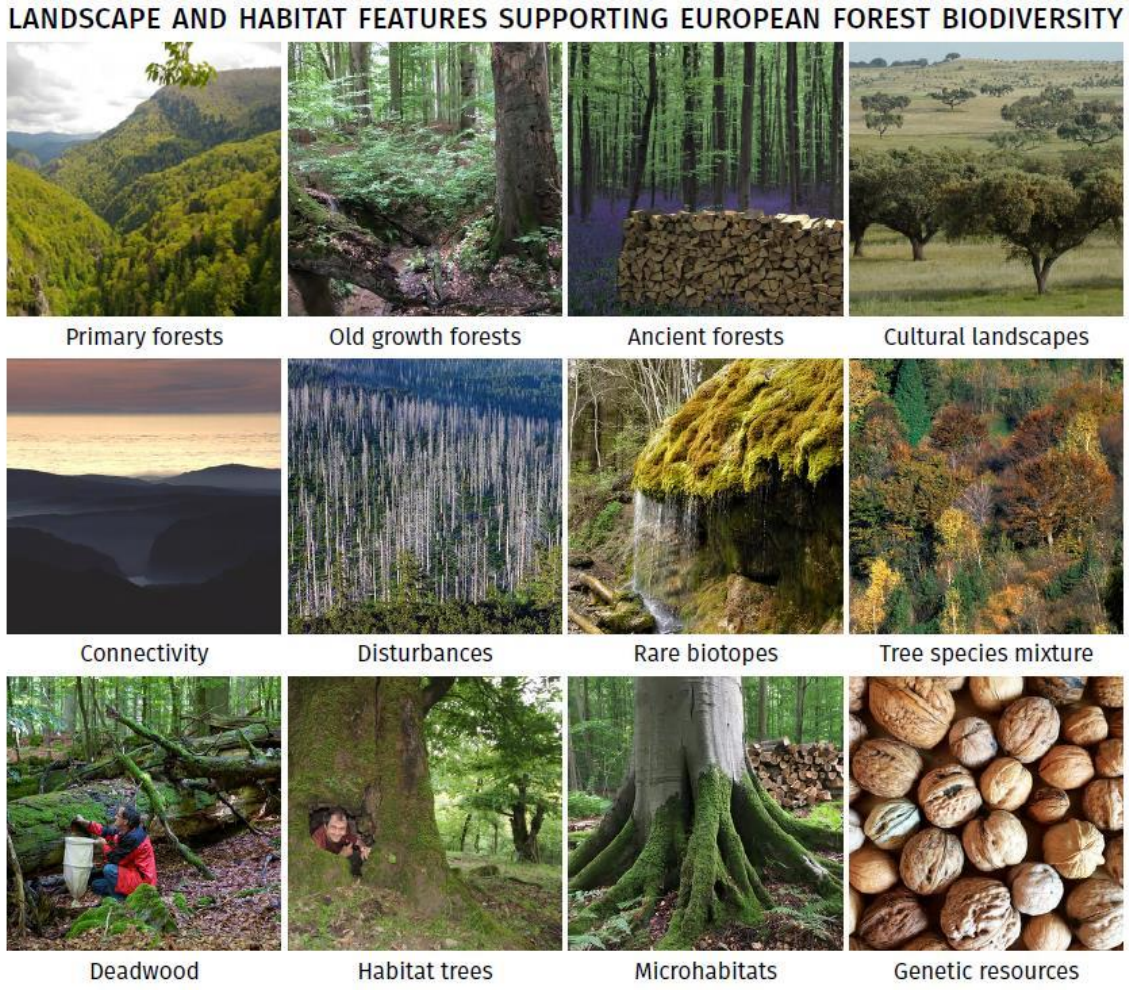
Scots pine



Dyderski *et al.* 2017 https://doi.org/10.1111/gbc.13925

Muys *et al.*, 2022

Biodiversity a prerequisite for resilience



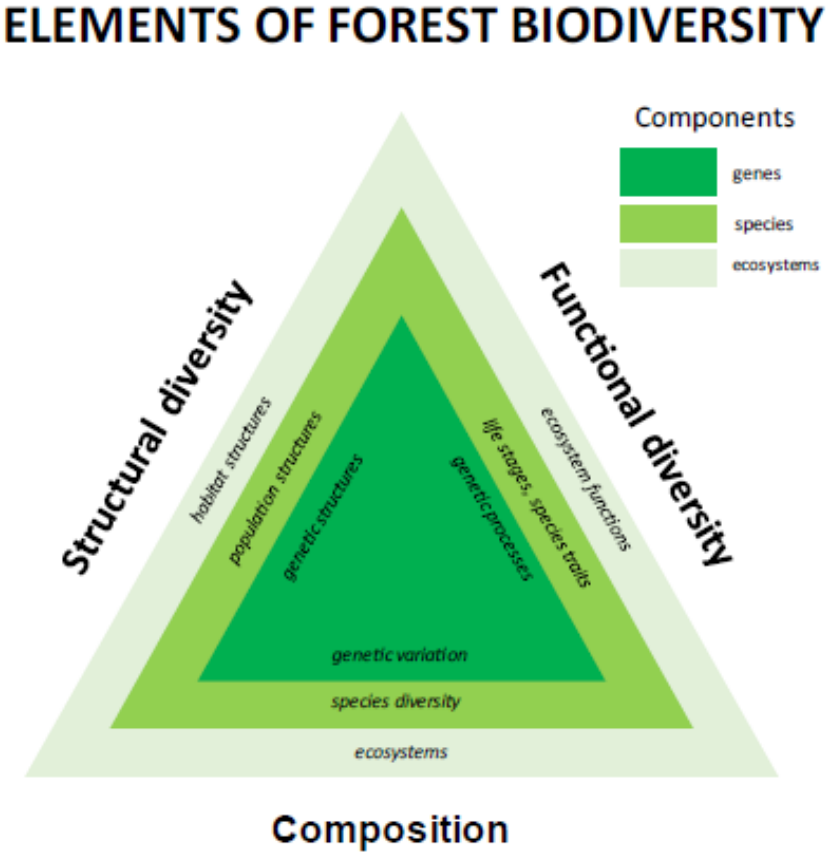
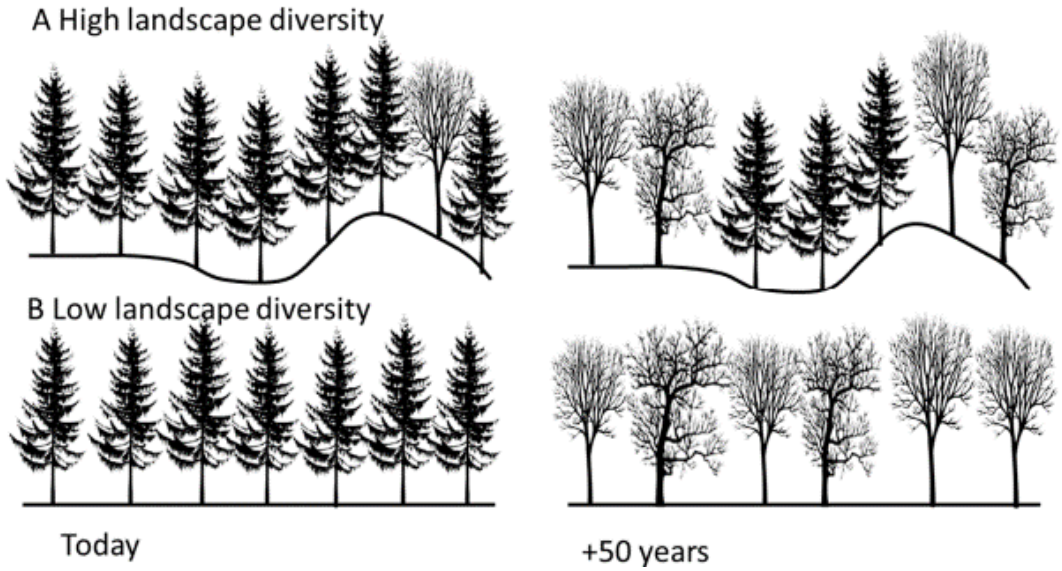


Figure 1. The main elements of forest biodiversity are represented as a triangle with three dimensions (composition, structure and function) that take account of the three hierarchical levels of components (genes, species and ecosystems). Modified after Noss (1990).

New species communities

- Magnitude of climate change
- Landscape heterogeneity
- Current completeness of potential species diversity
- Management planning decisions (i.e. feasible choice of frame of change)



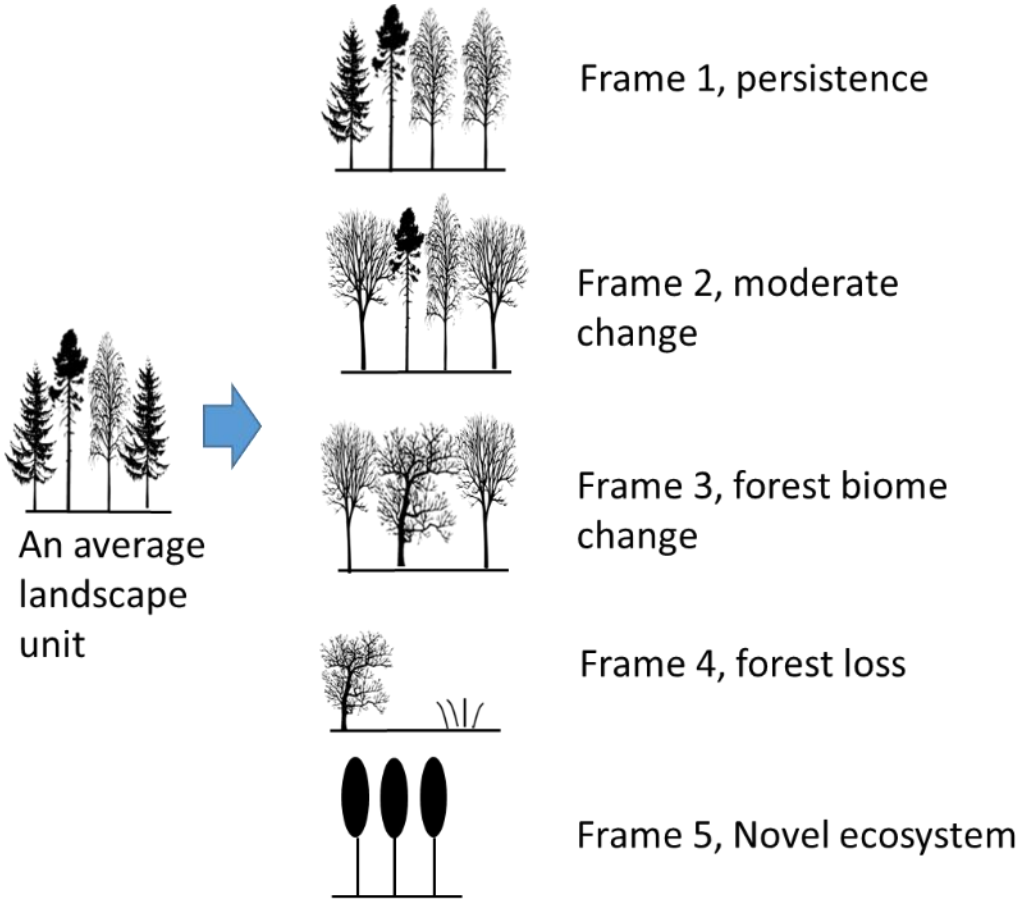


Figure 3. The frames of change in stand types and species composition—a trailing edge southern boreal forest example with leading temperate deciduous forest and oak savanna just to the south. Frame 1, persistence, the same tree species composition is sustained, perhaps with some minor shifts in relative abundance. Frame 2, moderate change, there are substantial changes in relative abundance of dominant tree species. Frame 3, forest biome change, major turnover of species composition, e.g., transition from boreal to temperate species. Frame 4, forest loss, change from forest to non-forest biome (e.g., savanna or grassland). Frame 5, novel ecosystems are established using exotic tree species suited to the new climate.

Frelich *et al.* 2020 https://doi.org/10.3390/f11090965

Forest management and biodiversity

How to secure forest biodiversity?

Internal and external threats.

- conversion (of forest land),
- harvesting,
- species choice.

A challenge:
what about forest management?

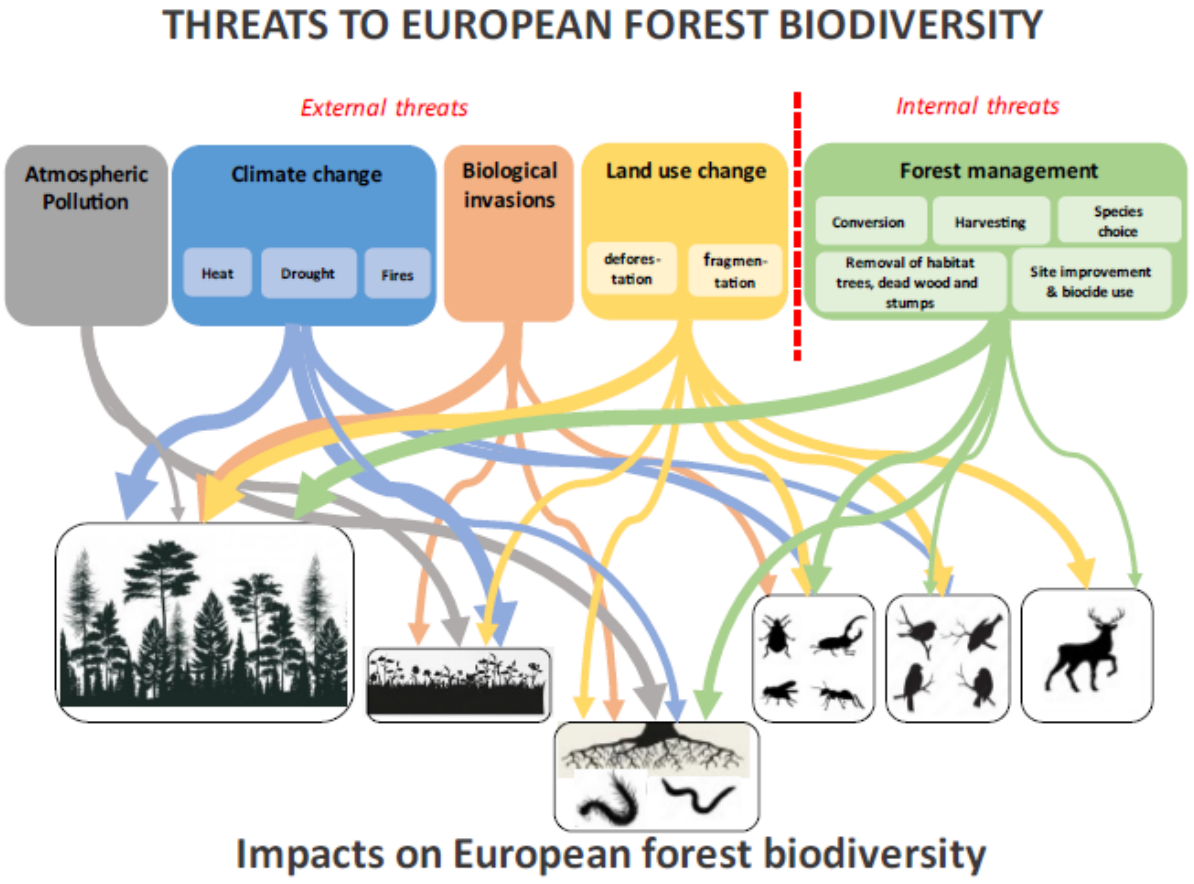
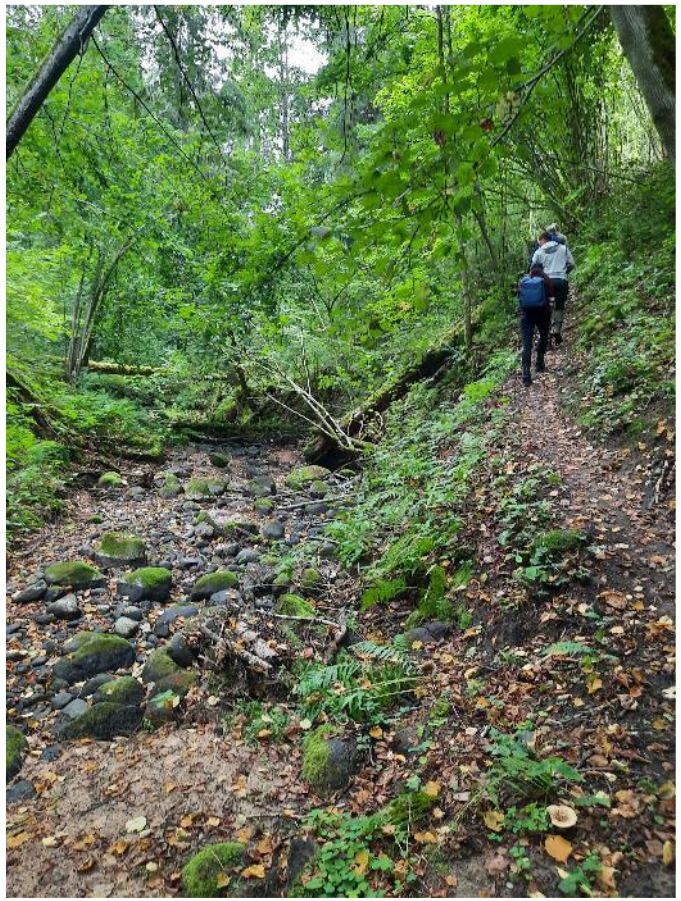


Figure 5. The relationships between major threats to biodiversity in European forests and particular groups of species (from left to right: trees, understory vegetation, soil organisms, insects, birds, mammals). The thickness of the arrows indicates the estimated magnitude of effects based on expert opinion. Indirect effects, such as changes in forest stand structure, are not represented.

Muys et al., 2022

Some forests host less species by nature



Other forests are more complex, also structurally

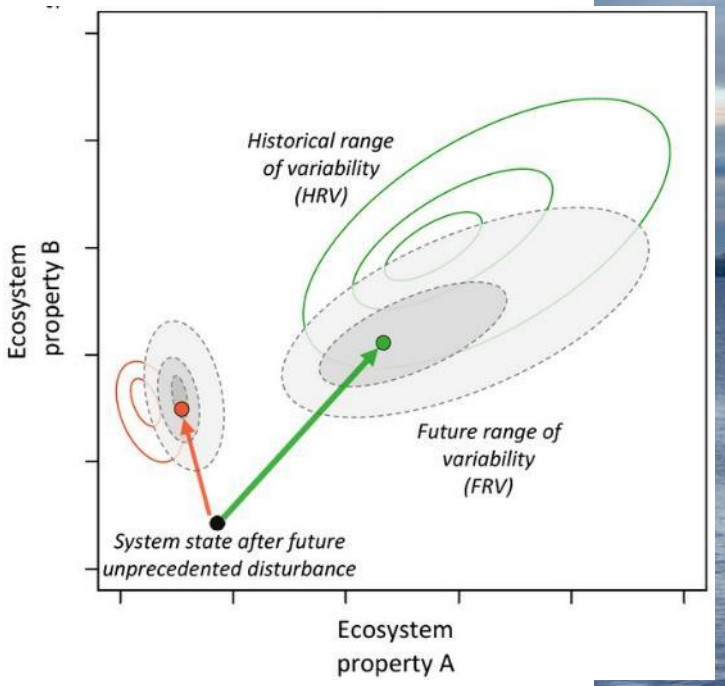
Natural disturbance-based forest management*

- Natural disturbances can facilitate diversification
- Within the range of local disturbance regime:
  rotation lengths, structure and species mixtures based on local natural disturbance regime (CCF and clear-cut!)

NB: Disturbance regimes themselves also alter due to climate change

*E.g. Kuuluvainen *et al.* 2021, Azalós *et al.* 2022, Pohlman *et al.* 2023

Natural range of variation



Graphic credit: Seidl *et al.* 2015

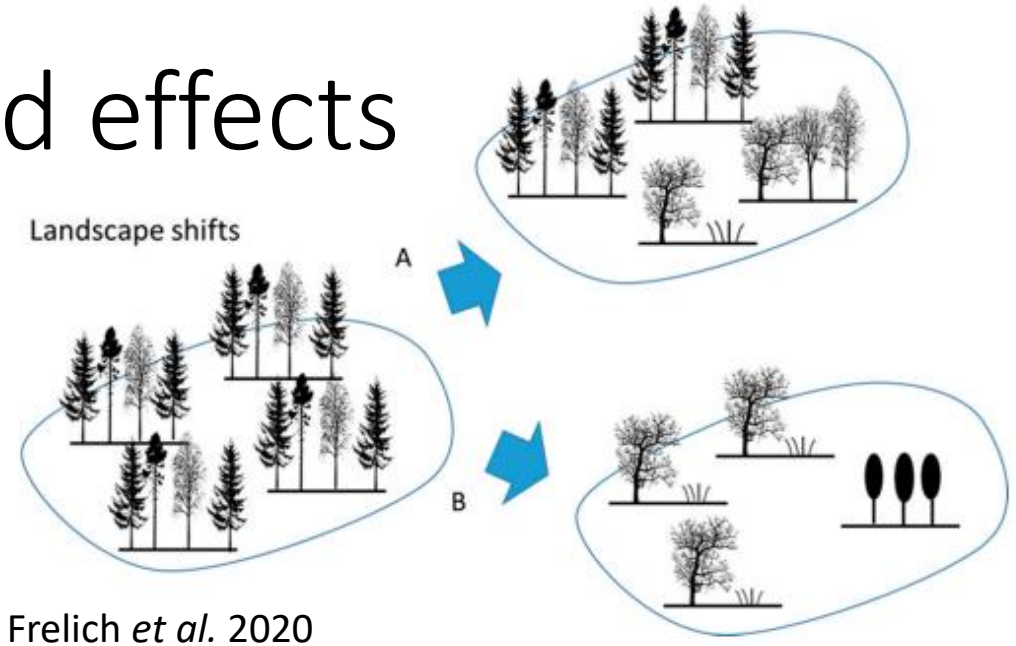
Photo credits: Birgit Vaarandi

Operating within the natural range of variation – increases options for ecosystems to bounce back after unforeseen events (natural/human caused) – risk spreading for continuation of natural processes

Cascading events, compound effects

2018 -> Extremely dry summer

Karula National Park, Southern Estonia, 2022



Frelich *et al.* 2020

Kristjan Ait - Karisöödi nature protection area, Southern Estonia, 2022

Evolution of forest management

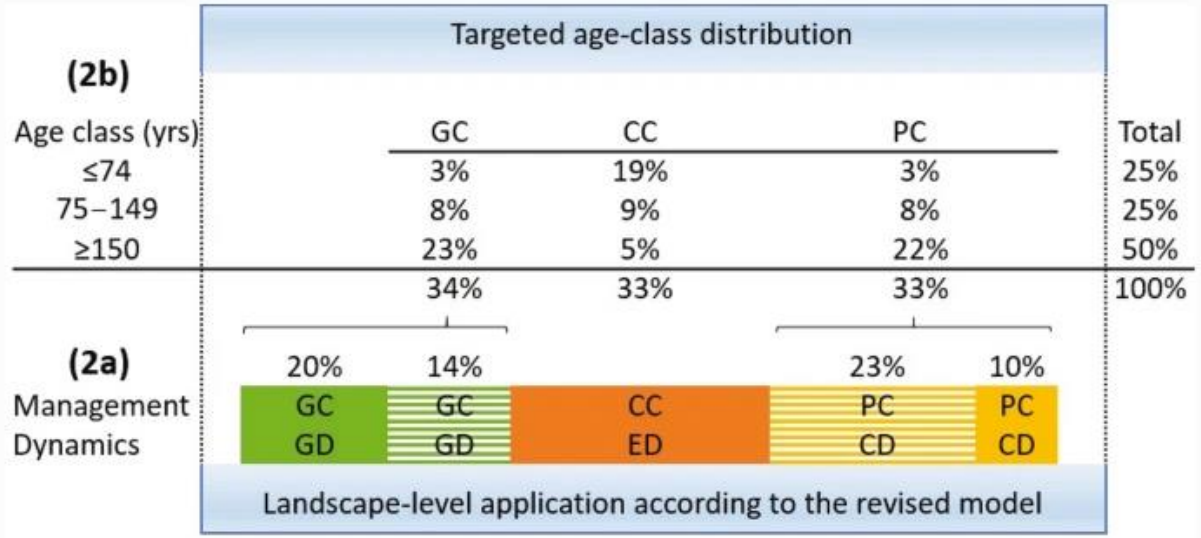
Balance between:

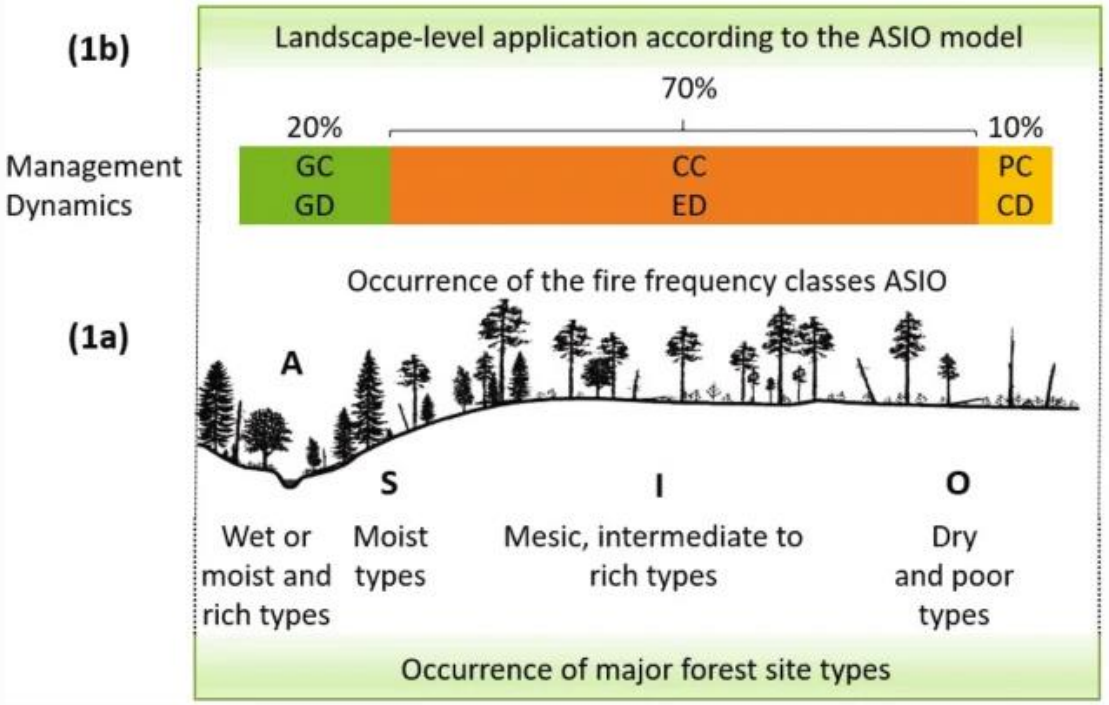
- Homogenisation for efficiency vs.
- Heterogeneity, adaptive capacity for resilience

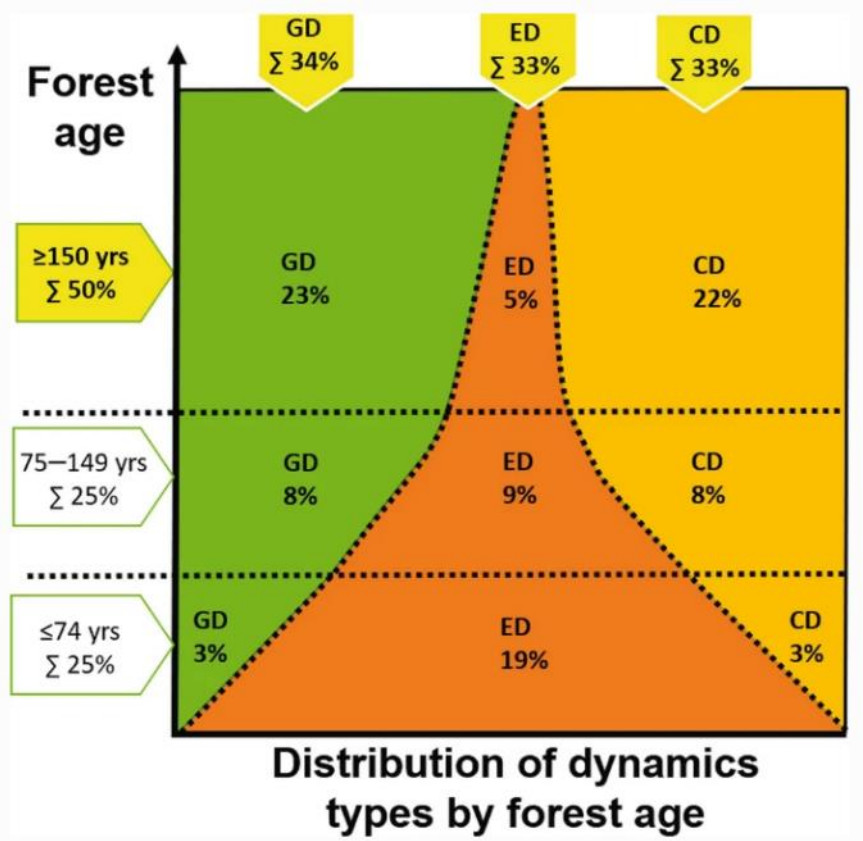
Retention forestry ⟷ Natural disturbance-based management ⟷ Continuous-cover forestry

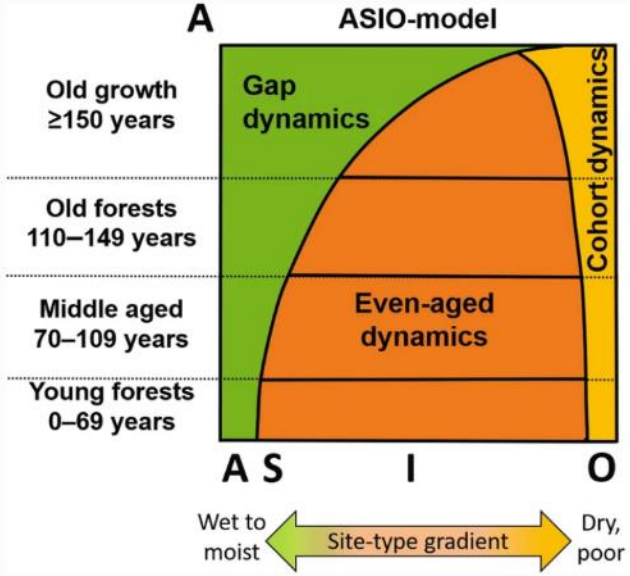
- Disturbance regimes
- Natural Range of Variation (NRV)
- Heterogeneity at different spatial scales
- Increased flexibility, adaptability in all types of ecosystem services

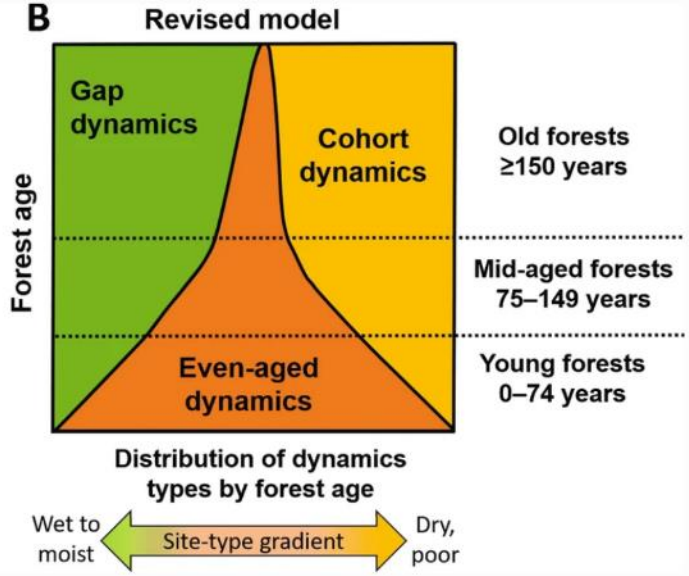
Kuuluvainen *et al.* 2021











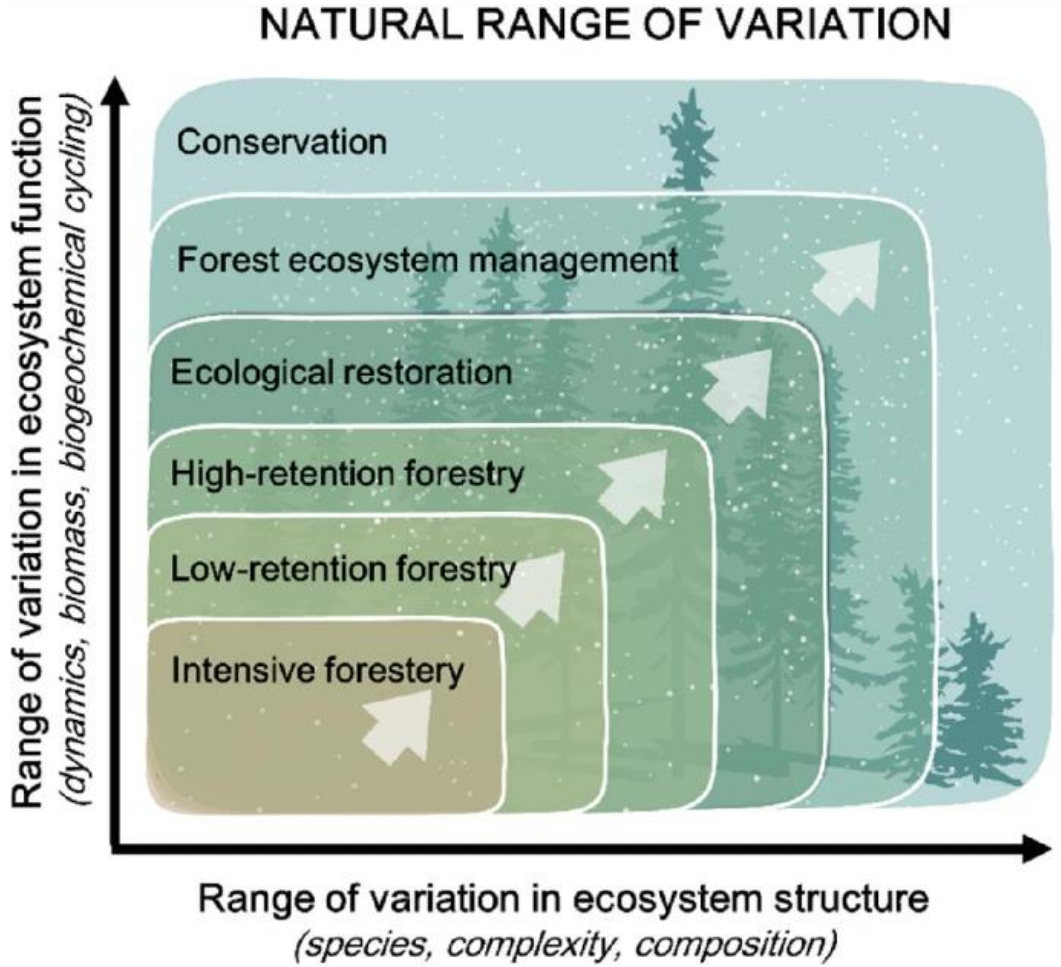
Berglund and Kuuluvainen 2021

Forest management – within the limits of ecological processes

- Land sparing vs land sharing
- Improved habitat connectivity
- Increased resilience and response diversity

Tree breeding > Improved genetic material

Restoration efforts
- Rewilding
- Prestoration



Gauthier *et al.* 2023
https://doi.org/10.1007/978-3-031-15988-6_1

Foto: *LVMI Silava*

SNS Nordic Forest Research

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skogforsk

NIBIO

Eesti Maaülikool EMU Estonian University of Life Sciences

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Thank you!

PROFOR
Promoting sustainable forestry in a growing bioeconomy