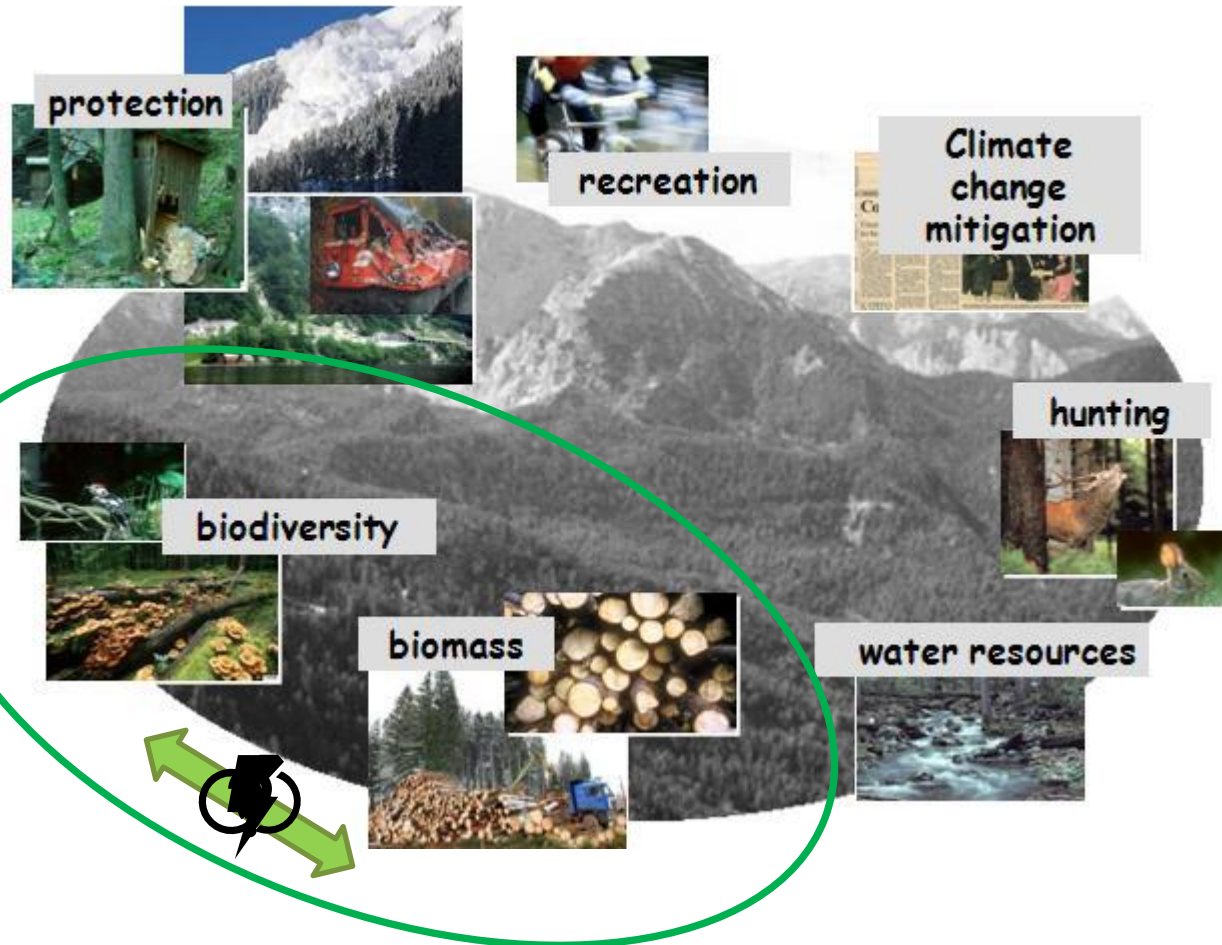


**Forest management impact on biodiversity in Central
European beech forests –
It is the landscape level that matters**

**Steffi Heinrichs, Christian Ammer, Peter Schall
& many scientists of the Biodiversity Exploratories**



How can we manage (not manage) forest landscapes for **biodiversity** and other services?

- Forests as „Multi-talents“ fulfilling many functions and services for human well-being

Article | Published: 13 April 2020

Replacements of small- by large-ranged species scale up to diversity loss in Europe's temperate forest biome


Ingmar R. Staude , Donald M. Waller, [...]Lander Baeten

Nature Ecology & Evolution 4, 802–808 (2020) | [Cite this article](#)

2176 Accesses | 15 Citations | 262 Altmetric | [Metrics](#)

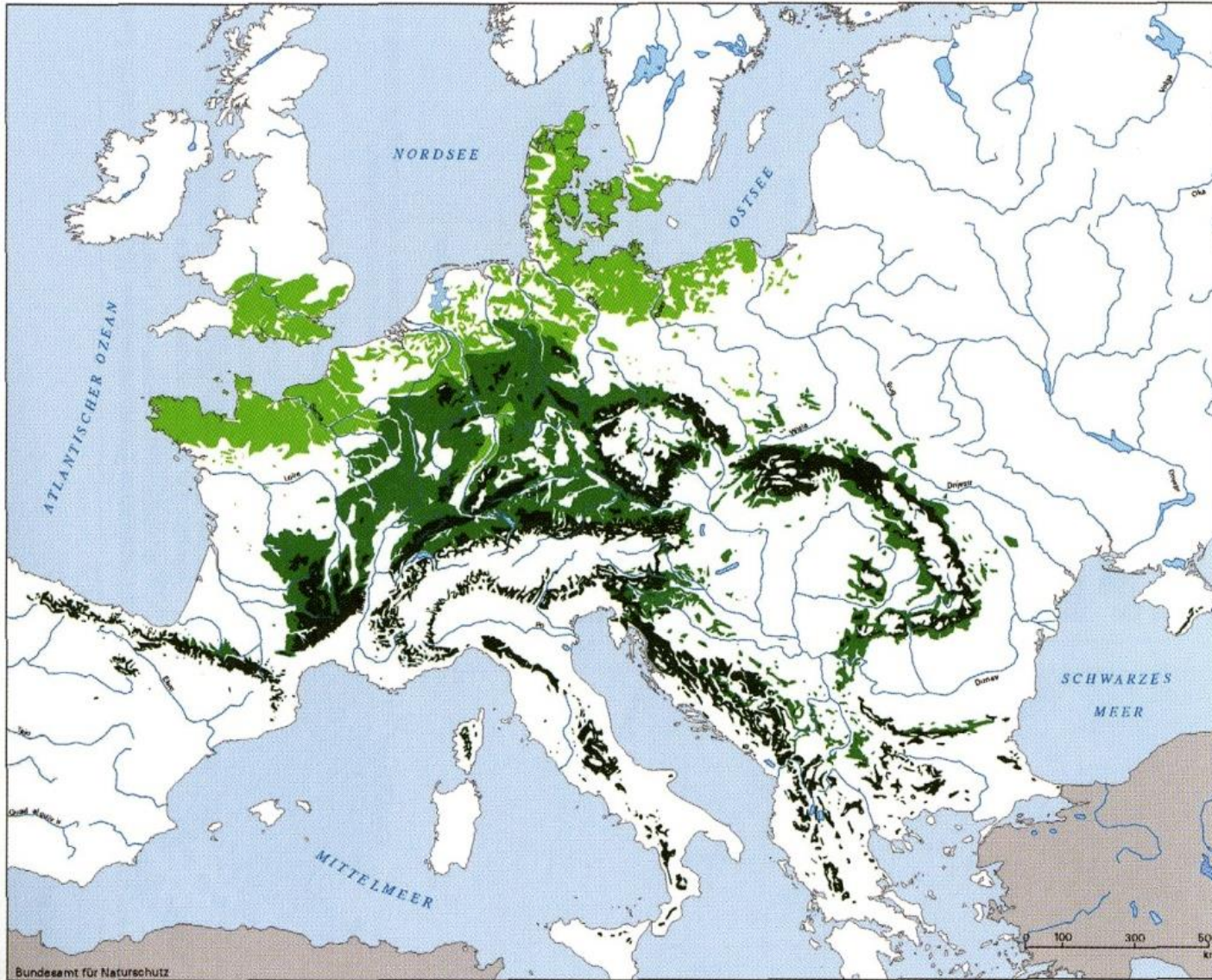
Article | Published: 30 October 2019

Arthropod decline in grasslands and forests is associated with landscape-level drivers

Sebastian Seibold , Martin M. Gossner, Nadja K. Simons, Nico Blüthgen, Jörg Müller, Didem Ambarlı, Christian Ammer, Jürgen Bausch, Markus Fischer, Jan C. Habel, Karl Eduard Linsenmair, Thomas Nauss, Caterina Penone, Daniel Prati, Peter Schall, Ernst-Detlef Schulze, Juliane Vogt, Stephan Wöllauer & Wolfgang W. Weisser

Nature 574, 671–674 (2019) | [Cite this article](#)

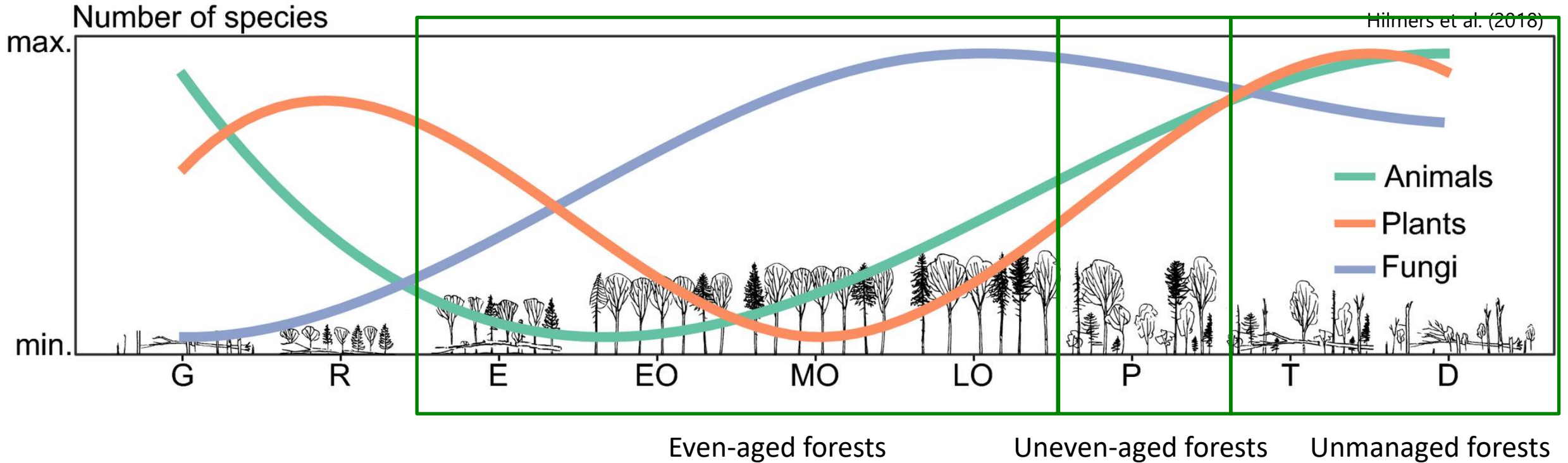
26k Accesses | 205 Citations | 2469 Altmetric | [Metrics](#)



European beech forests represent the potential natural vegetation across large parts of central Europe.

Höhenstufen: ■ planar(-kollin) ■ kollin-submontan ■ montan-hochmontan

Quelle: Bundesamt für Naturschutz (BfN), 2004



It is assumed that a small-scale forest management creating uneven-aged forest stands in combination with natural forest development (= no management on at least 5 % of the forest area) in managed forest landscapes will affect biodiversity positively.

„following MacArthur & MacArthur (1961)“

Are there biodiversity differences between forest management systems?

Do stand and landscape-level diversity respond differently?



3 Forest management systems of European beech



Even-aged forests (EA)

17 plots (3 thickets, 3 polewoods, 4 immature timber, 4 mature timber, 3 thicket with shelterwoods)



Uneven-aged forests (UEA)

13 plots near the localities Langula und Keula



Now unmanaged (UNM) (up to ca. 50 yrs)

13 plots in the National Park Hainich

DFG-Biodiversity Exploratories

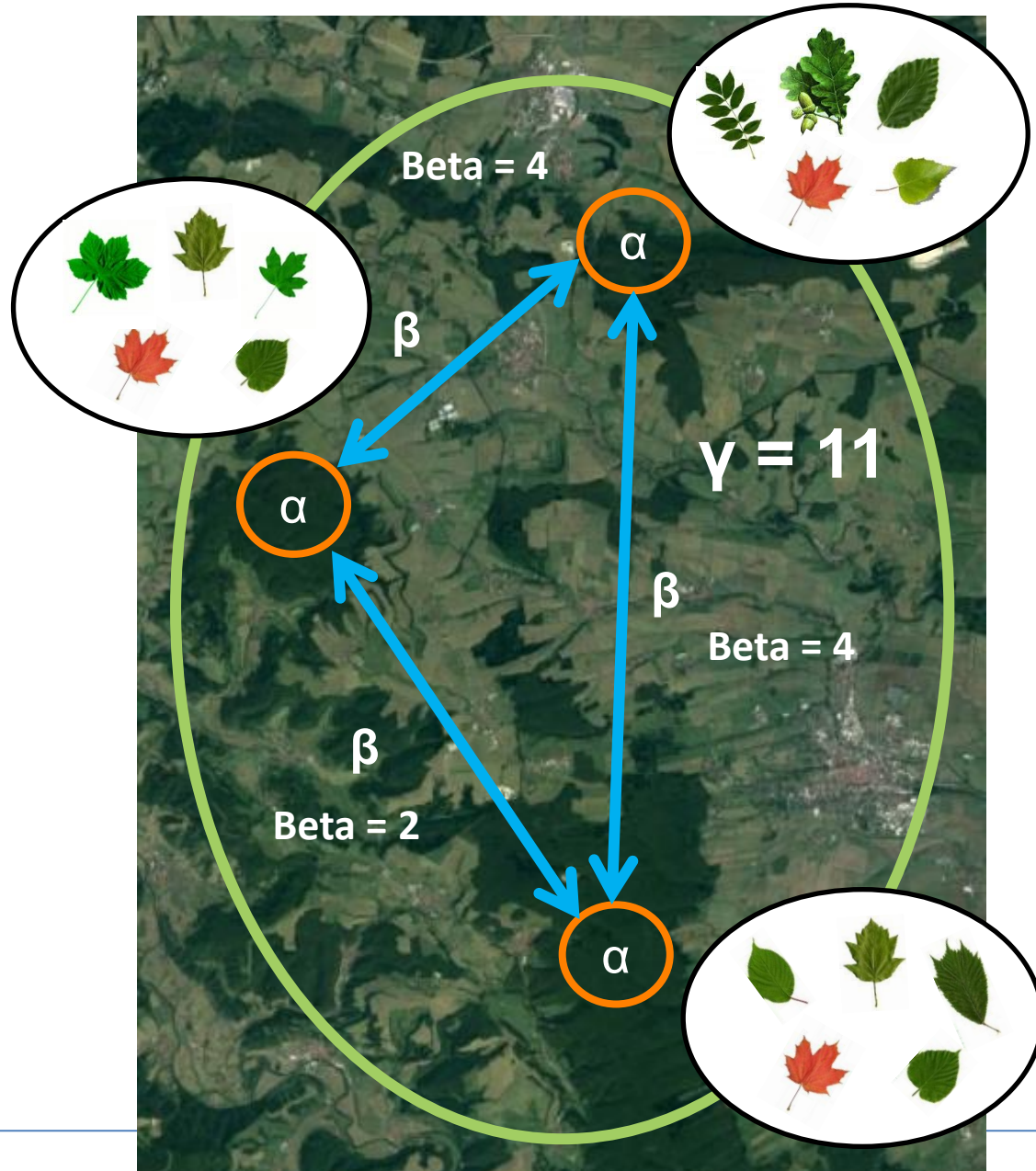


43 1ha plots

14 sampled Taxa from bacteria to vertebrates

Taxon	Sampling	Species number	
		all	Forest specialists
Bats	acoustic	13	8
Birds	acoustic-visual	39	16
Spiders	trap (ground)	96	70
Harvestmen	trap(ground)	16	
Beetles	trap (canopy & understorey & ground)	799	394
Hymenopterans	trap (canopy & understorey)	65	
Lacewings	trap (canopy & understorey)	37	
True bugs	trap (canopy & understorey & ground)	120	29
Vascular plants	relevé (herb layer)	119	54
Bryophytes	relevé (bark & deadwood & ground)	64	
Lichens	relevé (bark & deadwood & ground)	37	
Fungi			
deadwood	coarse woody debris	271	
ectomycorrhiza	soil DNA	823	
Bacteria	soil RNA (genera level)	1153	





α -diversity

Species richness per 1 ha plot =
stand level diversity

β -diversity *Baselga (2012)*

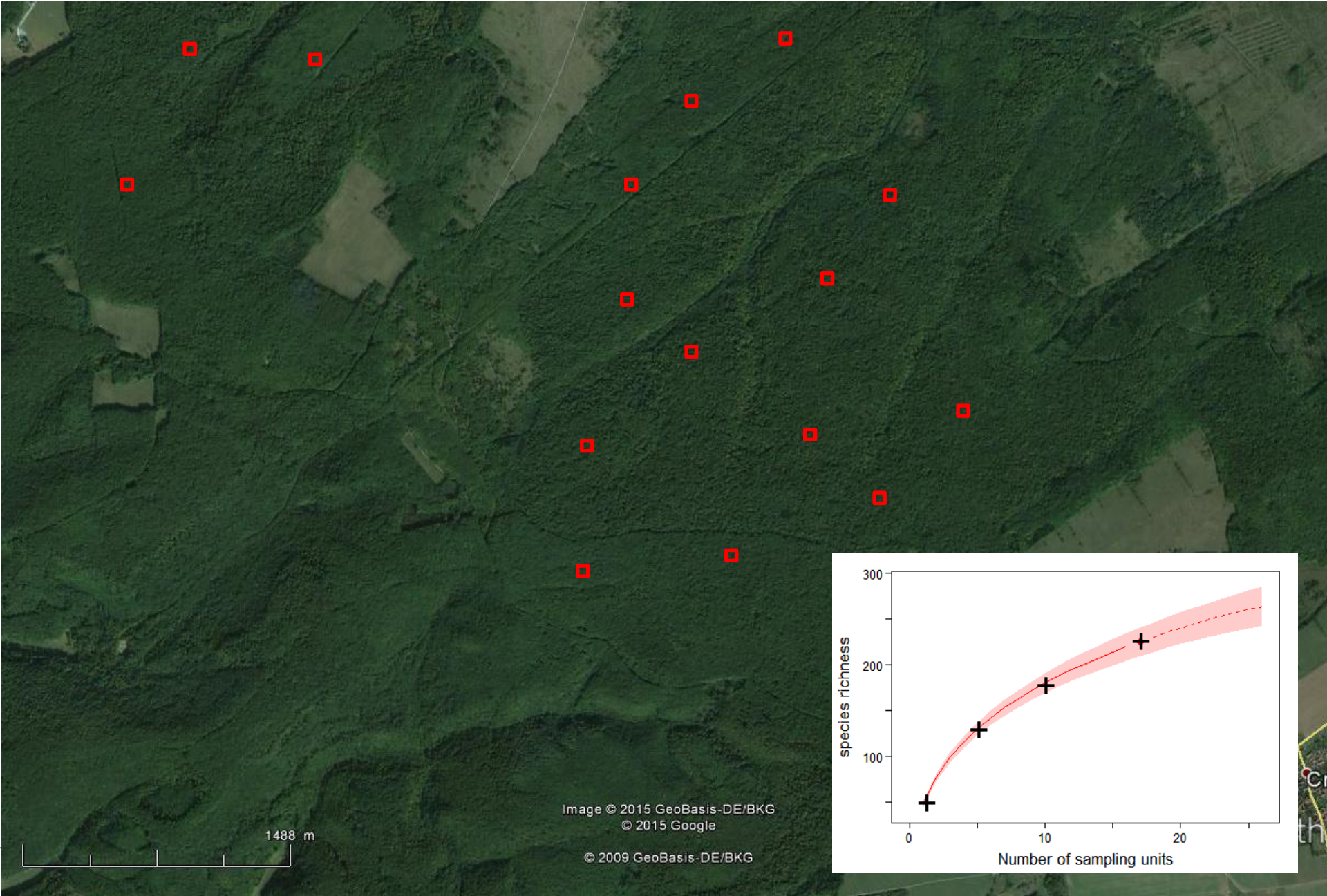
Compositional difference between plots
(Jaccard multiple-site dissimilarity)

γ -diversity ${}^0D, {}^1D, {}^2D$ *Chao et al. (2012)*

Accumulated species richness =
landscape level diversity

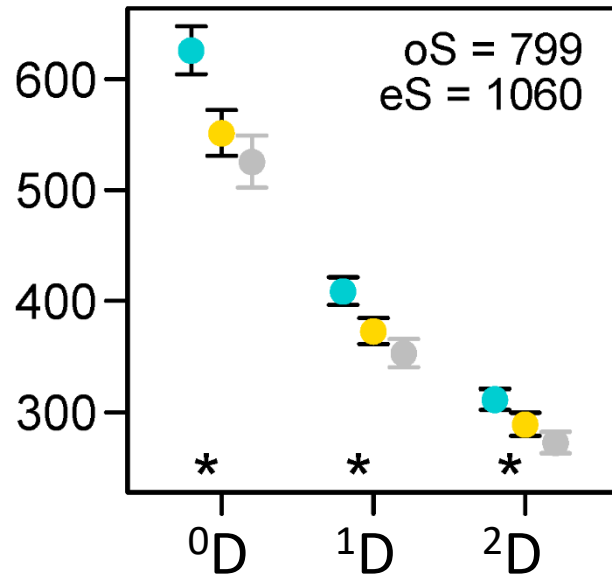
Species accumulation...

...to quantify landscape
level diversity.

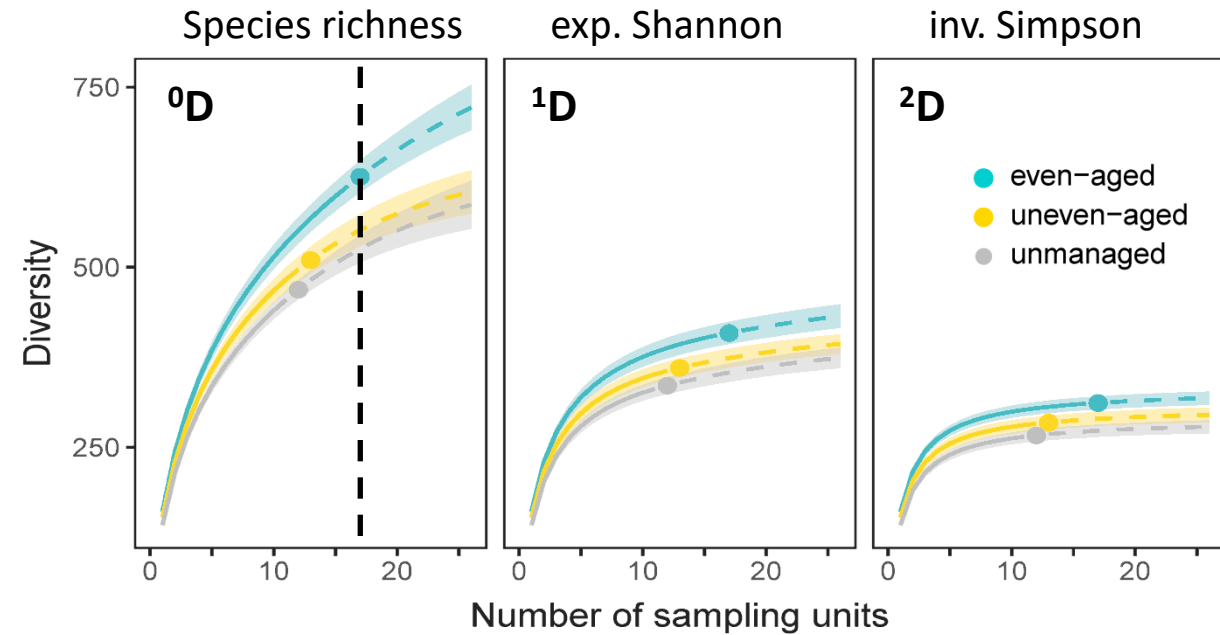


Gamma of beetles

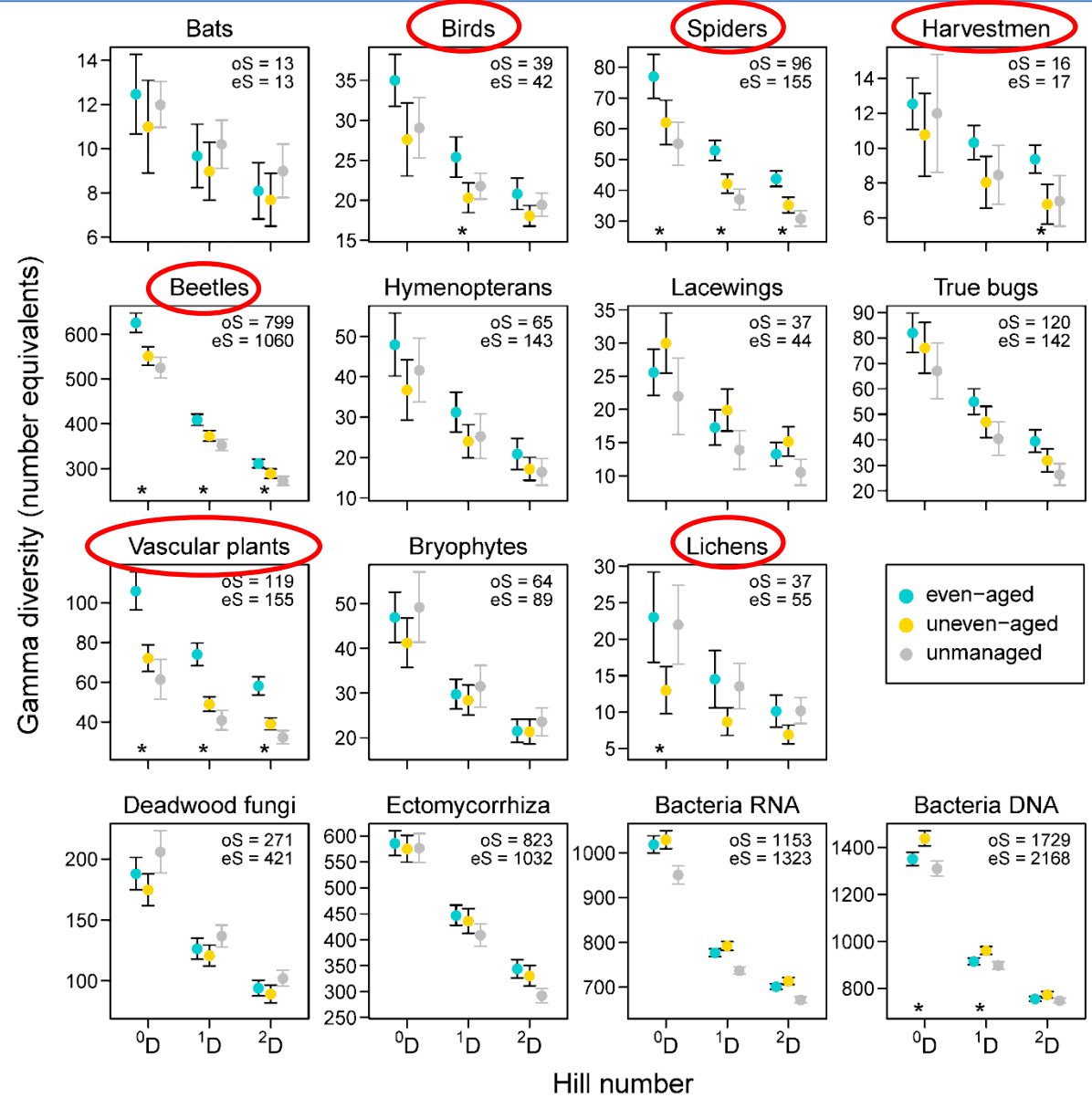
Result summary



Species accumulation curves



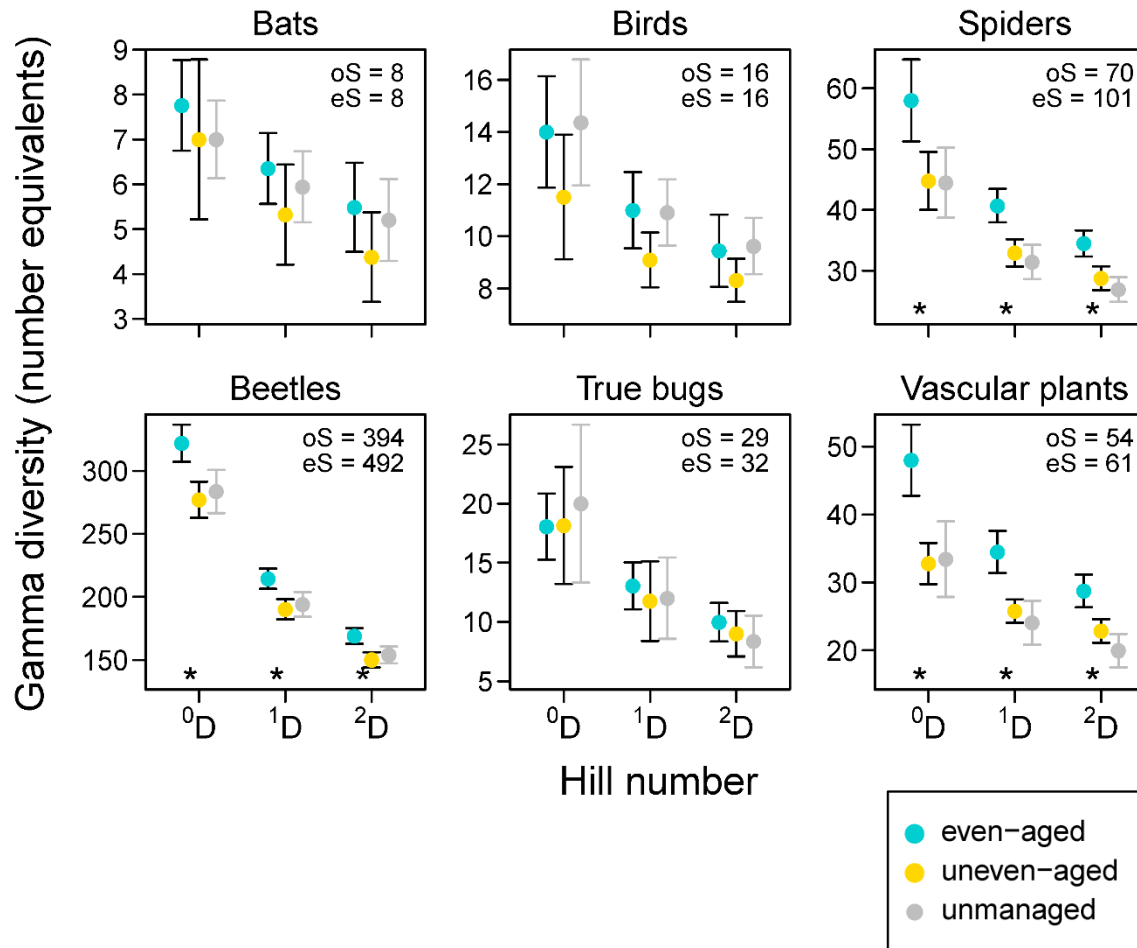
- In 6 out of 15 groups with higher gamma diversity in the even-aged system
- Rare and common species were affected similarly
- Lacewings and Bacteria (DNA) with higher gamma diversity in the uneven-aged system



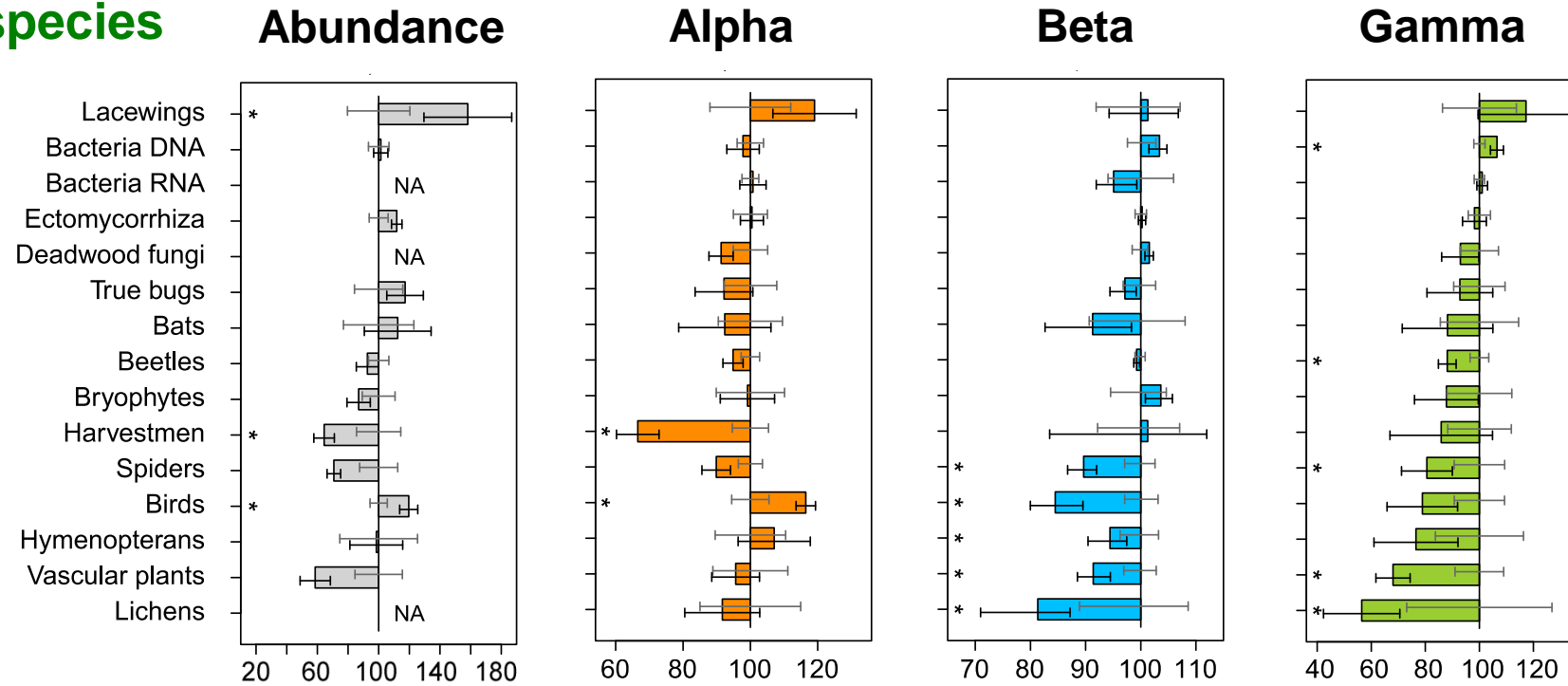
* Significant difference between even-aged and uneven-aged

- Higher gamma diversity in EA also for forest specialists.

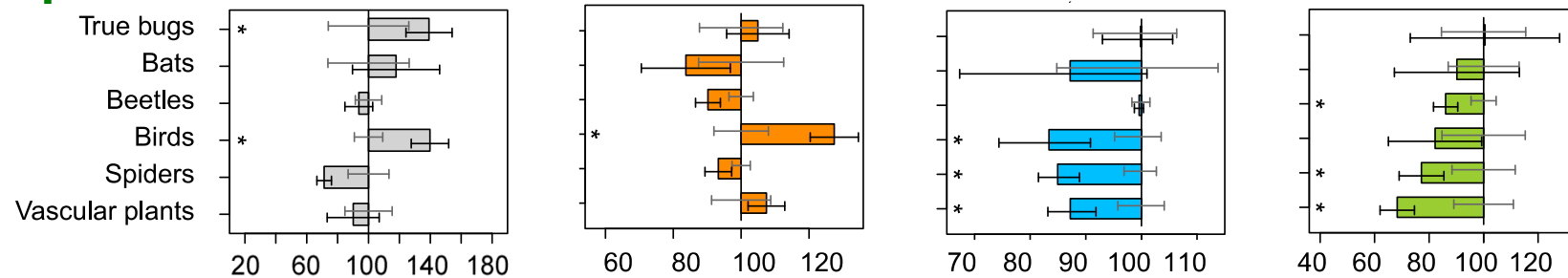
Forests specialists



All species

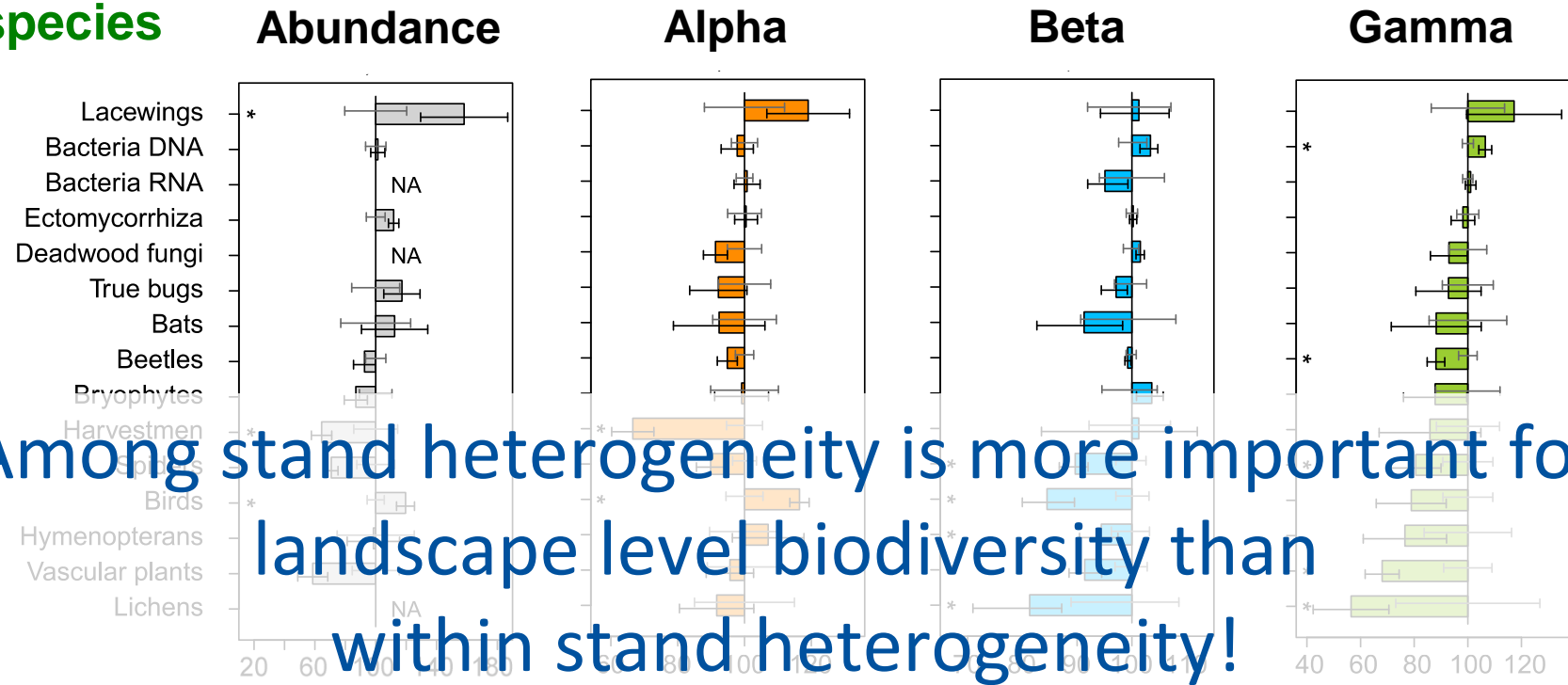


Forest specialists



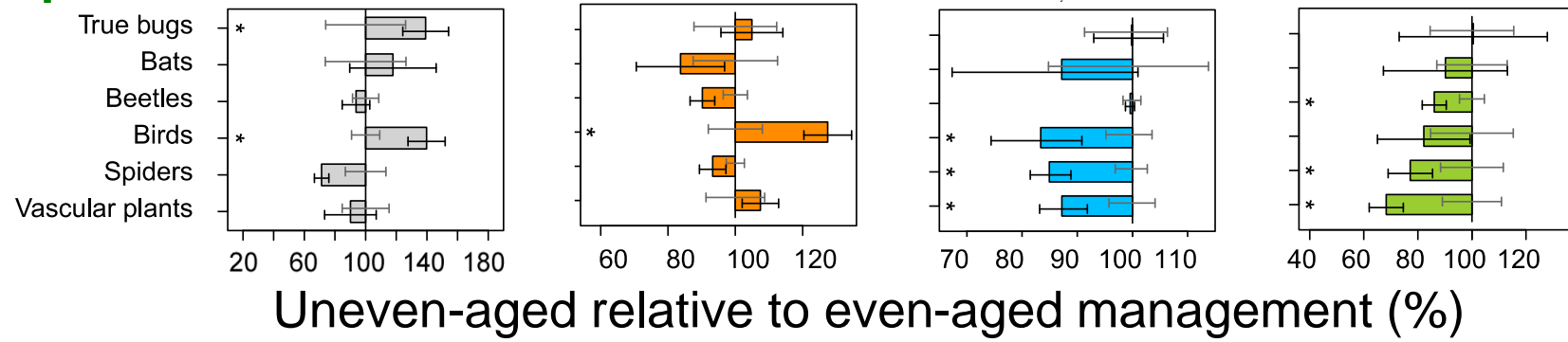
Uneven-aged relative to even-aged management (%)

All species

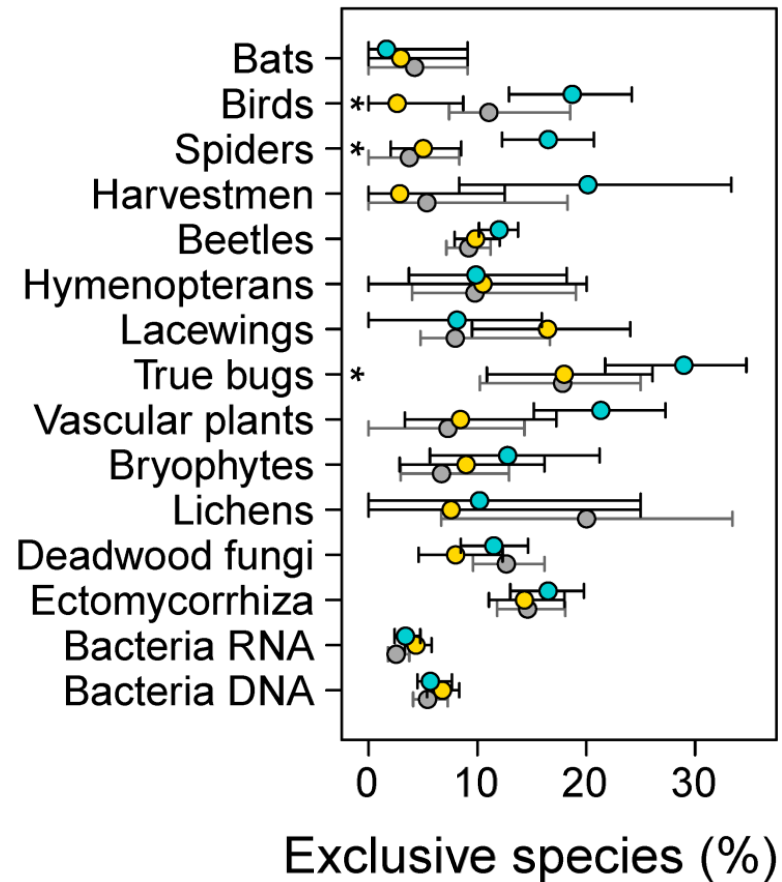


Among stand heterogeneity is more important for landscape level biodiversity than within stand heterogeneity!

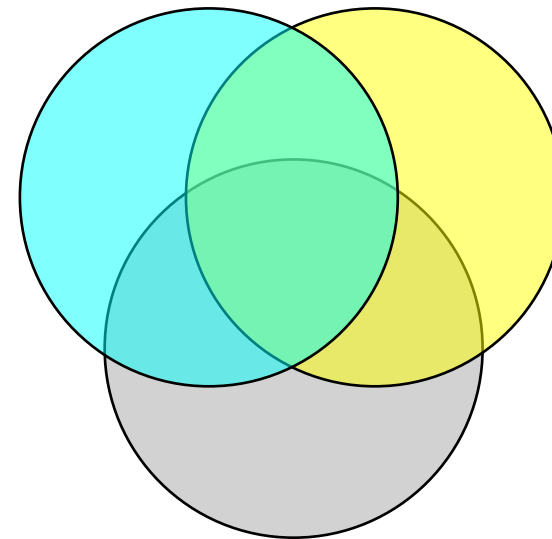
Forest specialists



But there is some complementarity between communities of management systems.



Is it “perfect” complementarity?



How should a managed forest landscape look like to support biodiversity?

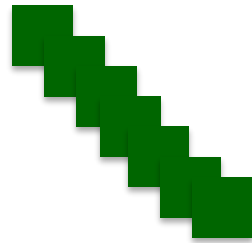


~~Even aged forest (Share ?)~~ + No management (Share ?) + Uneven-aged forest (Share ?)

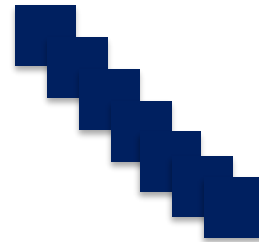
Is a mixture of uneven-aged forests and unmanaged forests effective for biodiversity conservation?

3 Forest management systems of European beech mixed in different proportions

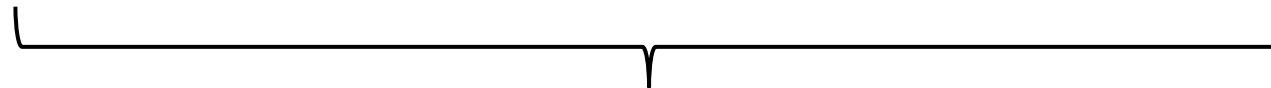
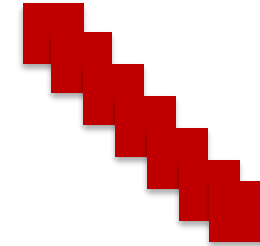
N = 17 plots



N = 13 plots



N = 13 plots



Gamma Diversity of „hypothetic forest landscapes“

- 66 different compositions of 10 plots
- 1000 repetitions



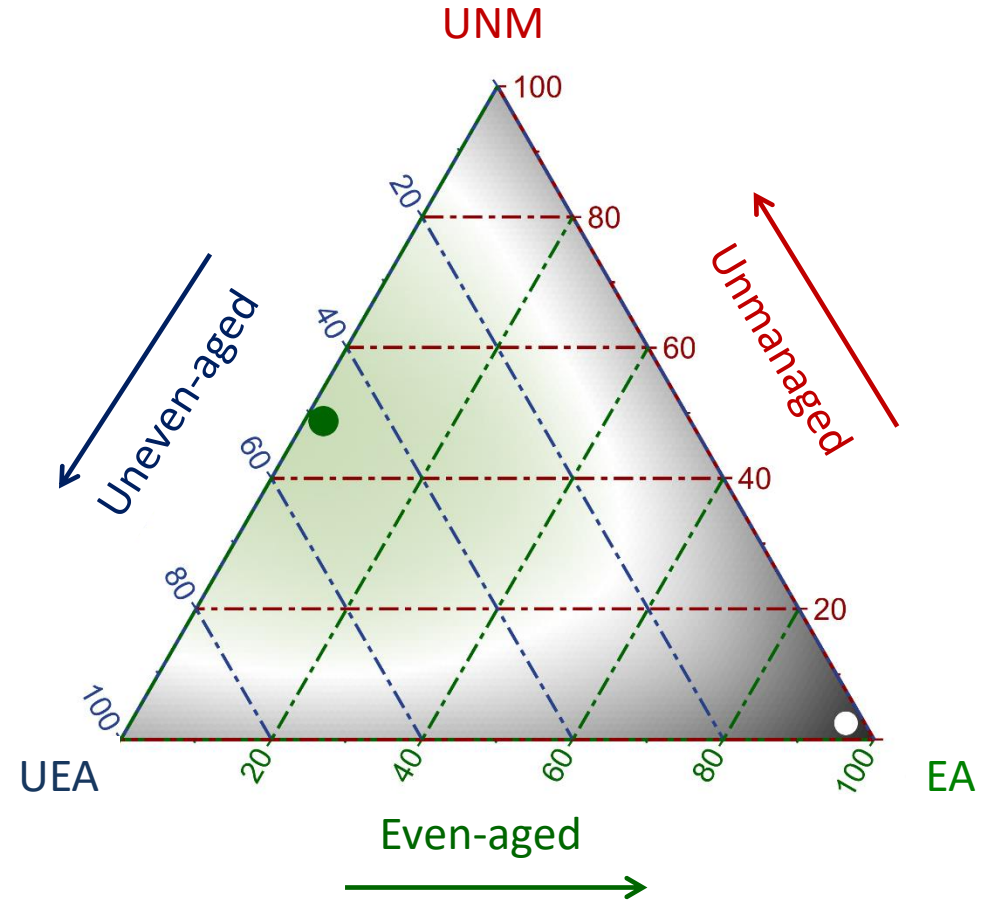
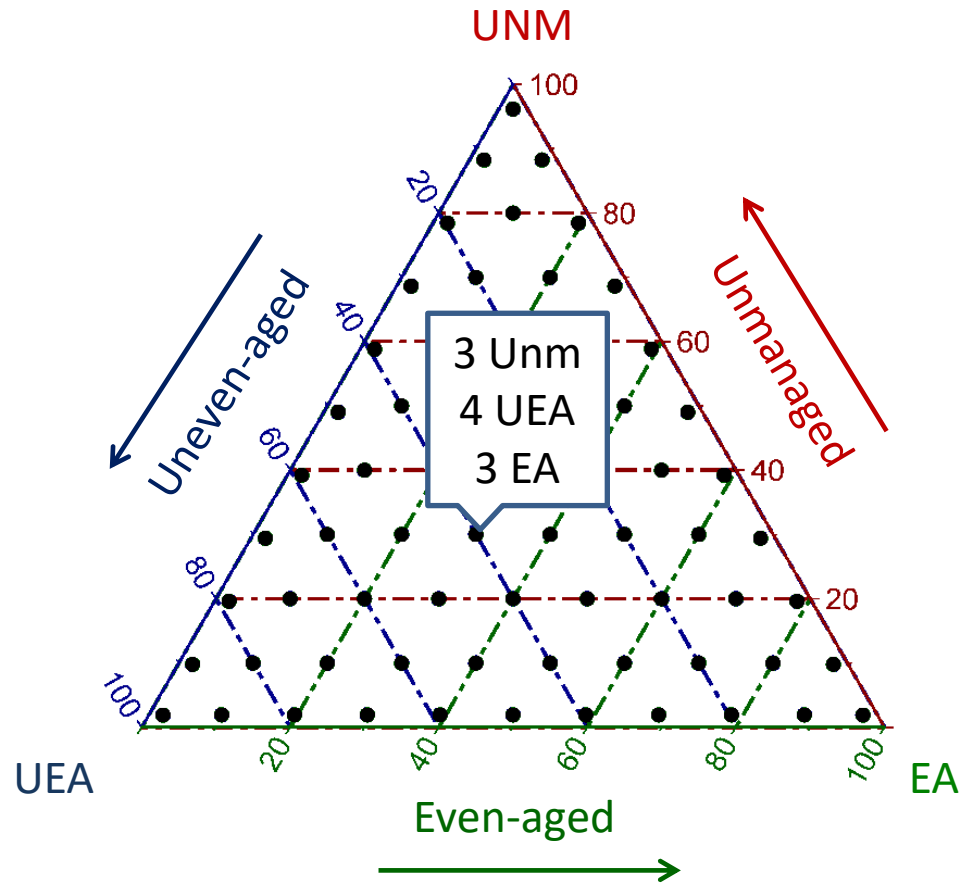
Even-aged forest (EA)



Uneven-aged forest (UEA)



Unmanaged (20 to ca. 40(50) y; Unm)



Bats



Birds



Lacewings



Beetles



Spiders



Hymenopterans



True Bugs



Harvestmen



Vascular plants



Lichens



Bryophytes



Deadwood fungi



Bacteria



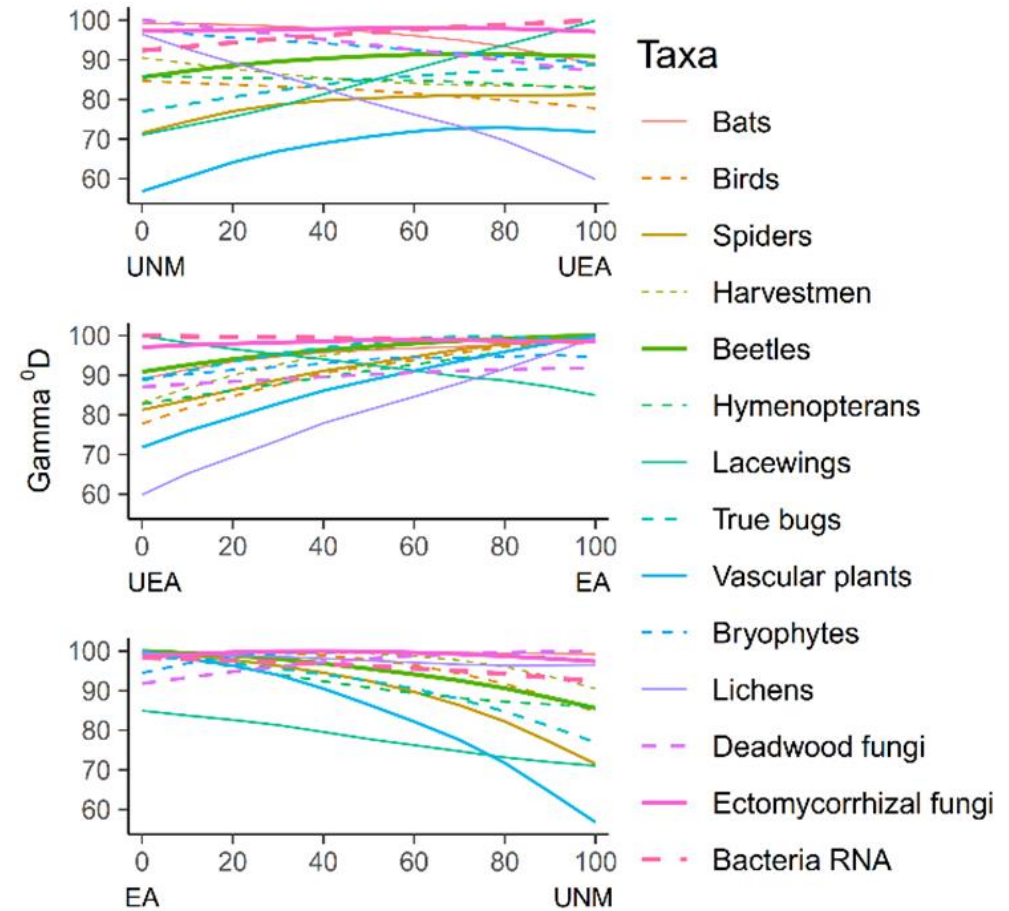
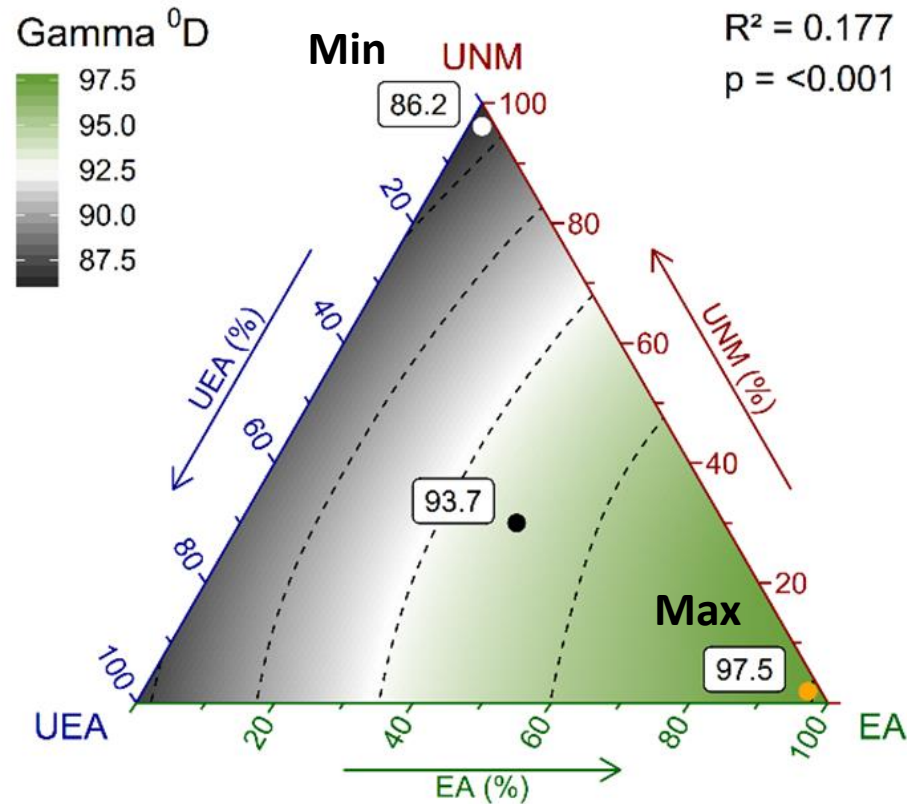
Ektomycorrhizal fungi



Multidiversity

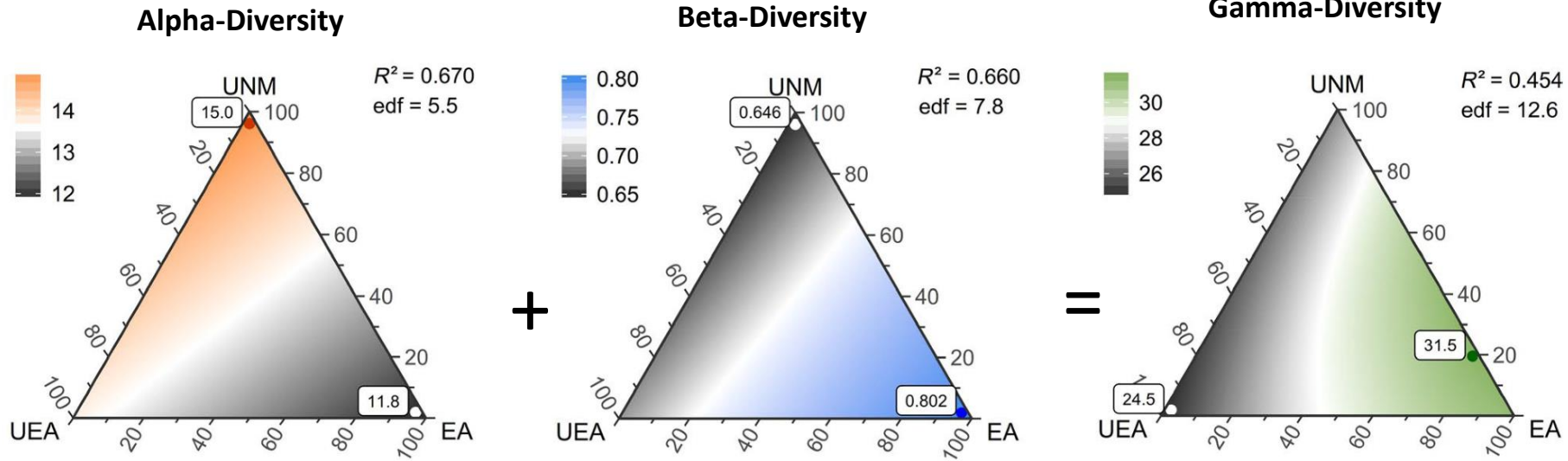
(sensu Allan et al. 2014)

Multidiversity in %

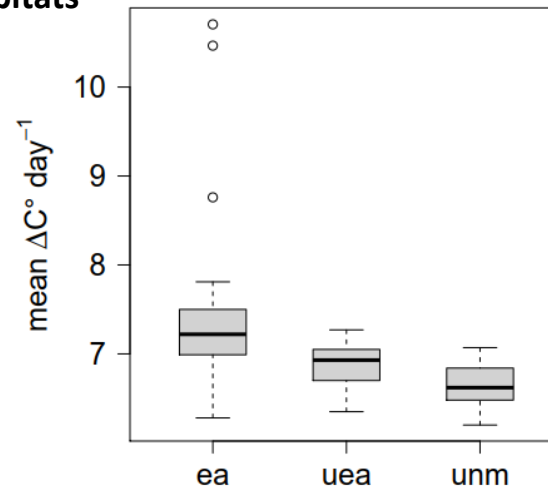
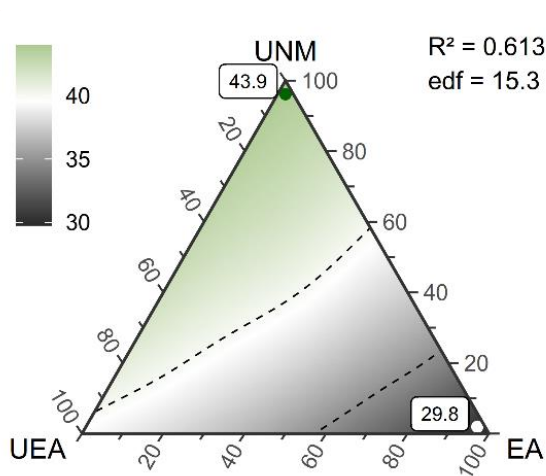


● Current composition of management systems

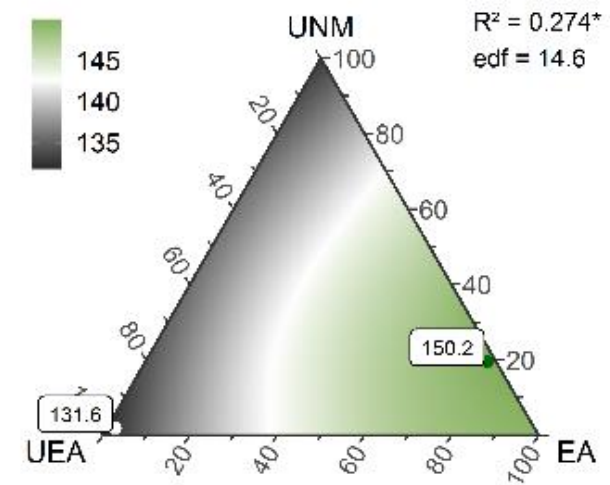
Forest specialists showed a similar pattern (minimum in UEA)!

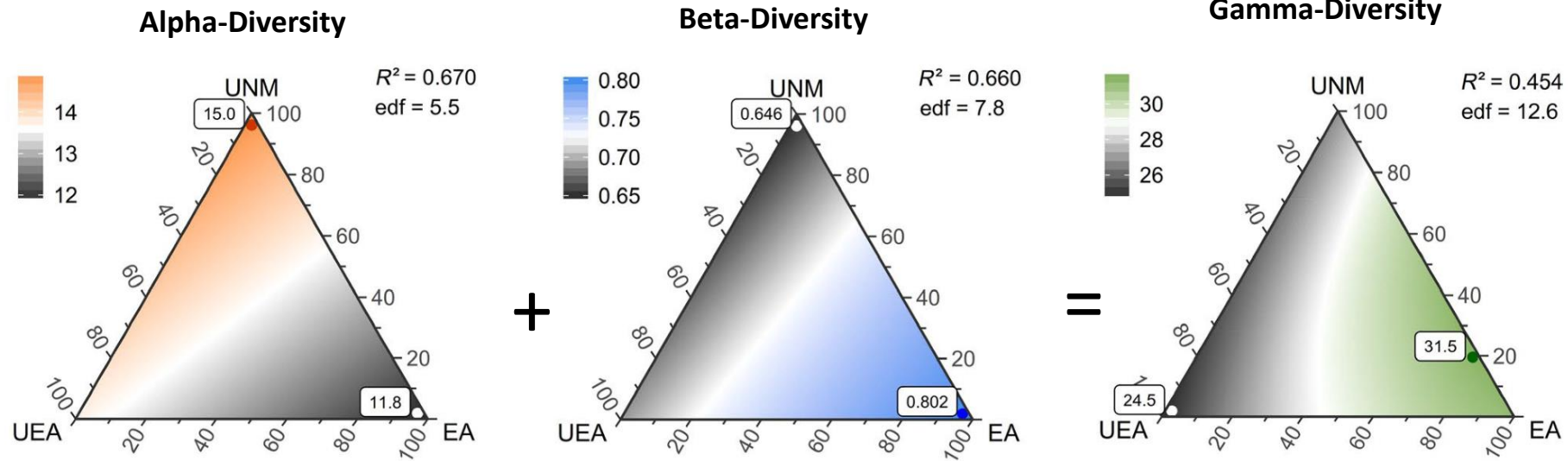


Gamma-diversity of tree-related microhabitats

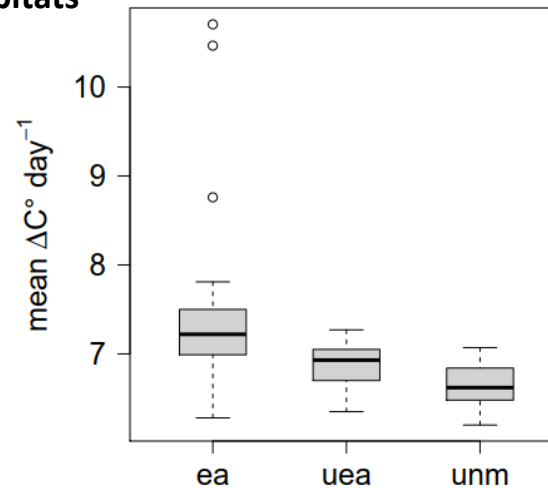
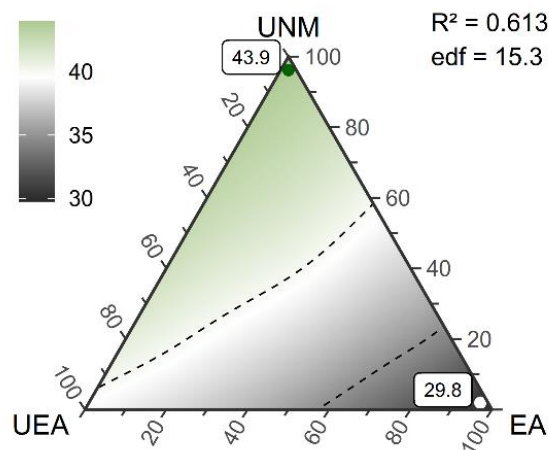


Saproxylic beetles





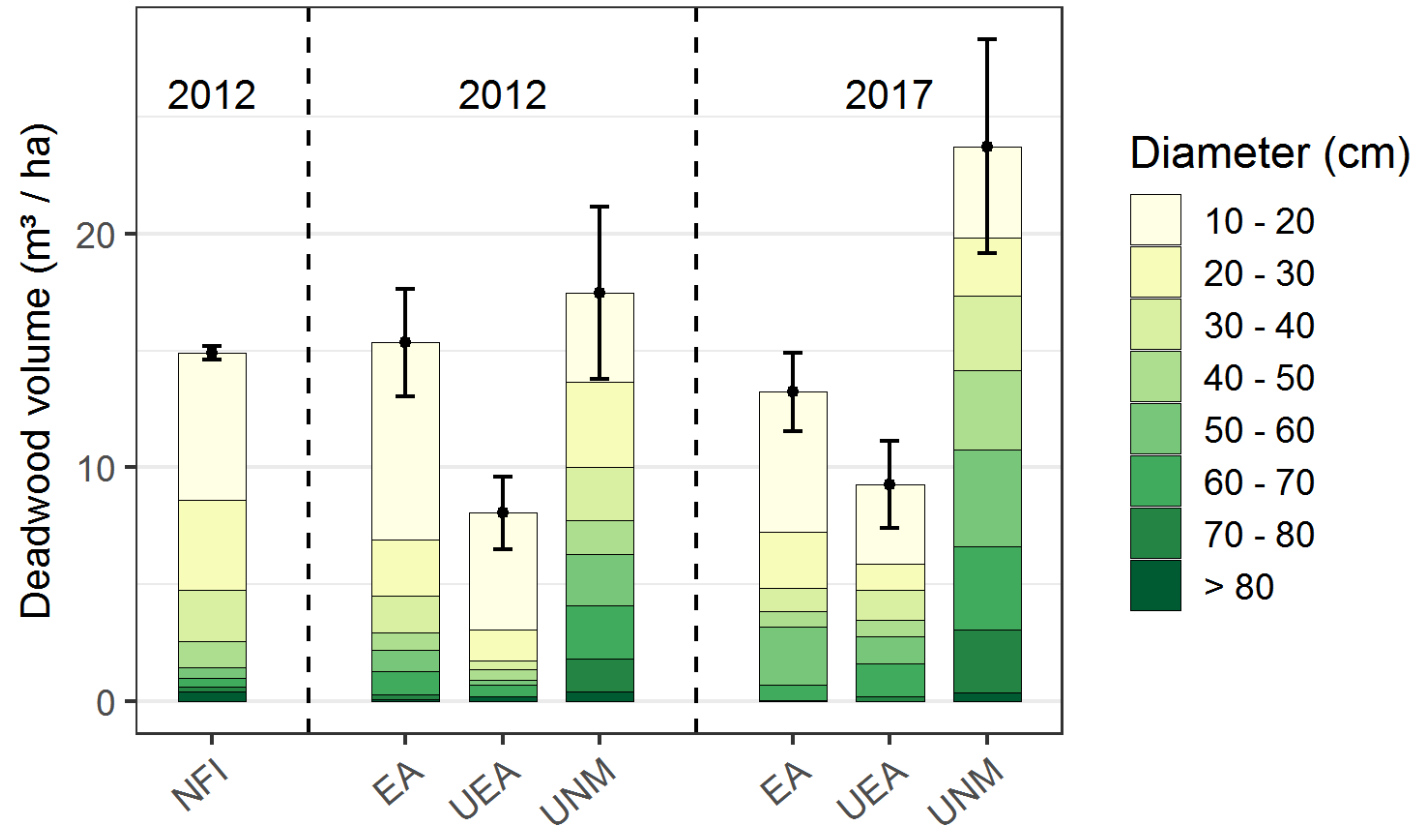
Gamma-diversity of tree-related microhabitats



Between stand heterogeneity within the EA system drives species diversity.

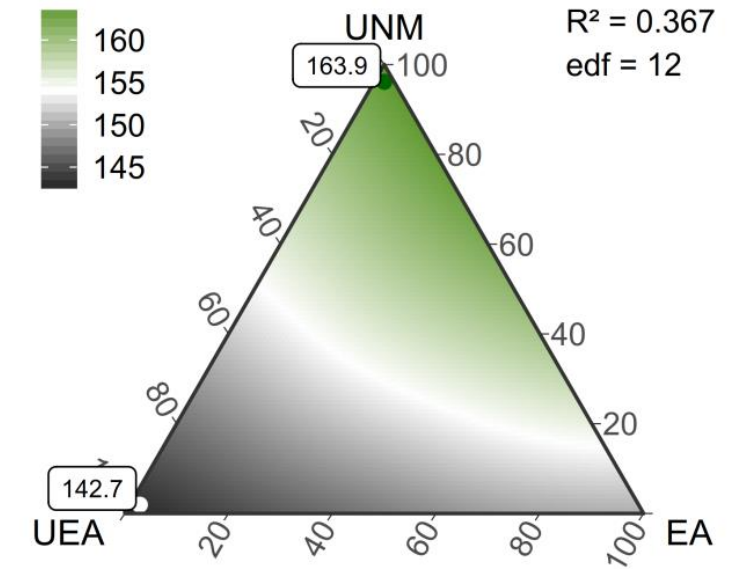
This heterogeneity is supplemented by structures of the unmanaged forests.

Deadwood amount in the Biodiversity Exploratories



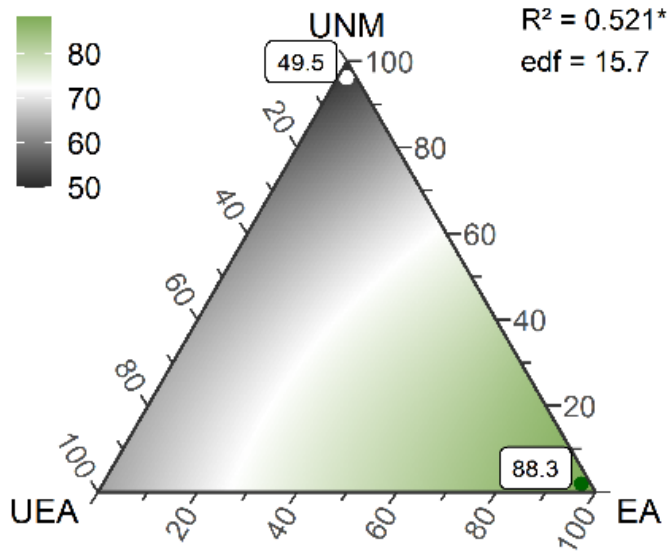
Gamma diversity of

Deadwood fungi

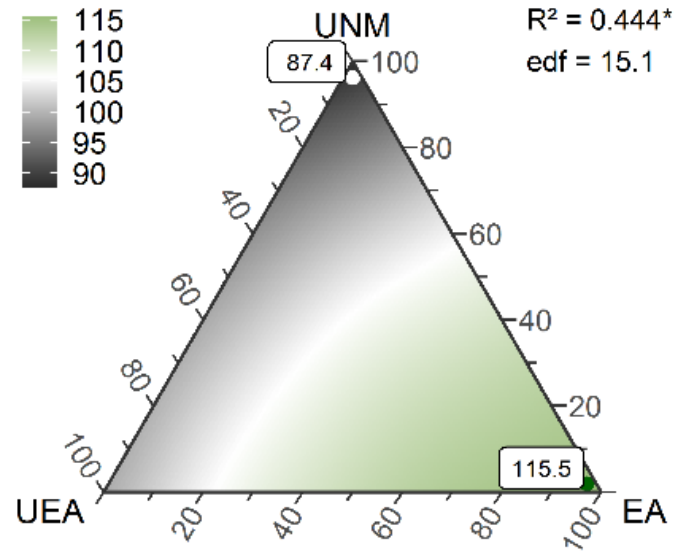


Specialized taxa benefit from conditions in forest reserves –
Deadwood dependent food chain

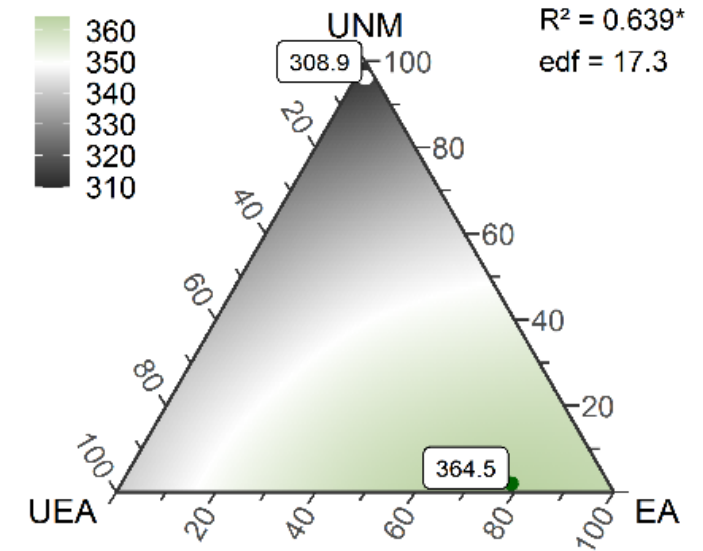
Vascular plants



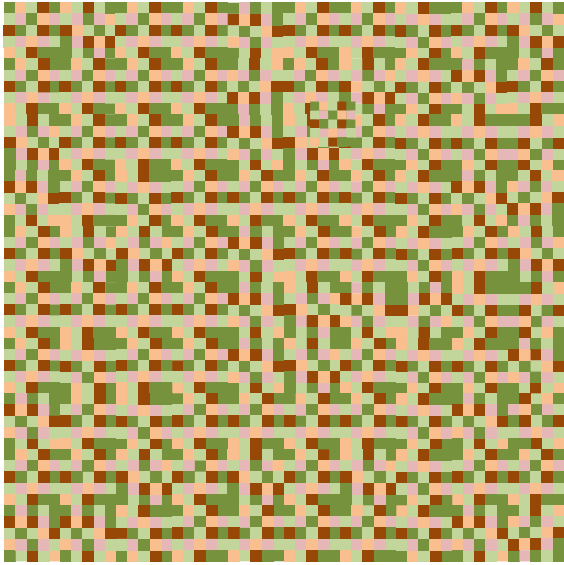
Herbivorous arthropods



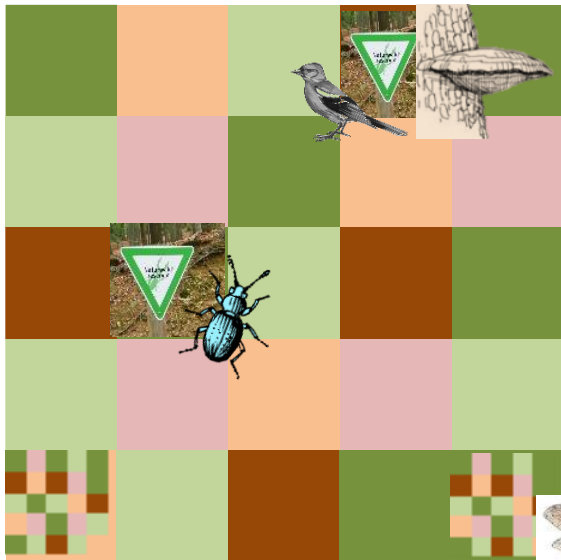
Carnivorous arthropods



The response of primary producers cascades up to higher trophic levels –
Herb layer dependent food chain



- Forest management per se is not negative for biodiversity in temperate beech forests.
- The complete focus on a small-scale heterogeneity within stands creating uneven-aged forests is not beneficial for the conservation of biodiversity in managed forest landscapes.
- On the other hand, management systems that create a heterogeneity in environmental conditions at a larger scale promote biodiversity.
- In such a landscape, the integration of unmanaged forests as a specialized habitat is important for specialized groups.
- Its importance will presumably increase with time since management abandonment.



Diversity creates diversity!





Photo: Steffi Heinrichs

Thank You!

Thanks to the Biodiversity
Exploratories

PHD students
Management teams

Technicians

Student helpers

Taxonomic
experts

BEO, BExIS

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