Challenges to integrate climate change mitigation, adaptation and biodiversity conservation in European forests

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Climate smart forestry

1. Increase carbon storage in forests and wood products, in conjunction with the provision of other ecosystem services and conservation of biodiversity;
2. Enhance forest resilience and adaptive capacity through active forest management;
3. Sustainable use of wood resources as a substitute for non-renewable, carbon-intensive materials

Adopted from Verkerk et al. 2020

Principles of close(r) to nature forest management – and their potential to contribute to A-M-B

- Retention of habitat trees, special habitats, and dead wood
- Promoting native tree species as well as site adapted non-native species
- Promoting natural tree regeneration
- Partial harvests and promotion of stand structural heterogeneity
- Promoting tree species mixtures and genetic diversity
- Avoidance of intensive management operations
- Supporting landscape heterogeneity and functioning

Larsen et al. 2022: CLOSER-TO-NATURE FOREST MANAGEMENT - From Science to Policy (under review)

How does CrTNFM address pressures on biodiversity?

Forestry internal pressures

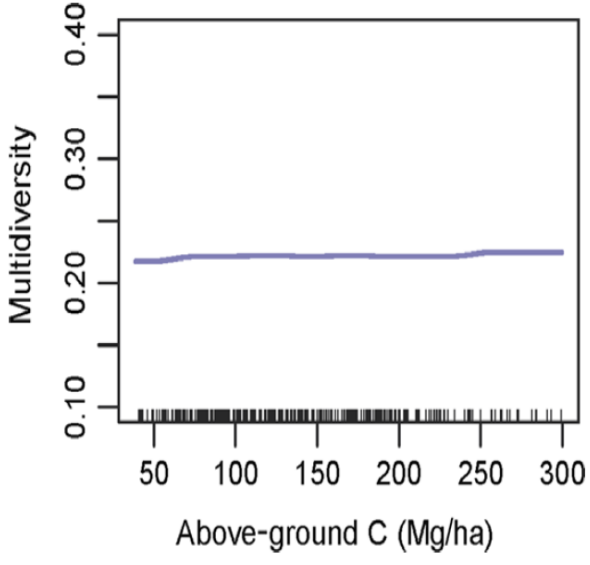
- Harvesting of old forests and old or dead trees
- Clearcutting with extraction of all trees
- Conversion of natural forest and habitat types
- Use of non-native or poorly adapted species
- Dense forests with high growing stocks
- Abandonment of traditional forest management approaches

External pressures

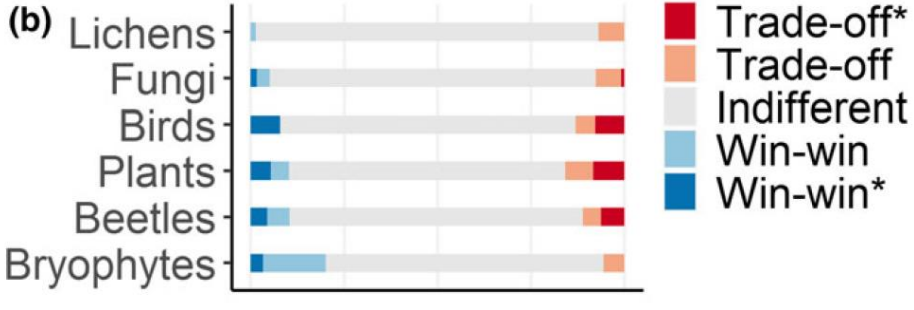
- Climate change
- Landscape fragmentation
- High populations of large herbivores
- Eutrophication
- Biological invasions
- Impacts of surrounding land-use

Larsen et al. 2022: CLOSER-TO-NATURE FOREST MANAGEMENT - From Science to Policy (under review)

Trade-offs between carbon stocks and biodiversity in European temperate forests



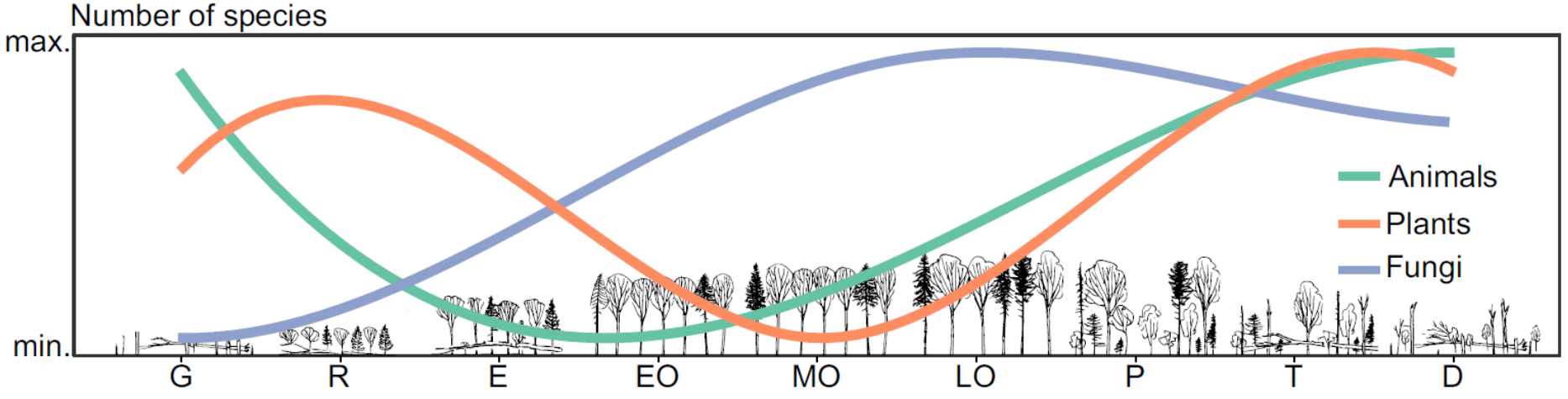
Relationship between multidiversity (scaled species richness of different taxonomic groups) and above-ground live carbon.



Proportion of win-win versus trade-off species across taxonomic groups in beech dominated forests

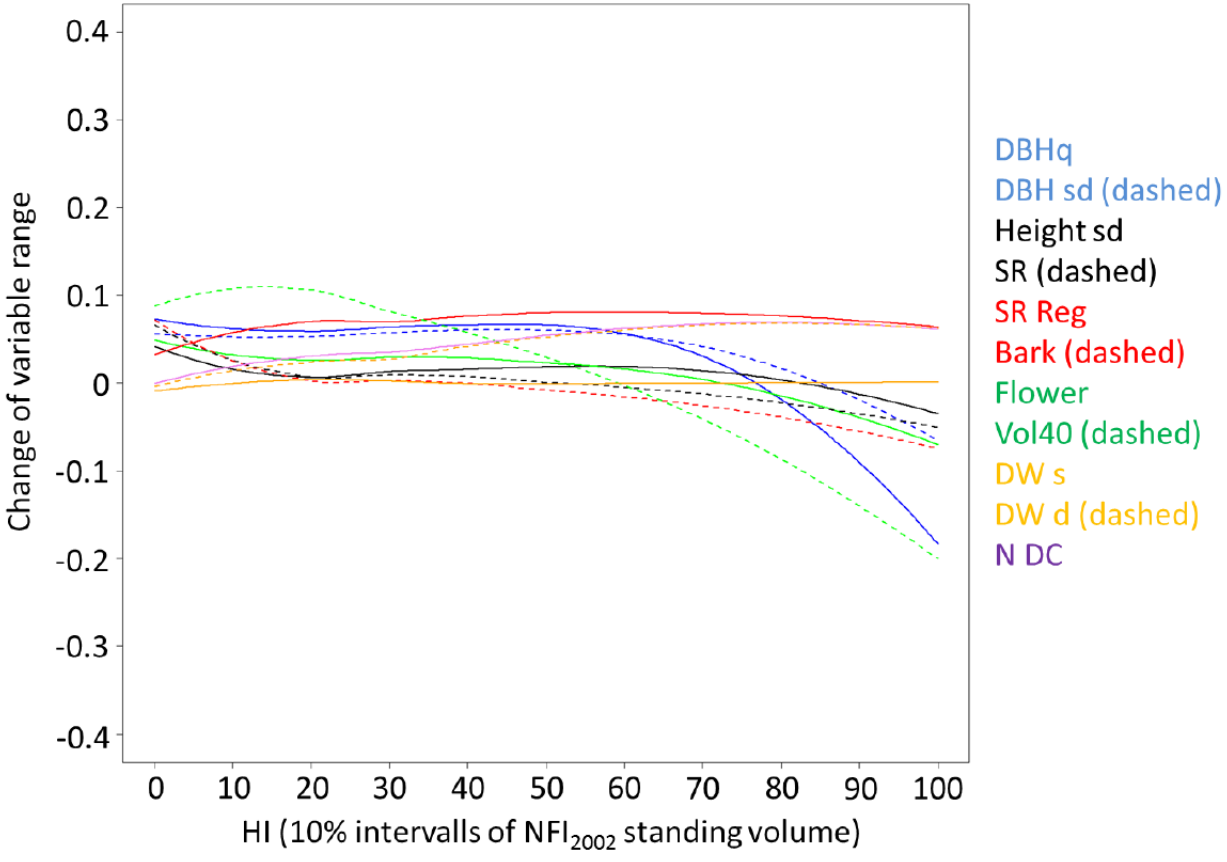
Sabatini et al. 2018

Biodiversity along temperate forest succession (Hilmers et al. 2018)



Normalized sum of predicted number of species along forest succession in the Bavarian Forest National Park for the three kingdom animals, plants, and fungi. Stages: G=gap; R=regeneration; E=establishment; EO=early optimum; MO=mid-optimum; LO=late optimum; P=plenter; T=terminal; D=decay.

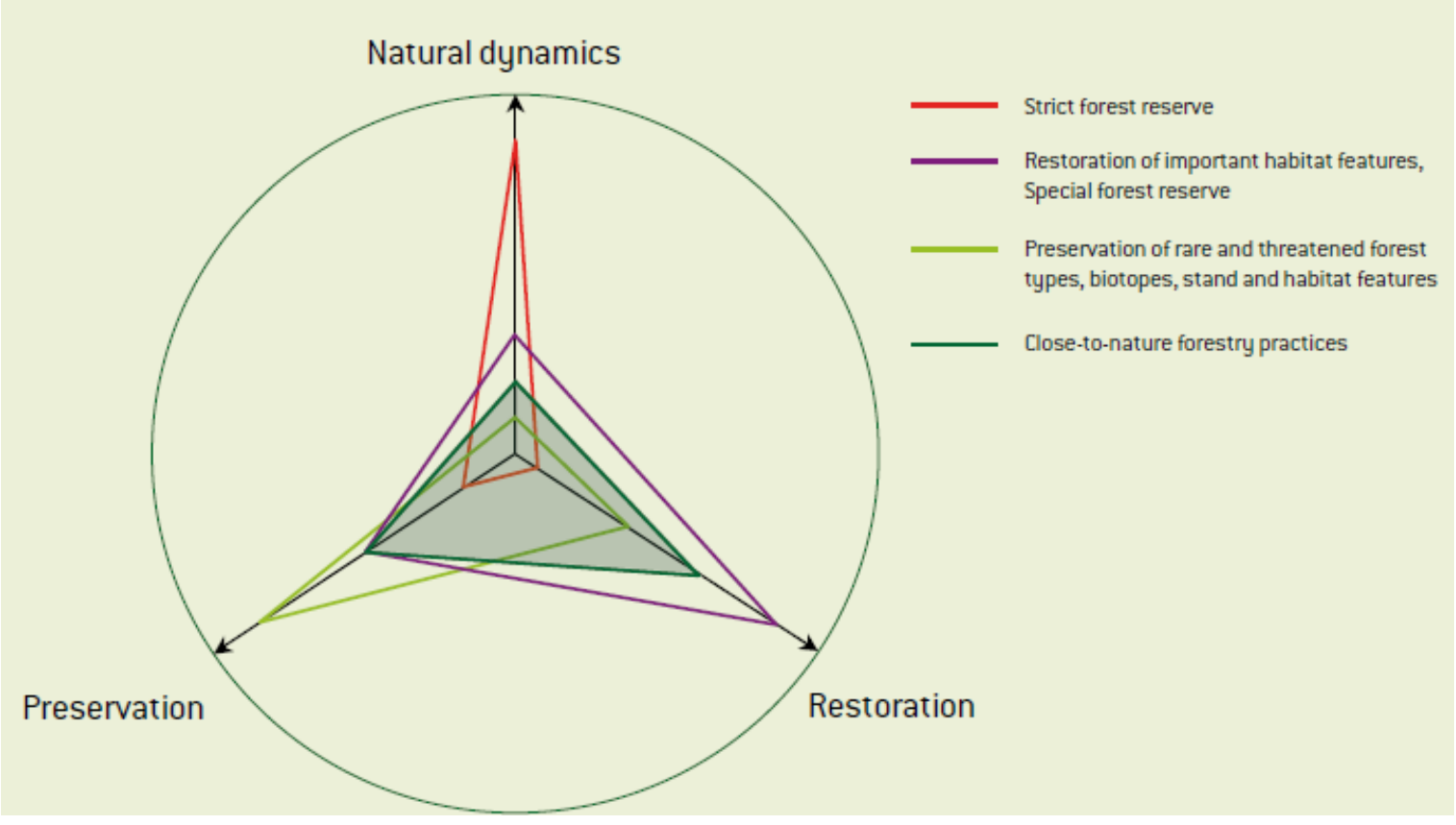
Changes in forest structure variables with harvesting intensity for national forest inventory plots from Baden-Württemberg (GER)



Storch F et al. (2019) Assessing the influence of harvesting intensities on structural diversity of forests in south-west Germany. ***Forest Ecosystems*** 6, 40, https://doi.org/10.1186/s40663-019-0199-6

For biodiversity conservation, we need both **less** and **more** intensive management

The role of CTNFM in nature conservation?



Qualitative model of the influence of different nature conservation approaches regarding three important conservation goals (axes) Bollmann (2011).

How does CrTNFM support resistence, resilience and adaptive capacity?

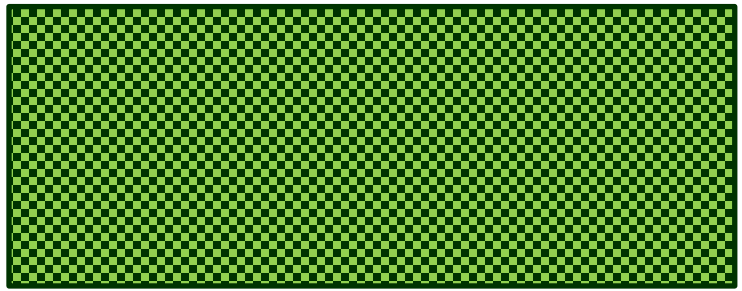
- Partial harvests, structural heterogeneity, advance regeneration
- Tree species and genetic diversity
- Site-adapted species
- Retention of legacies
- Supporting landscape heterogeneity and functioning
- Natural regeneration
- Focus on large trees
- High levels of growing stocks

Experiment to analyse the influence of retained structures on regeneration processes.

Are mixed and uneven-aged forests more resistant and resilient to stress and disturbance?

Portfolio effect

Mixed patches vs. Mixed stands

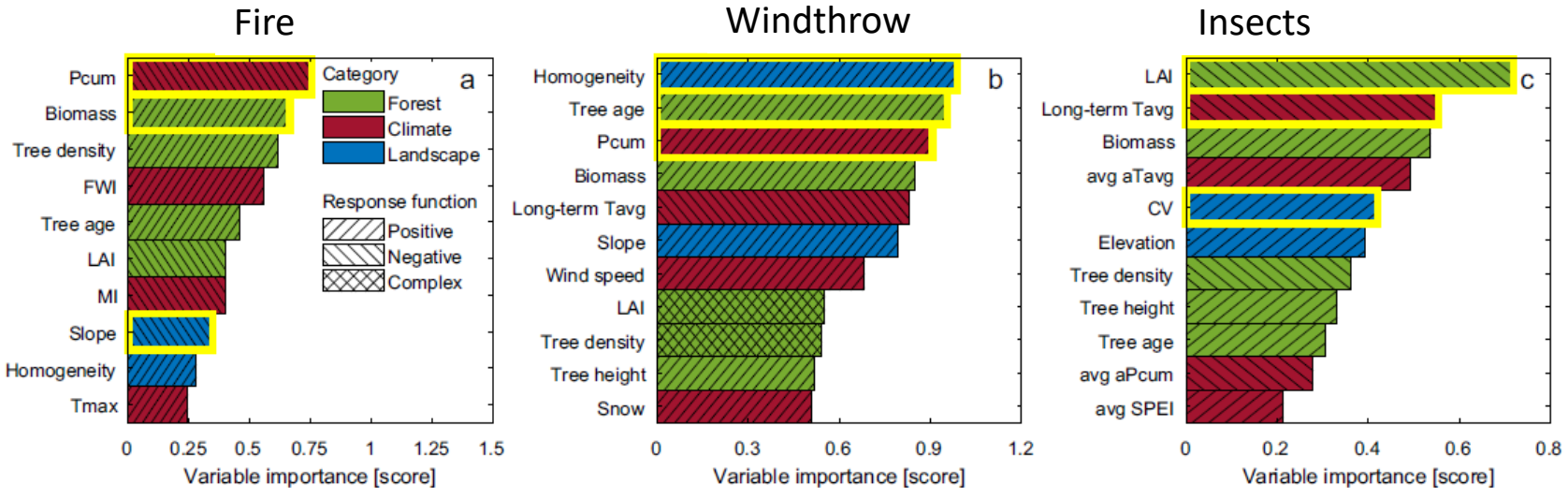


Burnt pine-oak forest

Wind damage in uneven-aged forest, Photo: Täger

Bark-beetle damage in spruce-beech forest

Importance of climatic, landscape and forest condition variables for vulnerability to disturbances of European forests (1979-2018).



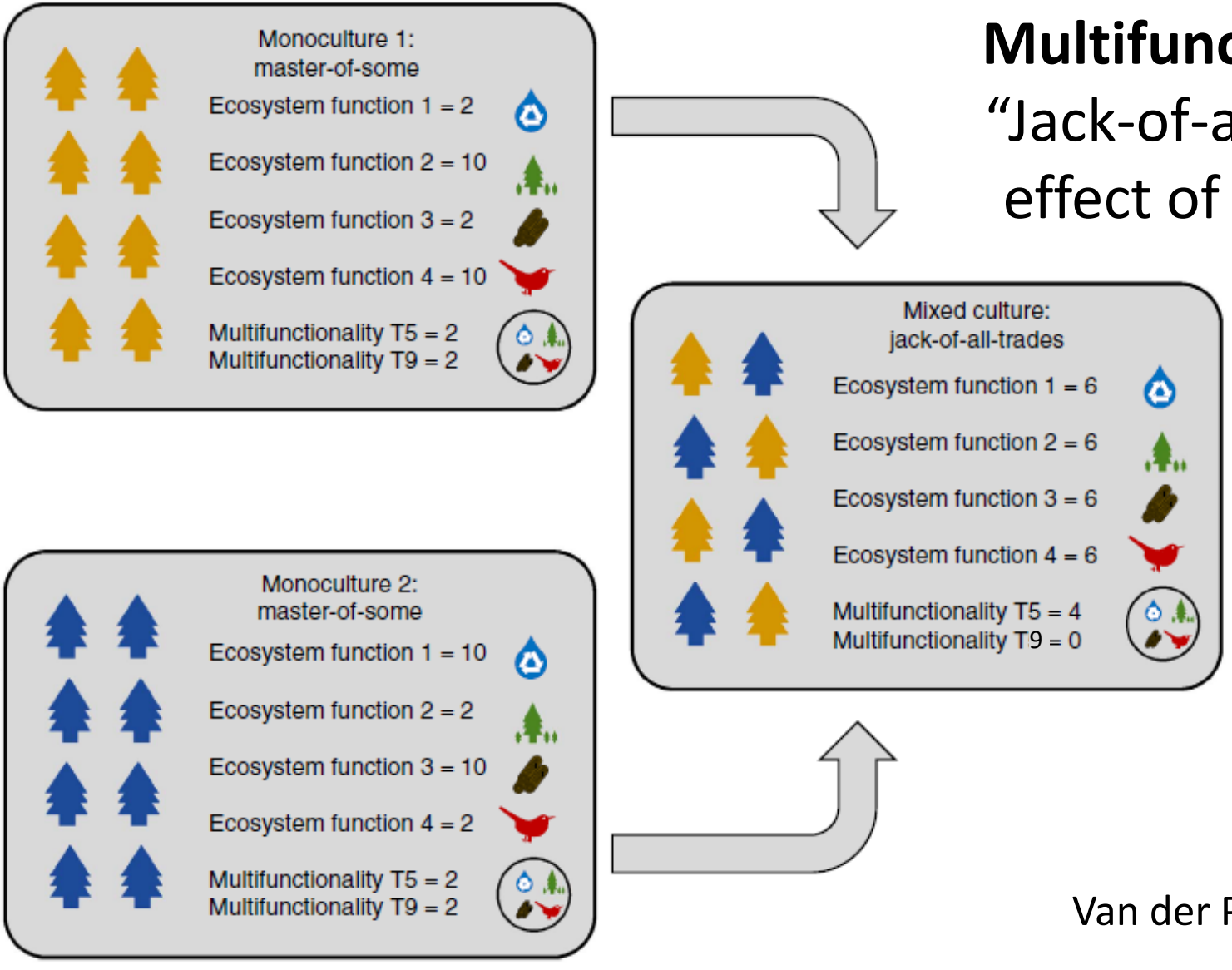
Biomass,
Stand density

Tree age,
Biomass

Leaf area index
Biomass

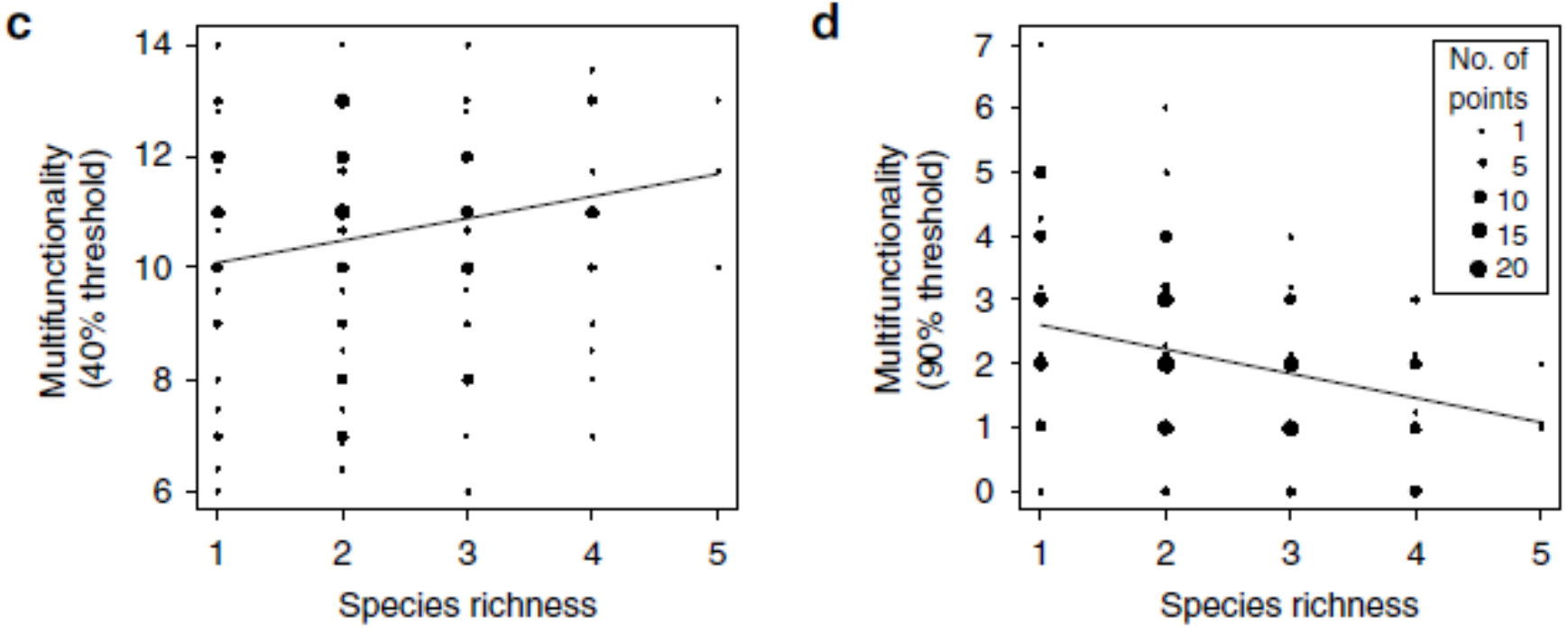
Forzieri et al 2021. https://doi.org/10.1038/s41467-021-21399-7

Multifunctionality:
"Jack-of-all-trades" effect of mixtures



Van der Plas et al. 2016

“Jack-of-all-trades” effect of mixtures



The multifunctionality value (number of functions above a 40% (left) or 90% (right) threshold value) as a response to species richness across 209 forest plots in Europe; Van der Plas et al. 2016. *Nature Communications* 7, 11109

How does CrTNFM support climate change mitigation?

- Partial harvests, structural heterogeneity, advance regeneration
- Tree species and genetic diversity
- Promoting native as well as site adapted non-native tree species
- Retention of legacies
- Avoidance of intensive management operations
- Natural regeneration
- Focus on large trees
- High levels of growing stocks

Strategy to store C in forests:

1. Provides mainly benefits until the sink is saturated. Ignores trade-offs with biodiversity and other ecosystem functions.
2. Is not free from risk due to increasing vulnerability to natural disturbances. May inhibit adaptation.
3. Neglects the urgent need to decarbonize the global economy. Projections for global resource extraction for biomass, fossil fuels, metal ores, and minerals by 2050 are associated with increases in greenhouse gas emissions of approximately 40%.

Adopted from Verkerk et al. 2020

What capacity do forest owners have to adapt and provide important ecosystem services?

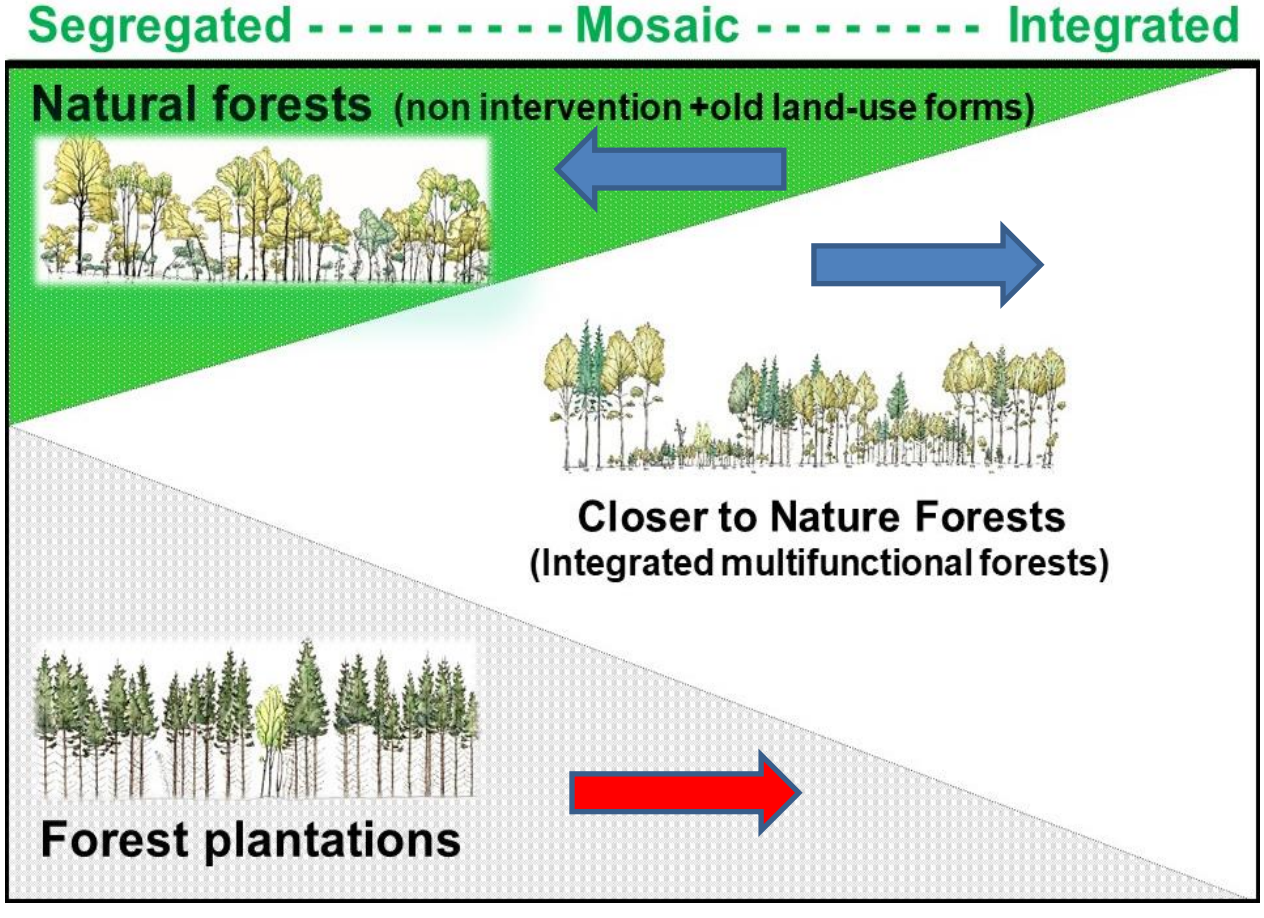
Reduced income through:

- More frequent disturbances:
  - less utilizable timber,
  - market distortions,
  - loss of assets
- Reduced productivity
- Shift to economically less profitable species
- Increasing retention levels

Increasing costs for:

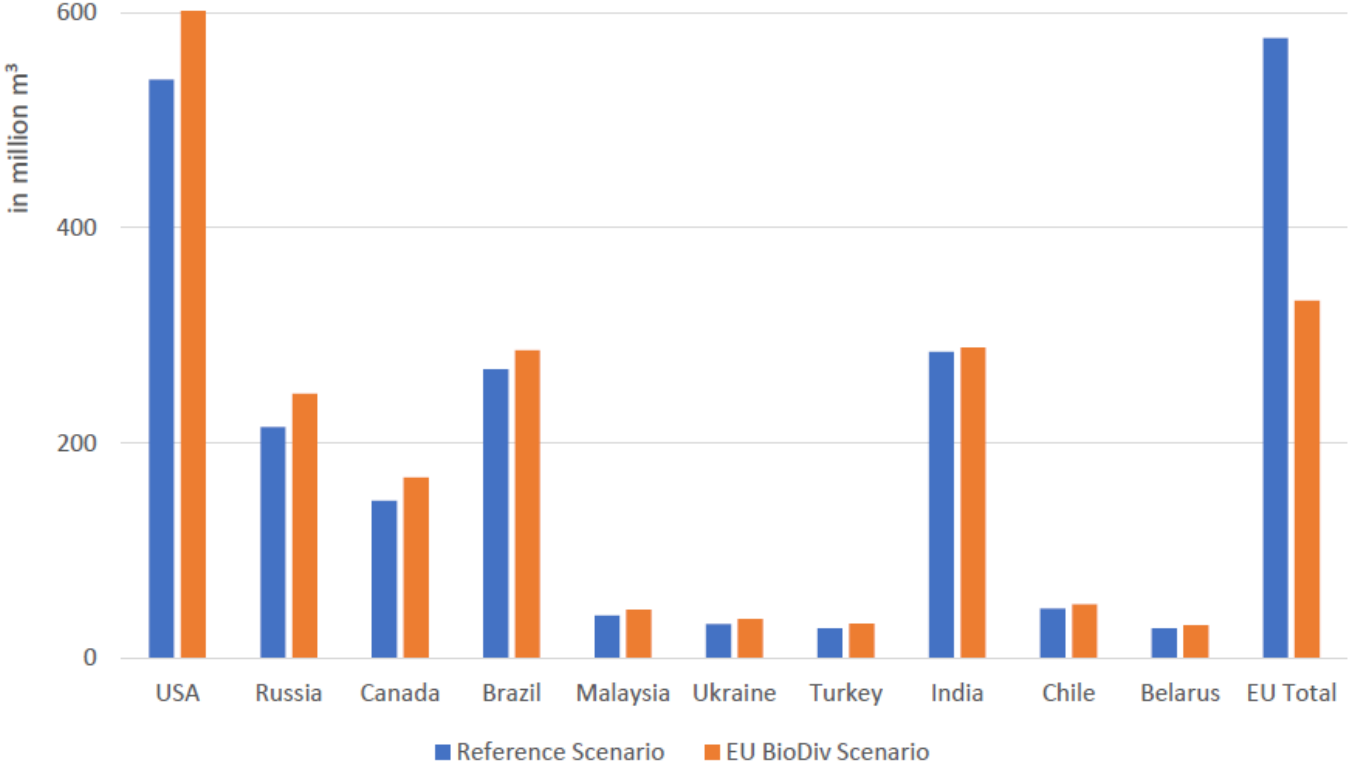
- Regeneration (more planting)
- Forest protection
- Tending and harvesting operations
- Traffic safety
- Risk management incl. monitoring
- Training
- …..

The role of CrTNFM in the forest landscape



Larsen et al. 2022: CLOSER-TO-NATURE FOREST MANAGEMENT - From Science to Policy (under review)

Possible leakage effects of implementation of EU Biodiversity strategy



Raw wood production of the countries with the greatest changes and the EU: Reference scenario (blue), EU BioDiv scenario (orange) in 2050.

Dieter et al. (2020) Assessment of possible leakage effects of implementing EU COM proposals for the EU Biodiversity Strategy on forests and forest management in non-EU countries. DOI:10.3220/WP1604416717000

Conclusions & Recommendations

1. Close(r) to nature forest management (CrTNFM) has the potential to serve many aspects of carbon smart forestry while supporting biodiversity.
2. To meet the challenges of supporting CC mitigation, adaptation and biodiversity conservation, a modern and flexible interpretation of CTNFM is required; including variable retention and embracing disturbances, assisted migration and planting, adapted target diameters and C stocks, and landscape approaches.
3. Trade-offs among CC mitigation, adaptation, biodiversity conservation and other ecosystem services need to be considered to avoid negative feedbacks (e.g. C stocks and biodiversity as well as adaptation) and leakage effects
4. Implementation requires much technical and financial support, in particular to small private forest owners, for the provision of ecosystem services

Thank you for your attention!

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