

The elusive links between biodiversity, multifunctionality and ecosystem services

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The elusive links between biodiversity, multifunctionality and ecosystem services

- What are ecosystem services about?
- What is multifunctionality about?
- What is biodiversity about?
- Ecosystem services as a boundary concept
- Elusive links?

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= the benefits humans derive from nature
(Costanza et al., 1997,
<http://www.nature.com/articles/387253a0>)

= nature's contributions to people
(Díaz et al., 2018,
DOI:10.1126/science.aap8826)

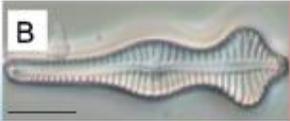
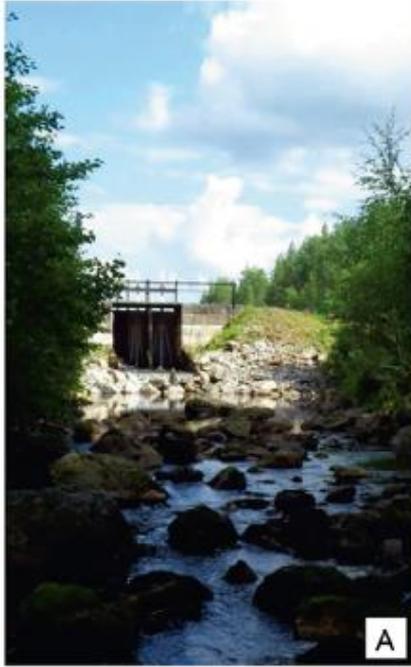
(Díaz et al., 2017, DOI:10.1126/science.aap8826)

18 NCPs / ESs:

1. Habitat creation and maintenance
2. Pollination and dispersal of seeds and other propagules
3. Regulation of air quality
4. Regulation of climate
5. Regulation of ocean acidification
6. Regulation of freshwater quantity, location and timing
7. Regulation of freshwater and coastal water quality
8. Formation, protection and decontamination of soils and sediments
9. Regulation of hazards and extreme events
10. Regulation of detrimental organisms and biological processes
11. Energy
12. Food and feed
13. Materials, companionship and labor
14. Medicinal, biochemical and genetic resources
15. Learning and inspiration
16. Physical and psychological experiences
17. Supporting identities
18. Maintenance of options

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Response traits

- Physiological tolerance
- Development time
- Number of offspring
- Longevity
- Habitat specialisation
- Resource specialisation
- Mobility
- Morphology
- Body size
- Body mass
- Habitat use
- Growth rate
- Resource requirements
- Resource acquisition rate

Effect traits

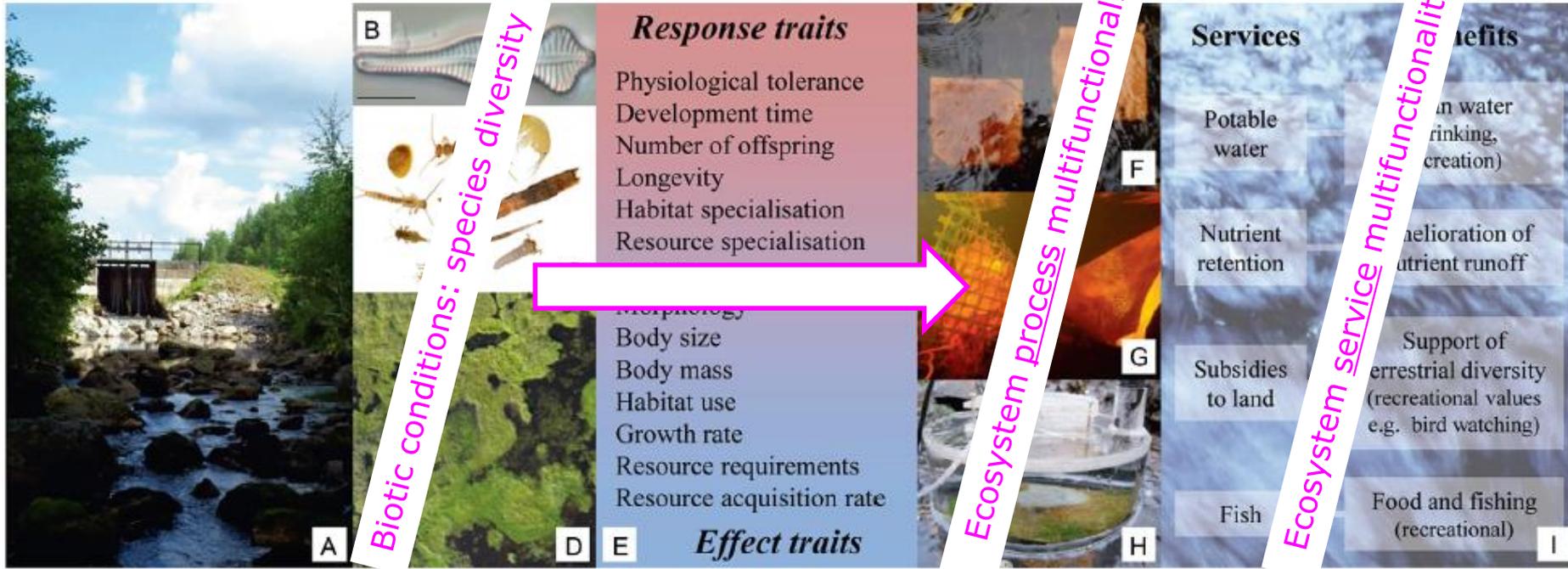


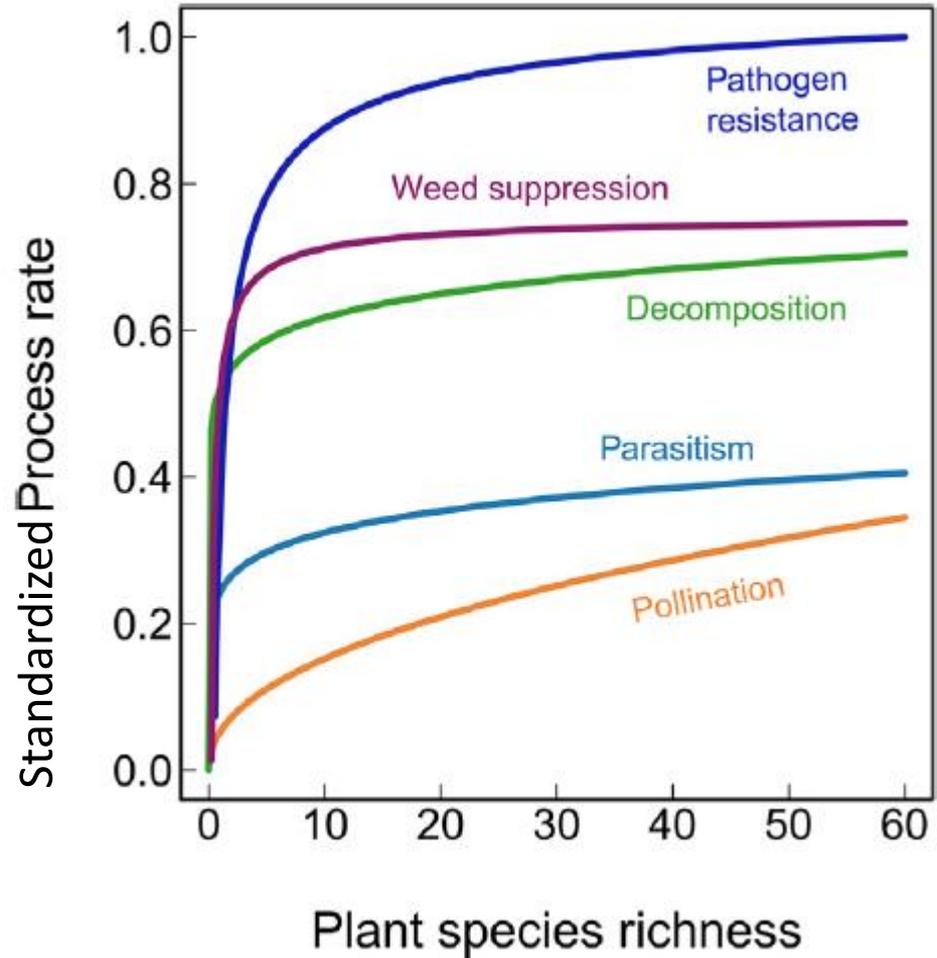
Services	Benefits
Potable water	Drinking water (recreation)
Nutrient retention	Mitigation of nutrient runoff
Subsidies to land	Support of terrestrial diversity (recreational values e.g. bird watching)
Fish	Food and fishing (recreational)

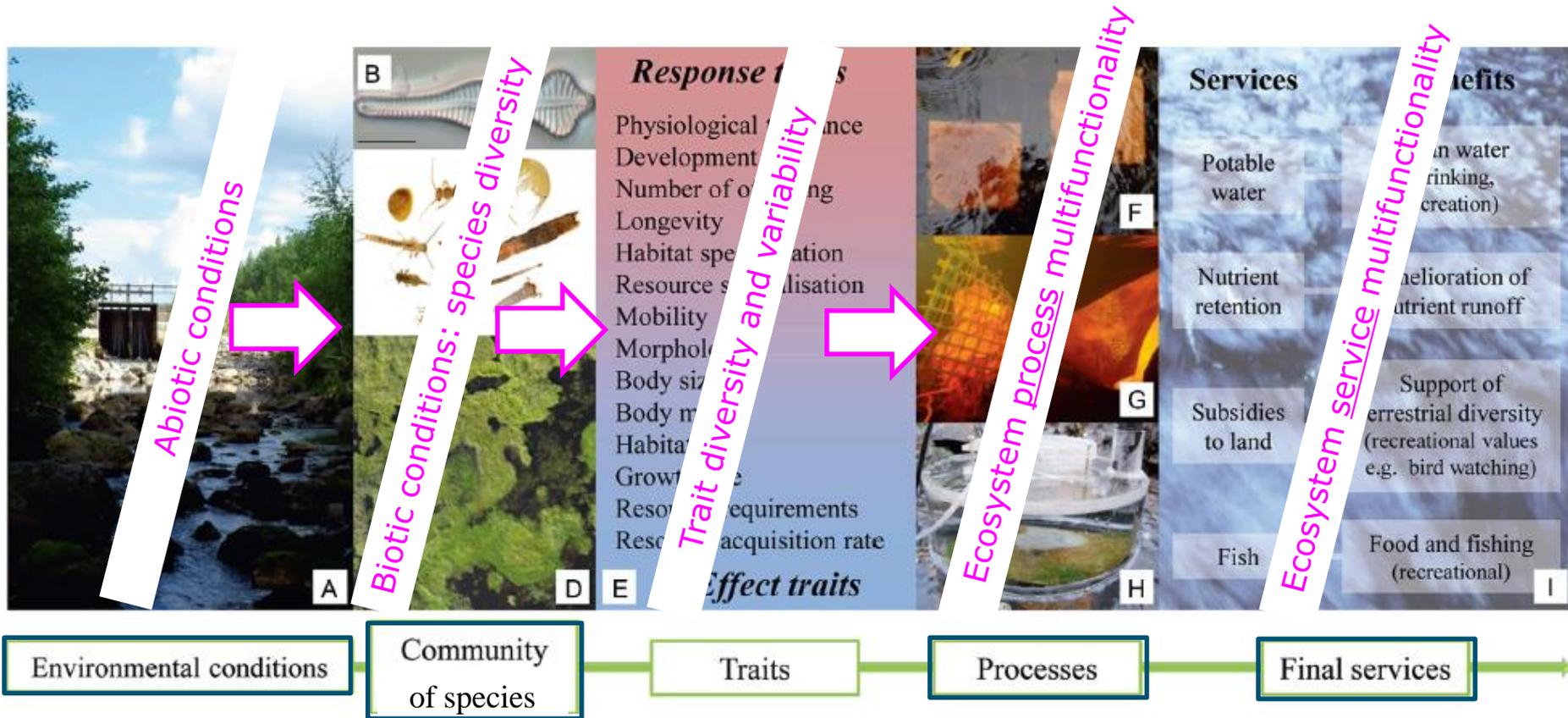


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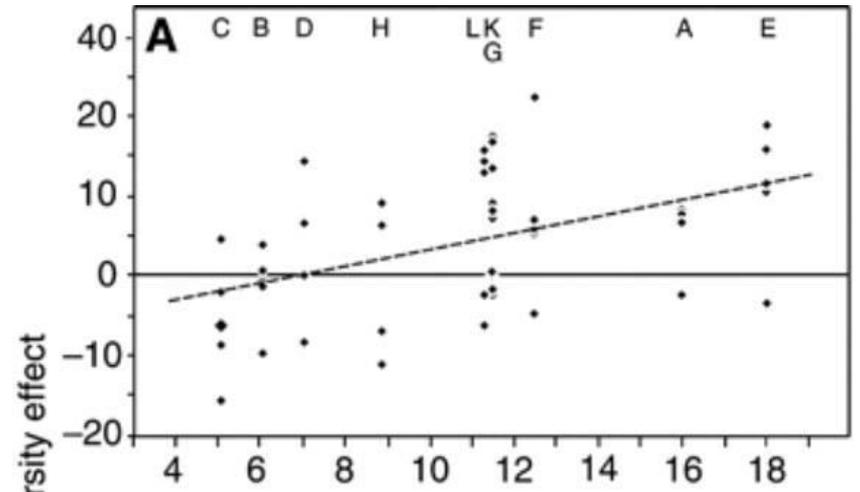




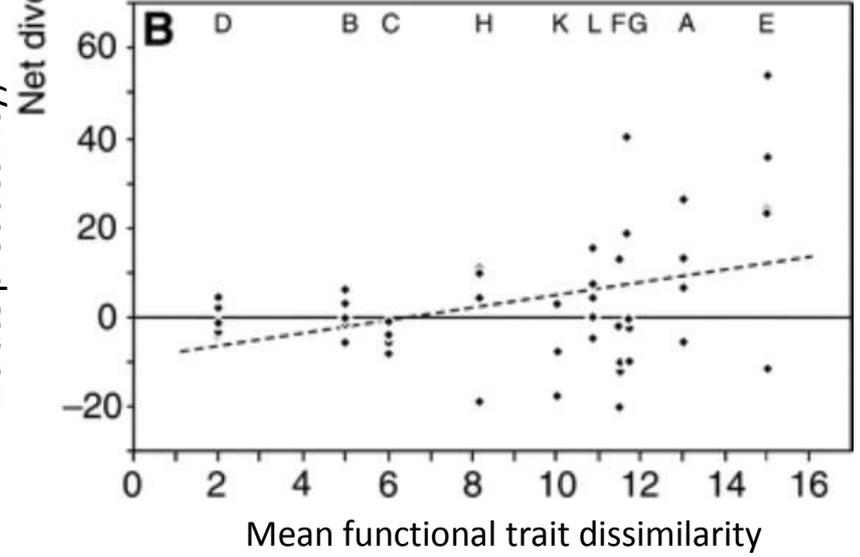


Heemsbergen et al., 2004,
doi: 10.1126/science

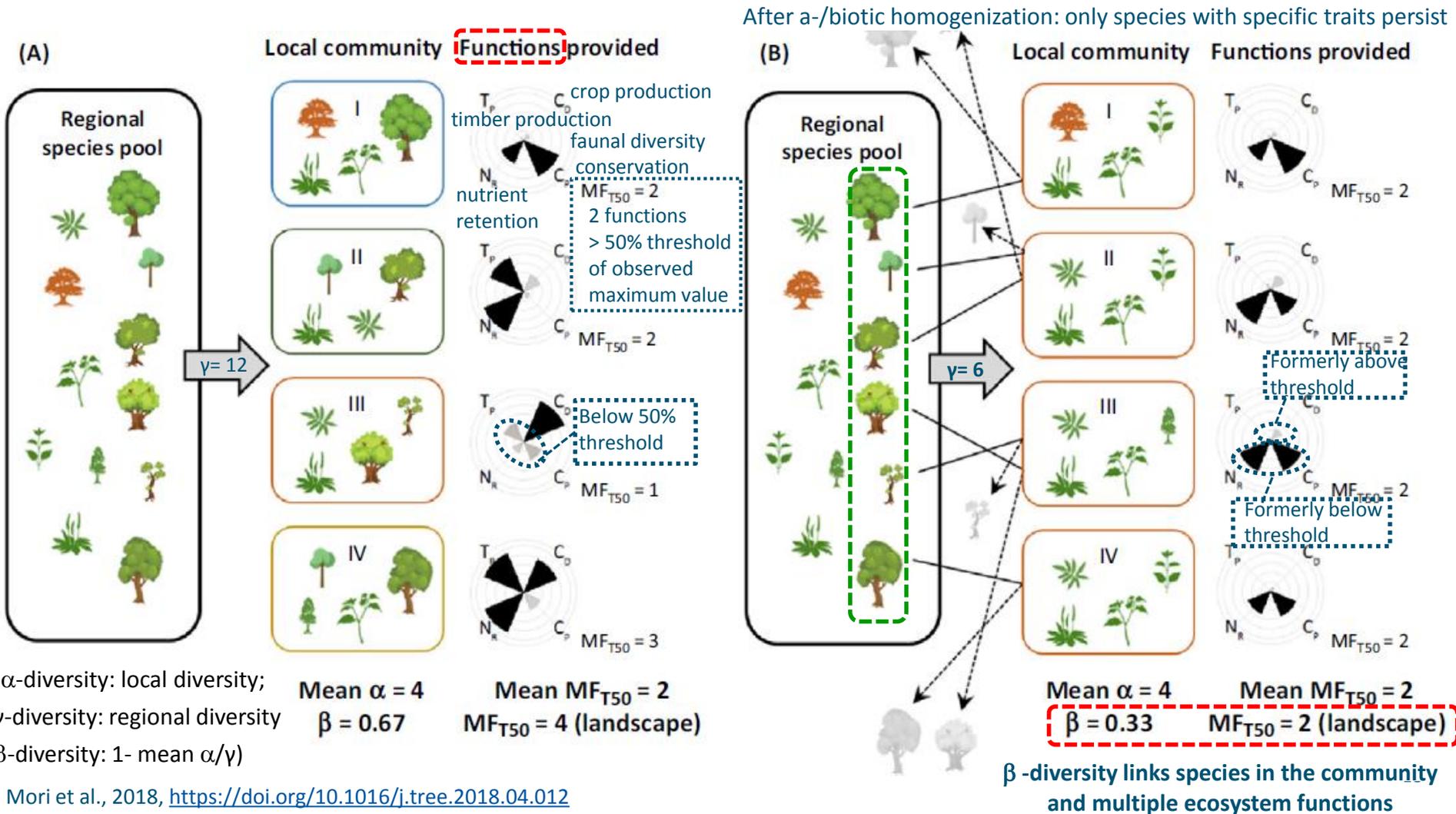
A. Soil respiration



B. Leaf litter mass loss
(similar result for gross
nitrate productivity)

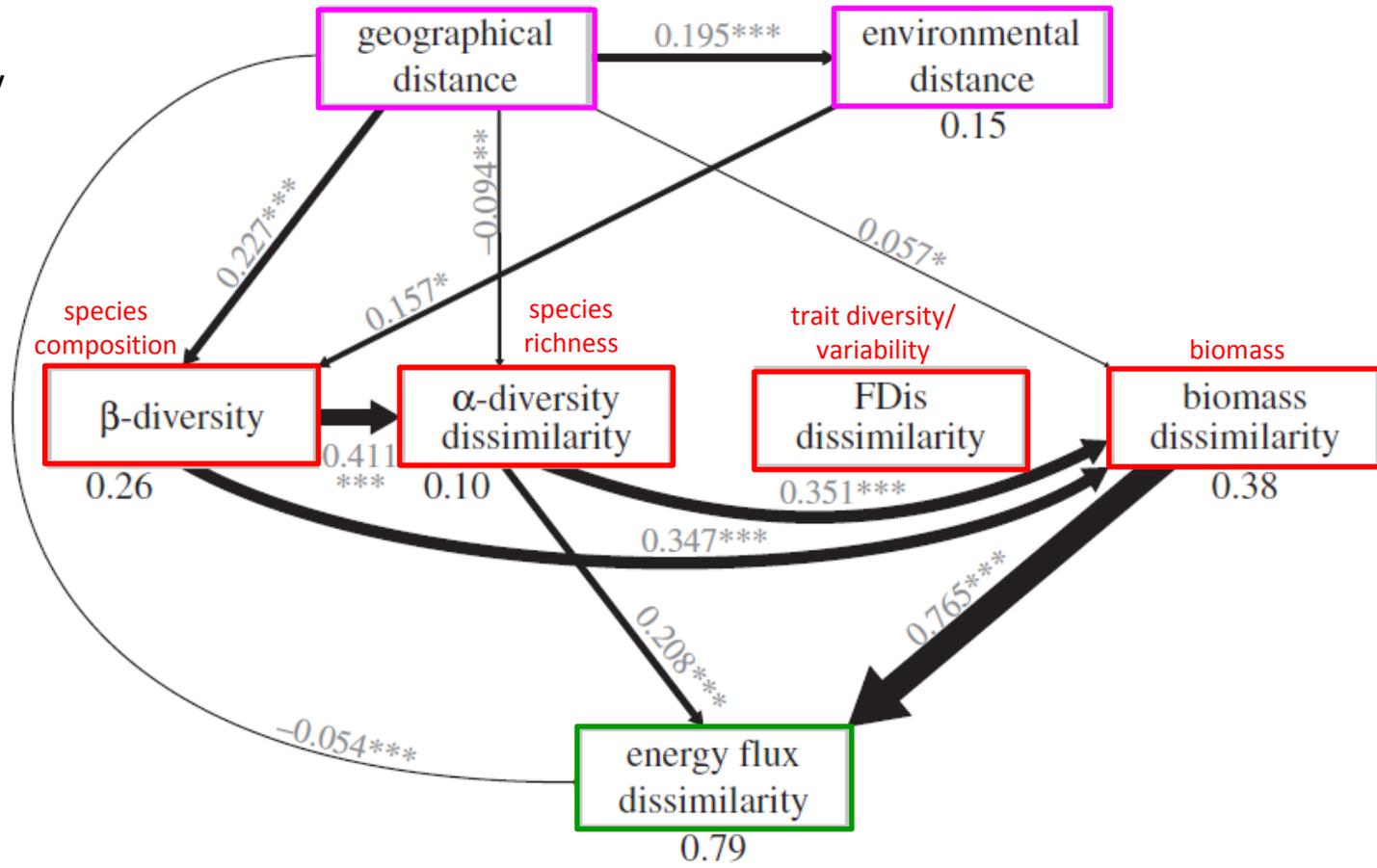




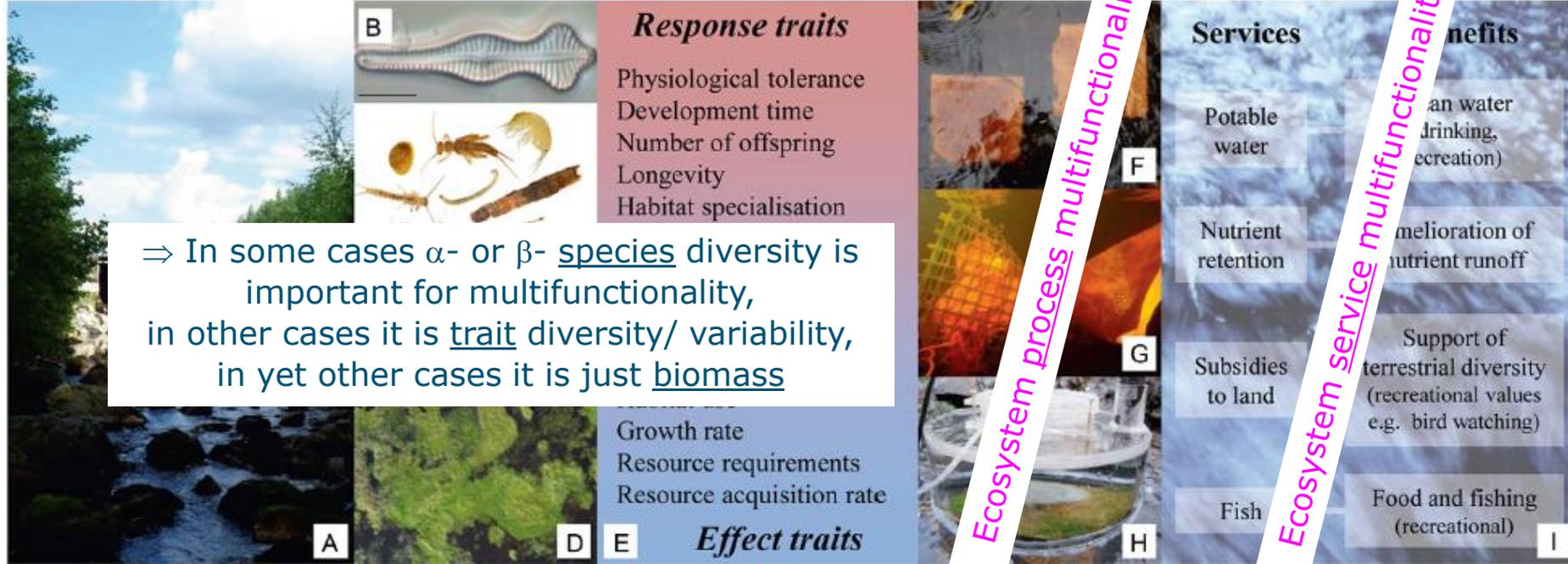


(α -diversity: local diversity;
 γ -diversity: regional diversity
 β -diversity: 1- mean α/γ)

Germany



Mechanisms determining **spatial** variation in energy fluxes of litter macroinvertebrate communities across **landscapes**



⇒ In some cases α - or β - species diversity is important for multifunctionality, in other cases it is trait diversity/ variability, in yet other cases it is just biomass



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Multifunctionality: the ability of ecosystems to simultaneously provide multiple *ecosystem processes and services*

Ecosystem process multifunctionality: the array of biological, geochemical and physical processes that occur within an ecosystem

Ecosystem service multifunctionality: the co-supply of multiple ecosystem services *relative to their human demand*

Response traits

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Effect traits

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Services

- Potable water
- Nutrient retention
- Subsidies to land
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Benefits

- Safe water (drinking, recreation)
- Mitigation of nutrient runoff
- Support of terrestrial diversity (recreational values e.g. bird watching)
- Food and fishing (recreational)

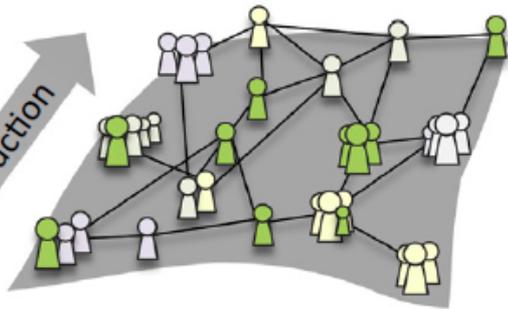
Ecosystem process multifunctionality

Ecosystem service multifunctionality

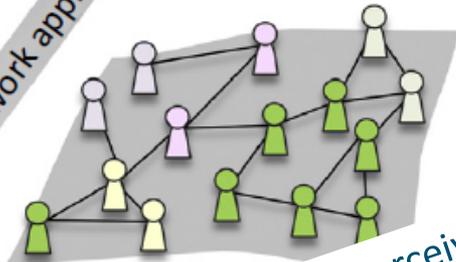
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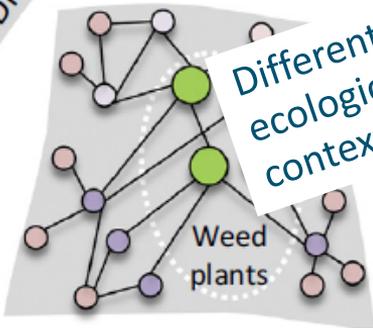
Direction of network approach construction



Layer 3. **Economic networks** reflect information associated with costs between nodes such as individuals, villages, conservation organisations and enterprises, or mixtures of all of these. For example, the sensibilities associated with financial transactions for herbicides purchases or the costs of a pollinator conservation scheme accrued from the management of weeds. The nodes may be a regrouping of +L



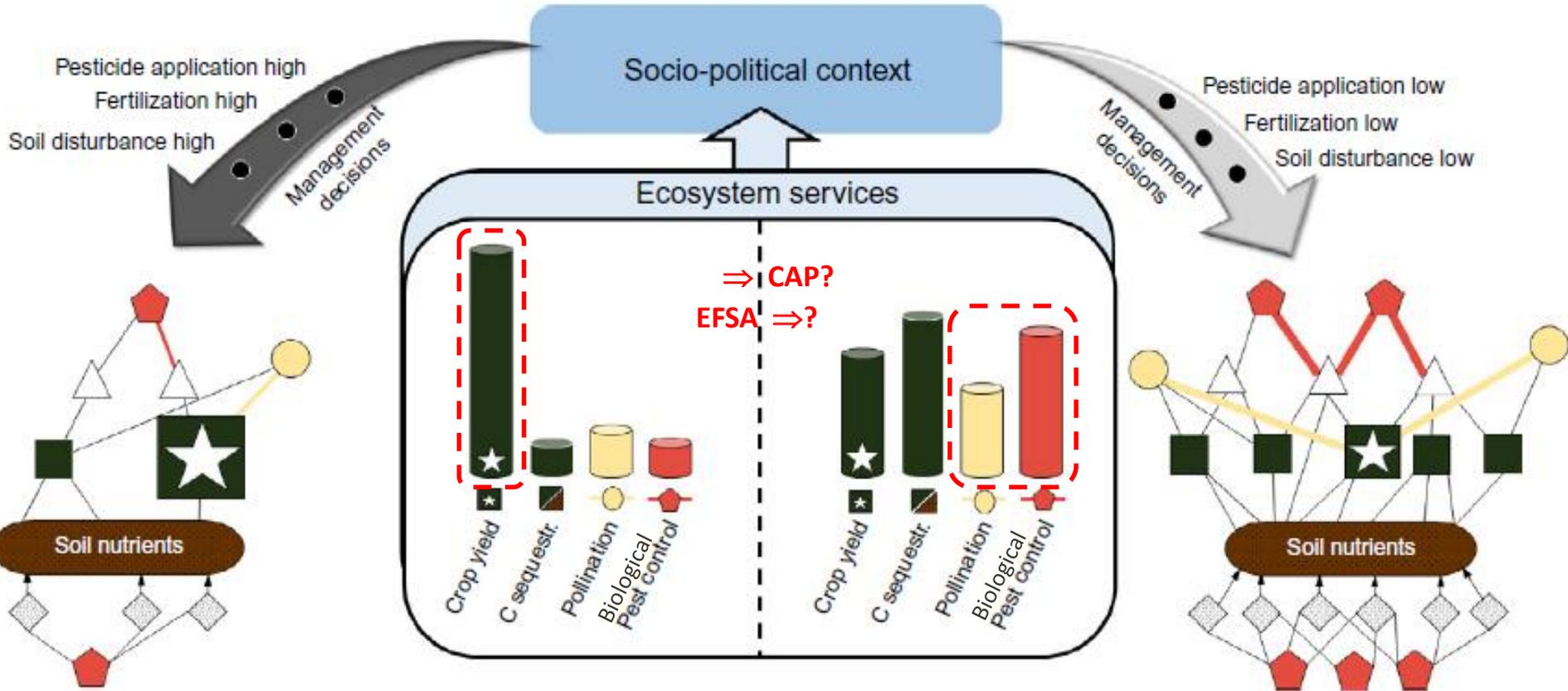
Layer 2. **Social network** layers may be composed of networks that reflect sensibilities associated with the use of weeds of layer 1. For example, farmers and landowners who can vary in their conservation preferences and shared views on the costs of weed management, and attitudes towards the use of herbicides. The network approach the structure of the network to that of the ecological network (Layer 1).



Different actors perceive ecosystems services differently, related to the socio-ecological and socio-economic circumstances and, indeed, to the socio-political context, hence....

Ecological networks are composed of links representing trophic, competitive, and other interactions between nodes that are typically species. Here, following Pocock (2000), the green nodes are weed plants surrounded by pollinators, parasitoids and herbivores. These weeds are the core, natural science nodes that structure the social and economic layers above (layers 2 and 3). This is critical for two reasons. Firstly, we identify the structuring ecology that drives biodiversity-derived ecosystem service. Secondly, this structuring limits the size of the network approach question. Now, the network approach is limited to ecological, social and economic questions of EcoS derived from weed biodiversity rather than being open-ended.

...stakeholder interests can influence feedbacks between ecosystem services and management of complex ecosystems



Management decisions that focus purely on one ecosystem service such as crop yield...
... can limit the balance of ecosystem services provided by other species in complex food webs

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Elusive= “difficult to track down”, but not untractable!

