Effect of habitat availability on small scale distribution of diversity and processes in tree-related microhabitats in primeval and managed beech-dominated forests

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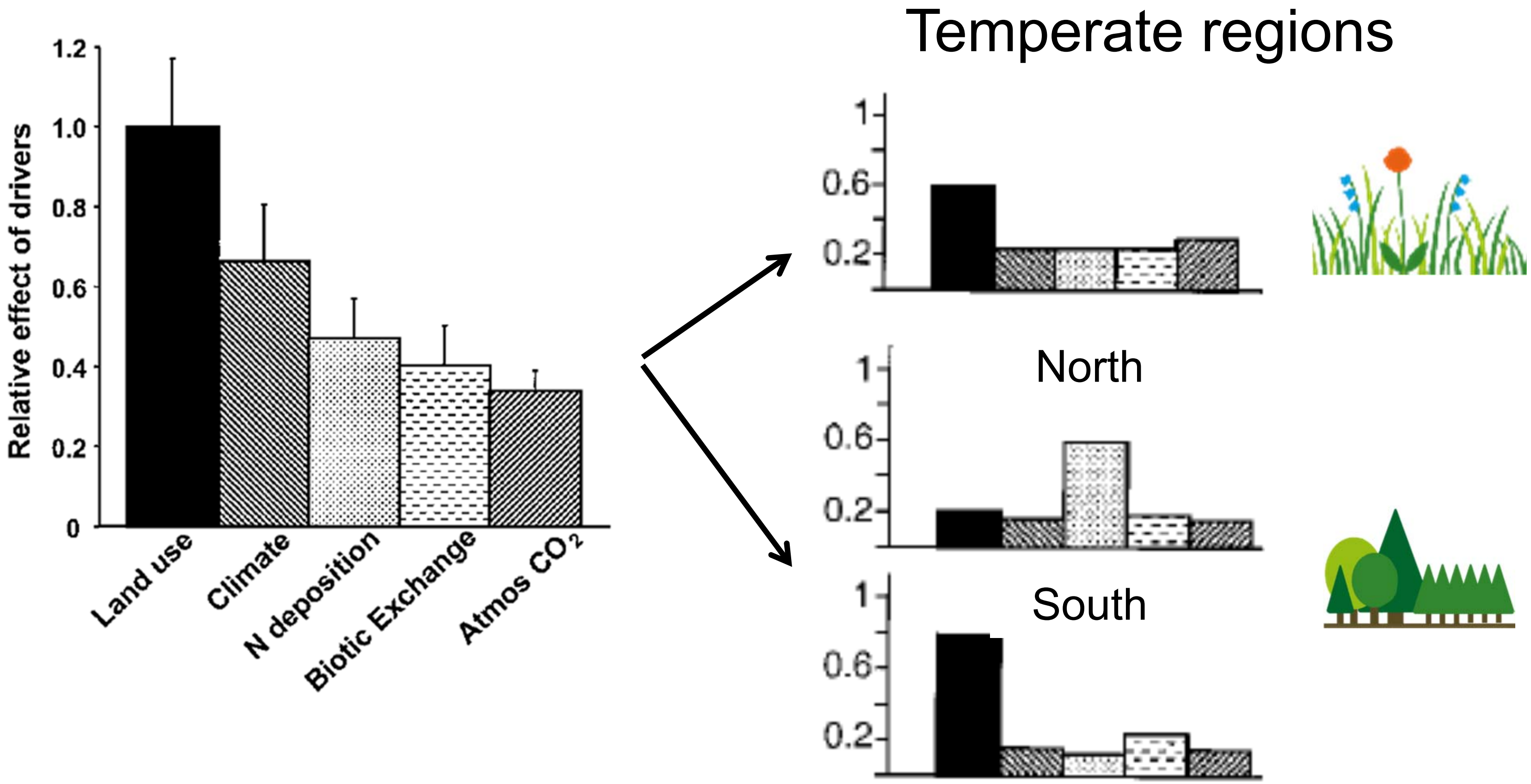
Temperate and Boreal Primeval Forests in the Face of Global Change, Lviv, Ukraine, 2-8.9.2019

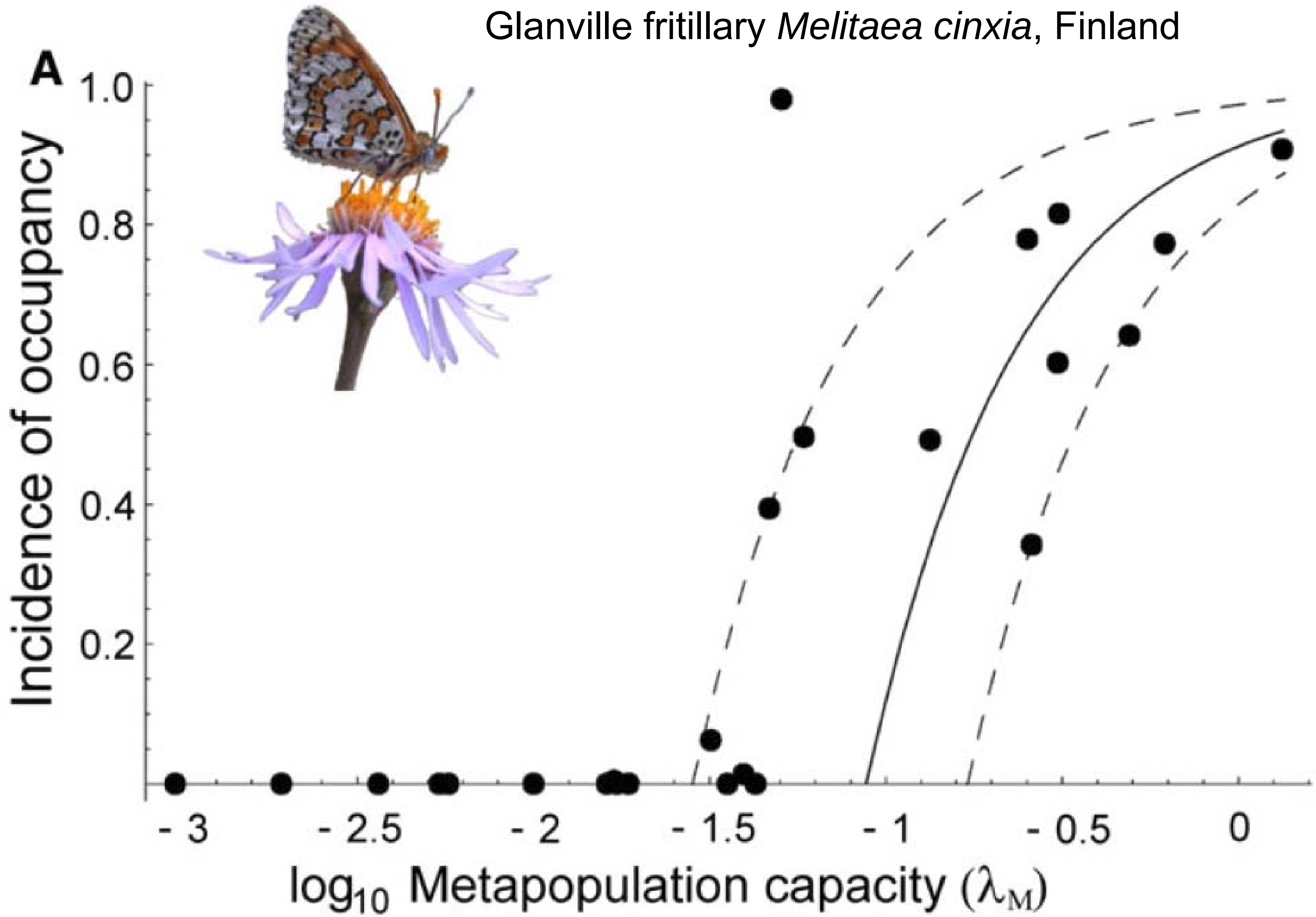
Main global drivers of biodiversity loss



Sala et al. (2000): *Science* 287, 1770-1774.

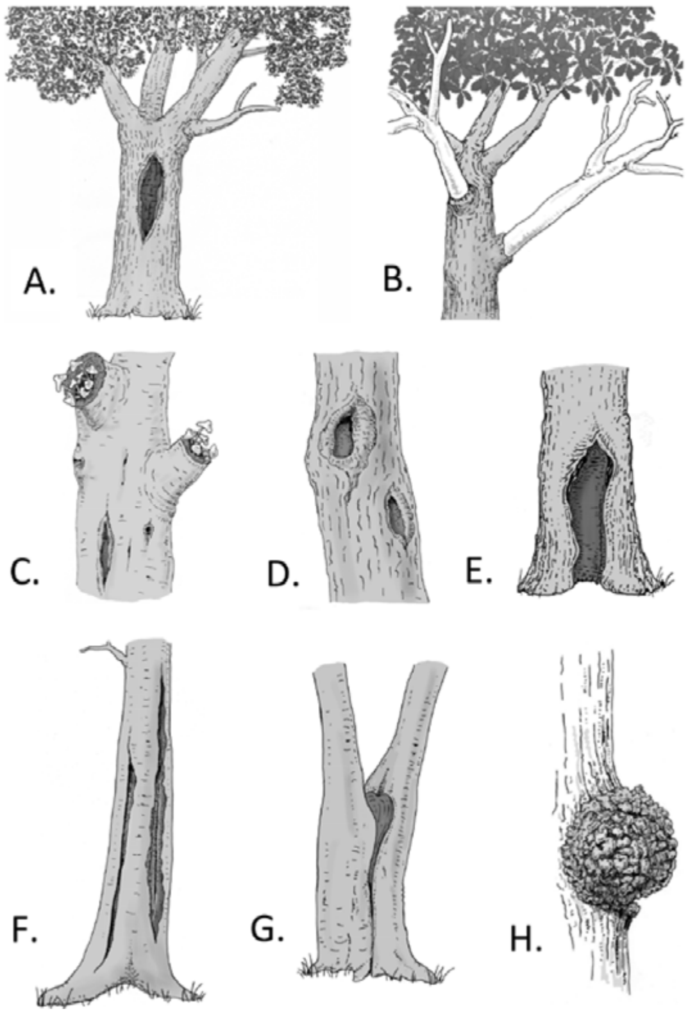
Habitat loss and species diversity

Glanville fritillary *Melitaea cinxia*, Finland



Hanski (2011): *Ambio* 40 (3):248-255

Tree-related microhabitats (TreMs) as model system



Hermit beetle
(*Osmoderma eremita*)

Violet click beetle
(*Limoniscus violaceus*)

Scirtidae
(*Prionocyphon serricornis*)

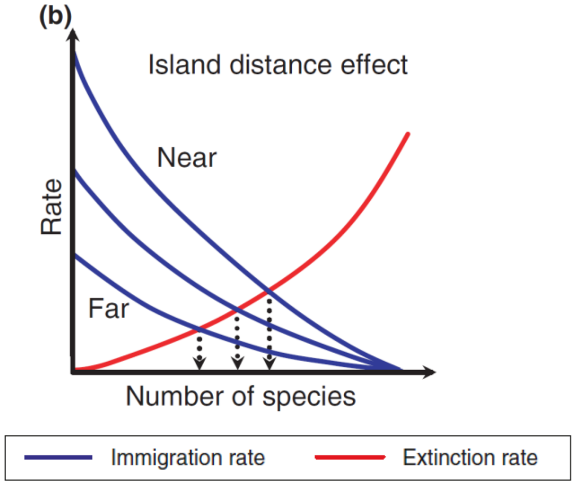
A. Bark loss; B. Crown deadwood; C. Fruiting bodies of saproxylic fungi; D. Trunk rot-hole; E. Trunk base rot-hole; F. Cracks; G. Fork split; H. Burr

Larrieu et al. (2018) Ecol Indic 84:194-207.

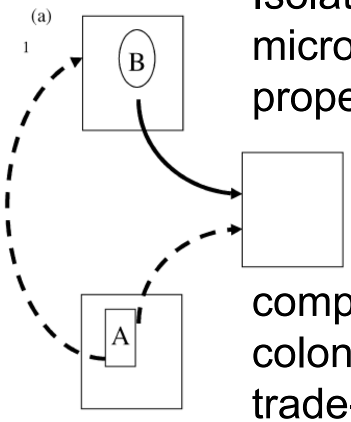
Spatial and community dynamics in TreMs

Five paradigms for metacommunity theory

Island biogeography



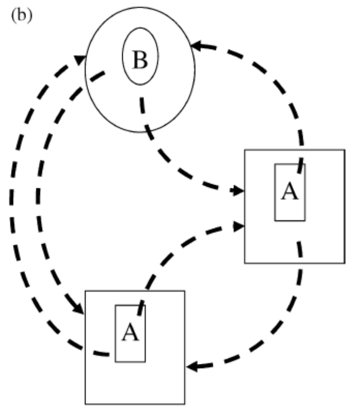
Patch-dynamics



Isolation & microhabitat properties important

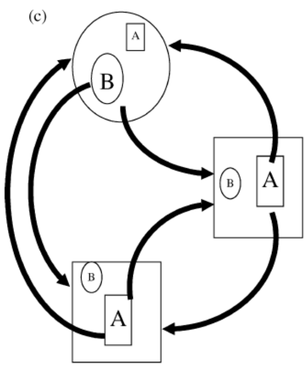
competition-colonization trade-off

Species sorting



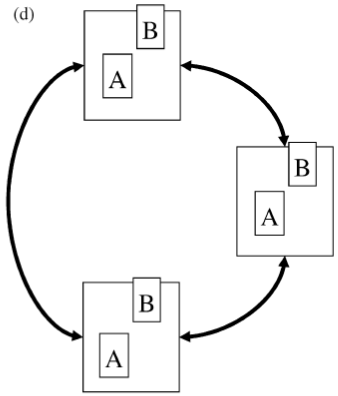
Only microhabitat properties important

Mass-effects



All species persist in sources and sinks
Abundance and species richness unaffected
Composition depends on microhabitat properties

Neutral



Independent of isolation and microhabitat properties

Leibold et al. (2004) Ecol Lett 7 (7):601-613.; Warren et- al (2015)) Ecol Lett 18 (2):200-217.

Research questions

(1) Do small scale differences in habitat availability affect the diversity and composition of organisms developing in TreMs?

→ reduced habitat availability decreases abundance and diversity and change community composition (H1a)

→ spatial effects are more important than niche difference (H1b)

(2) Does this translate into a change in related processes?

→ lower abundance and diversity result in lower decomposition rates (H2)

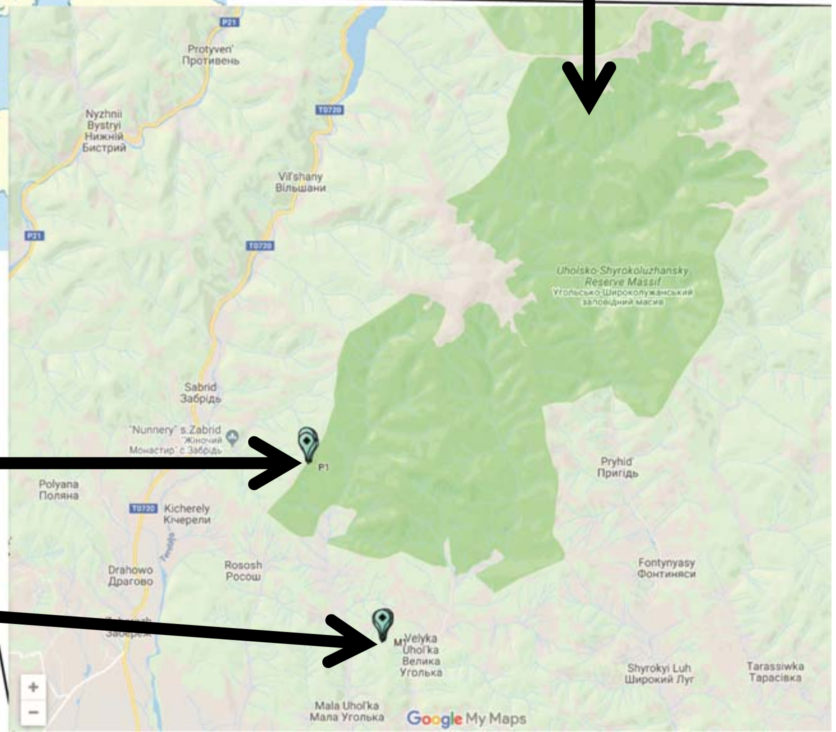
(3) Are these relationships affected by management?

→ Spatial effects are more important in managed forests due to less well connected microhabitats (H3a)

→ Biodiversity-Decomposition relationships are less steep in managed forests due to functionally impoverished community (H3b)

Study sites

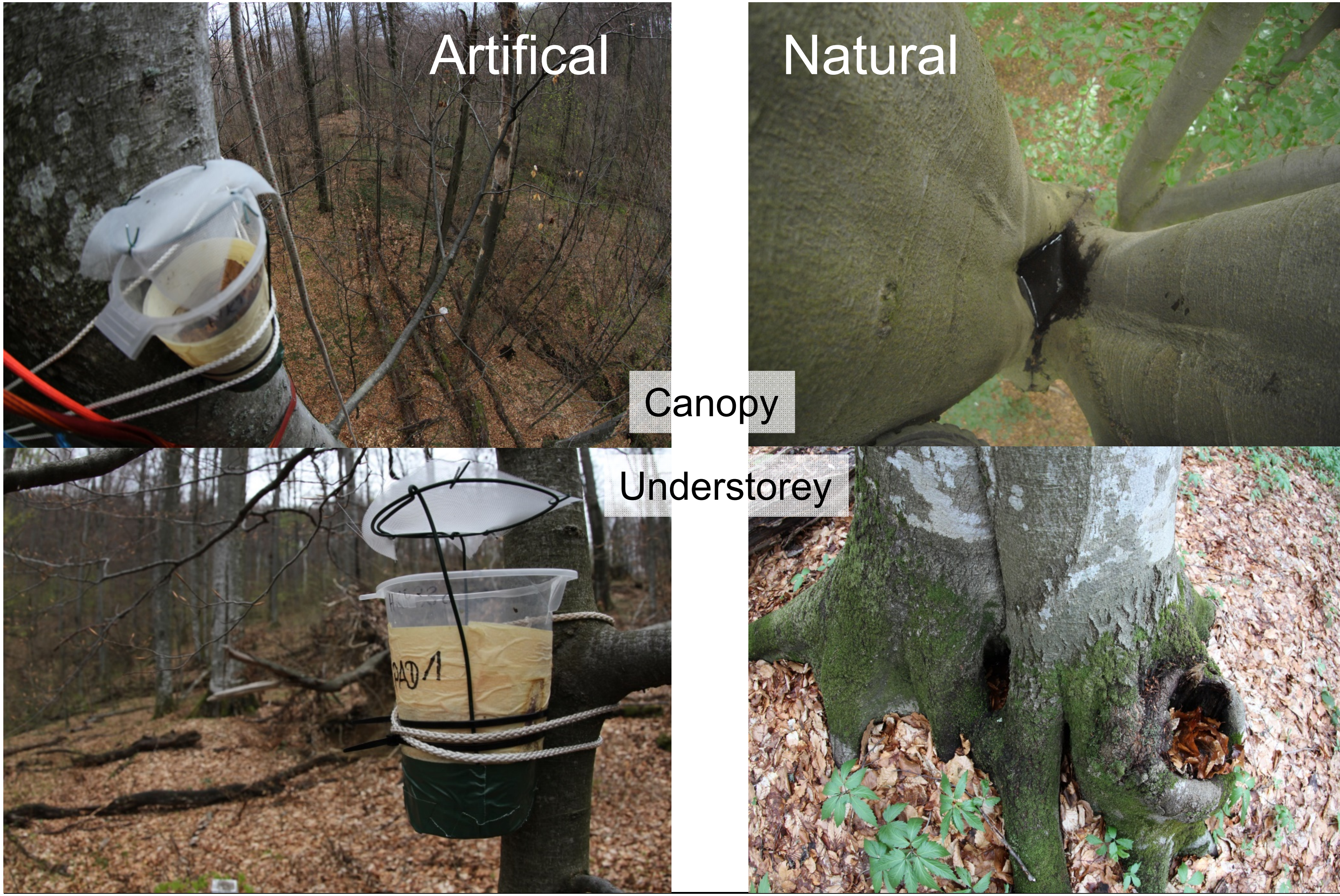
Uholka-Shyrokyi *Luh* reserve



2 sites of 10ha

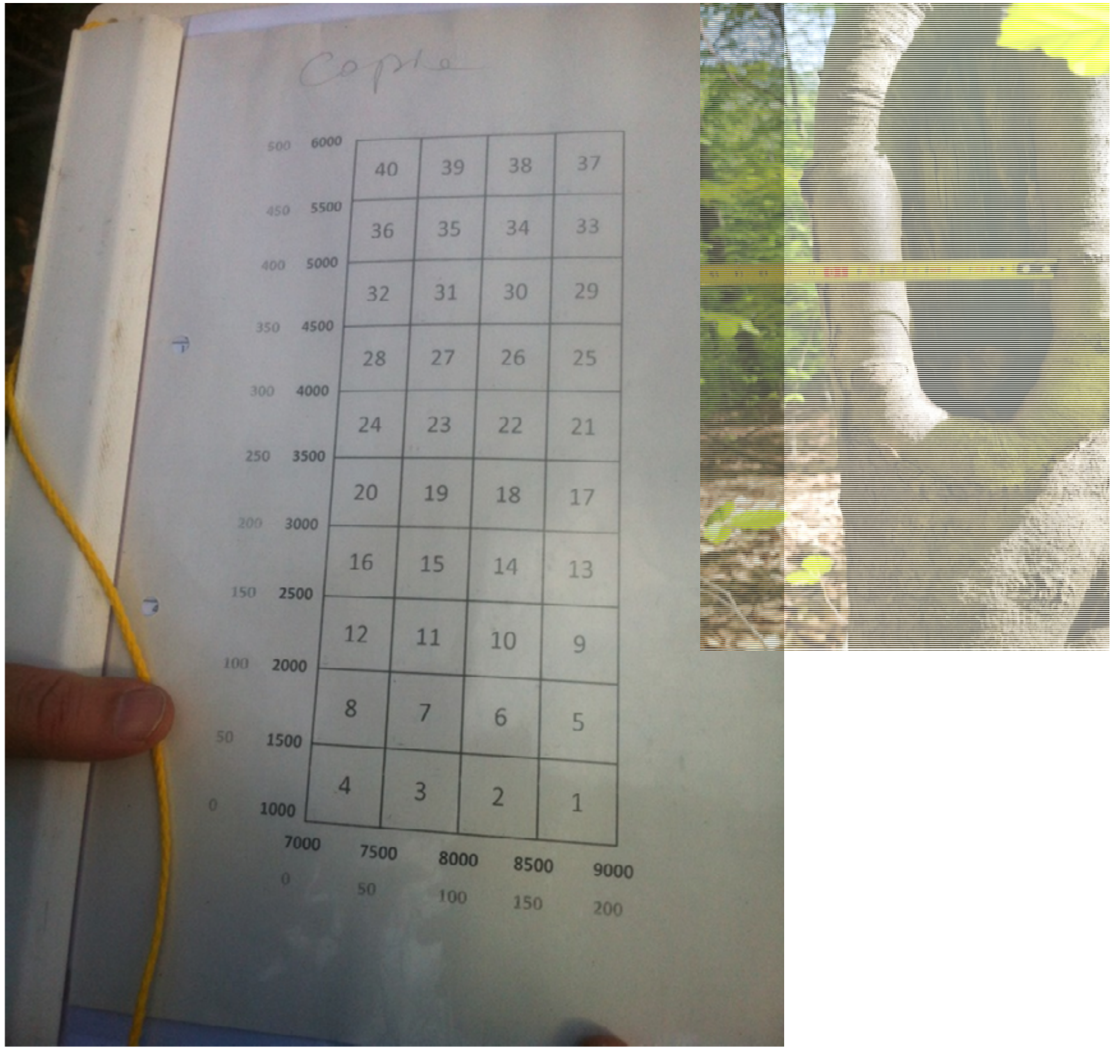
- Primeval forest (Mala Uholka)
- Managed forest (Velika Uholka)

Study system – water-filled tree holes (primeval/managed)



Study system – rot holes (primeval only)

Methods – mapping TreMs



All tree holes of the 10ha plots were mapped

Parameters assessed:

Tree scale

- coordinates
- dbH [cm]
- Tree species

Tree-hole scale

- TH origin **W**
- TH type (pan, rot hole; dry/water-filled) **W**
- Height above ground **W/R**
- Size (Volume) **W/R**
- developmental stage **R**
- Ground contact **R**

Methods – sampling rot holes

- 58 rot holes
- Covered with black material
- Opening to sampling jar
- Two years
- Species identification in the lab

Methods – sampling natural water-filled tree holes

- 27 tree holes at each forest site
- June 2017/2018
- Measuring water volume, pH, O_2, temperature
- Complete sampling of tree hole content
- Measuring detritus amount
- Identification to species or morphospecies

Methods – sampling artificial water-filled tree holes

Dried beech leaves

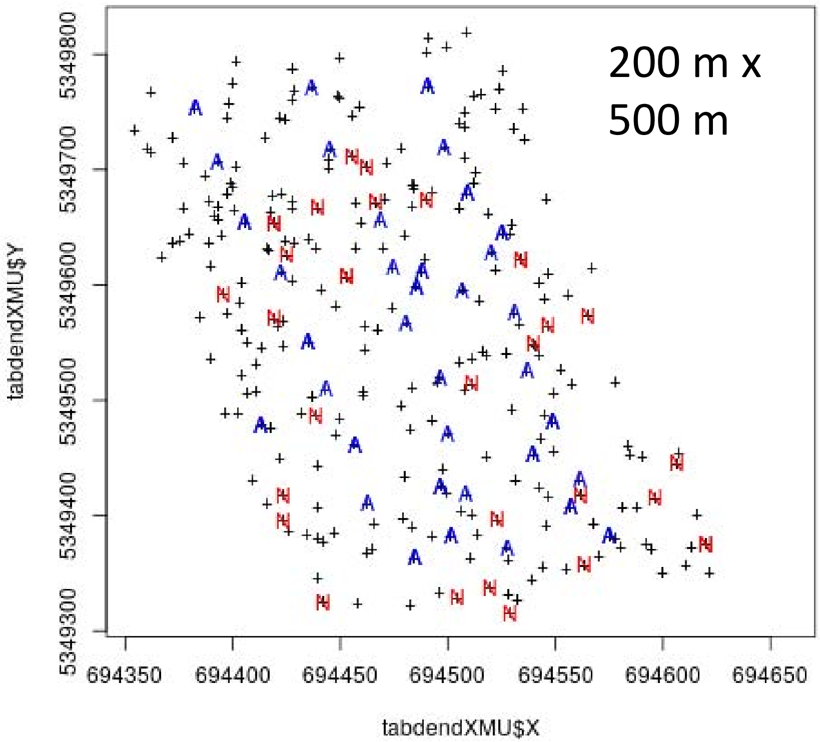
- 27 tree holes at each forest site
  + 8 understorey and canopy
- April-July 2017/2018
- Installation in a regular grid
- Defined water volume (600ml)
- Defined detritus amount (2mg)
- Roof to avoid detritus input
- Identification to (morpho-)species
- Measuring decomposition

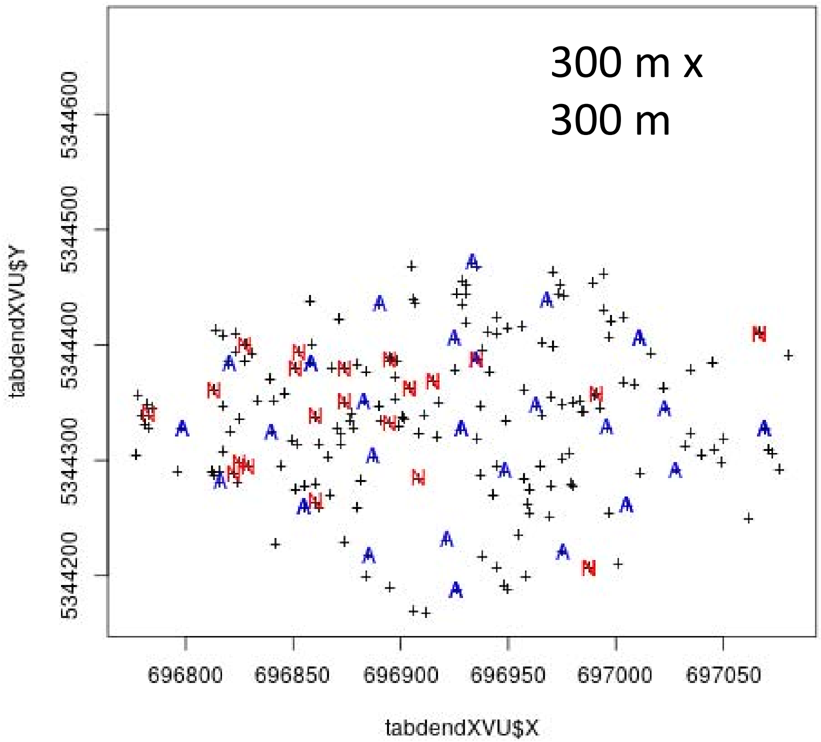
Spatial distribution water-filled tree holes

Primeval forest

A Artificial holes
N Natural holes
+ mapped holes

Managed forest





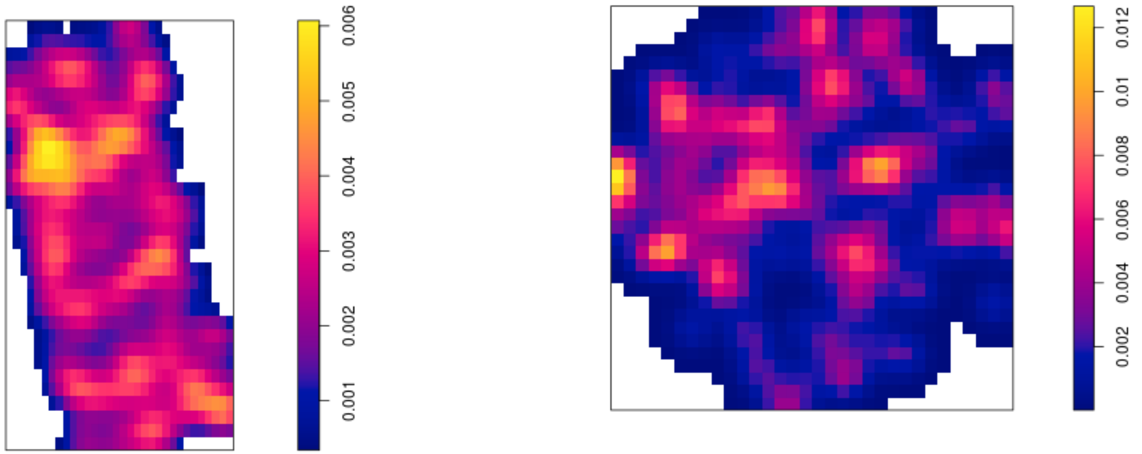
Total 358 dendrotelms
Average intensity 33.78 per ha

Total 271 dendrotelms
Average intensity 33.51 per ha

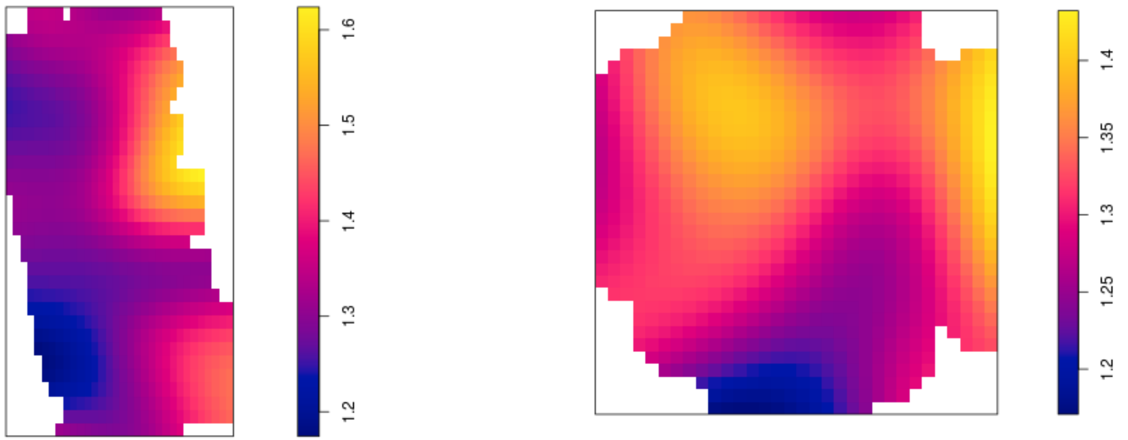
Density of water-filled tree holes

Primeval forest | **Managed forest**

denspat =
density of trees
with dendrotelms



densmoot =
density of
dendrotelms



Drivers of abundance and species richness

z/t-values	Abundance (Poisson GLM)				Species richness (ordinal regressions)			
	Artificial		Natural		Artificial		Natural	
	Primeval	Managed	Primeval	Managed	Primeval	Managed	Primeval	Managed
Intercept	-3.516 ***	2.117*	-3.242**	-	-			
pH	15.130***	-11.000***	3.136**	-	-	-2.132	1.508	-
Temperature	-5.928 ***	13.438***	-	-	-	1.408	-	-
O_2	-	-	-	-	-	-	1.490	-
Detritus_mg	-2.911**	-	4.948***	-	-	-	2.695	-
Height	32.034***	NA	-	-	-	-	-	-
Denspat	-3.652 ***	-5.704 **	-	-	-	-	-	-
Densmoot	2.656 **	2.693**	2.163*	-	-	1.453	1.532	-

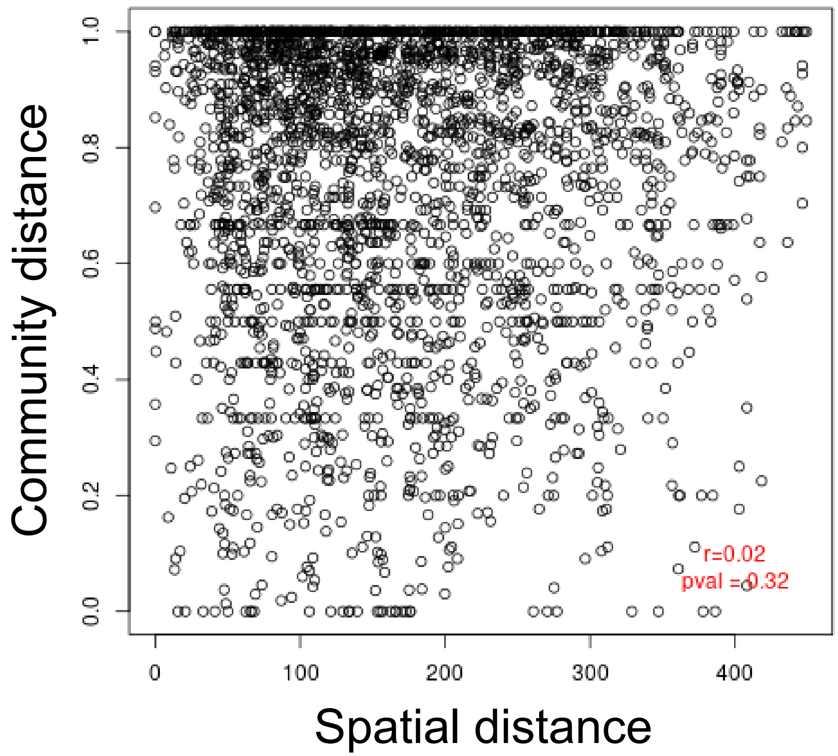
Denspat = density of trees which got dendrotelms
Densmoot = density of dendrotelms

Environment
Space

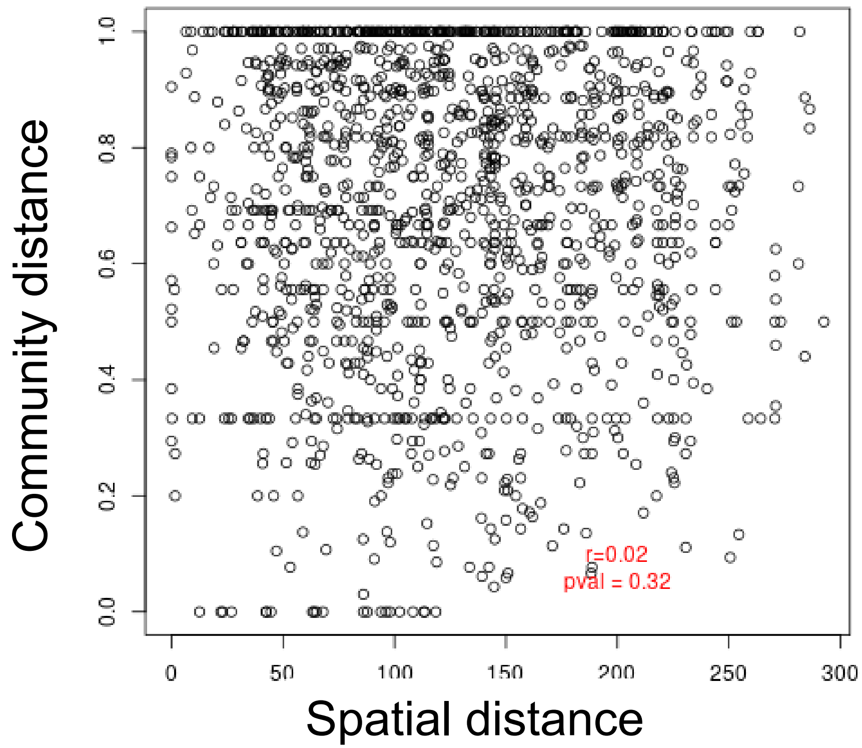
- Stepwise reduction of the models based on AIC
- Only significant parameters of the final model are shown

Habitat availability vs. community composition

Primeval forest

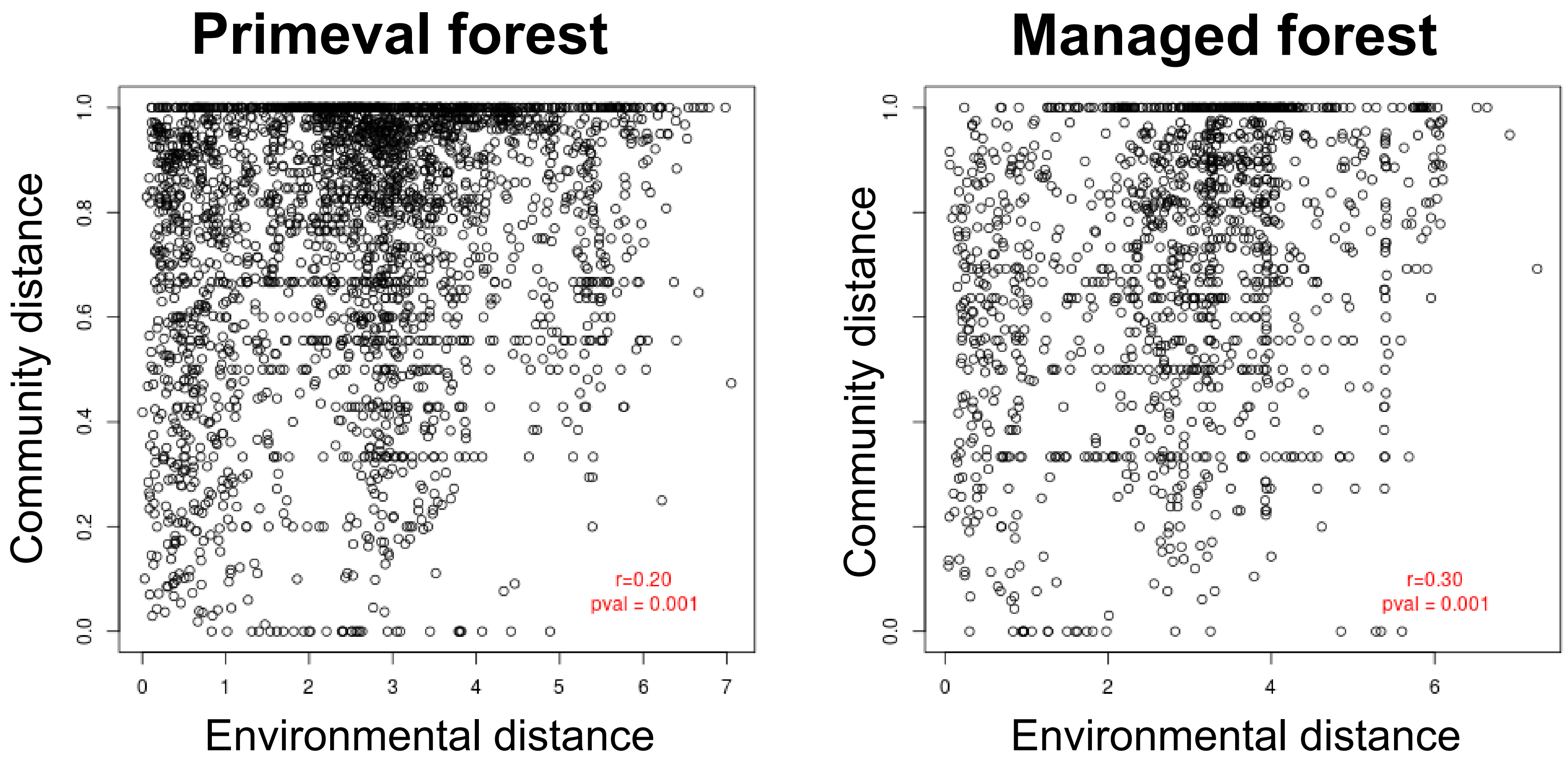


Managed forest



- Construction of a 3D-network where vertices are the observed dendrotelms
- We weighted the edges of the network with 3D-distances between dendrotelms
- We calculated distances (shortest paths on network) between sampled dendrotelms
- We compared these distances with Bray-Curtis community distance using a mantel test and evaluation of pval by permutation (999)

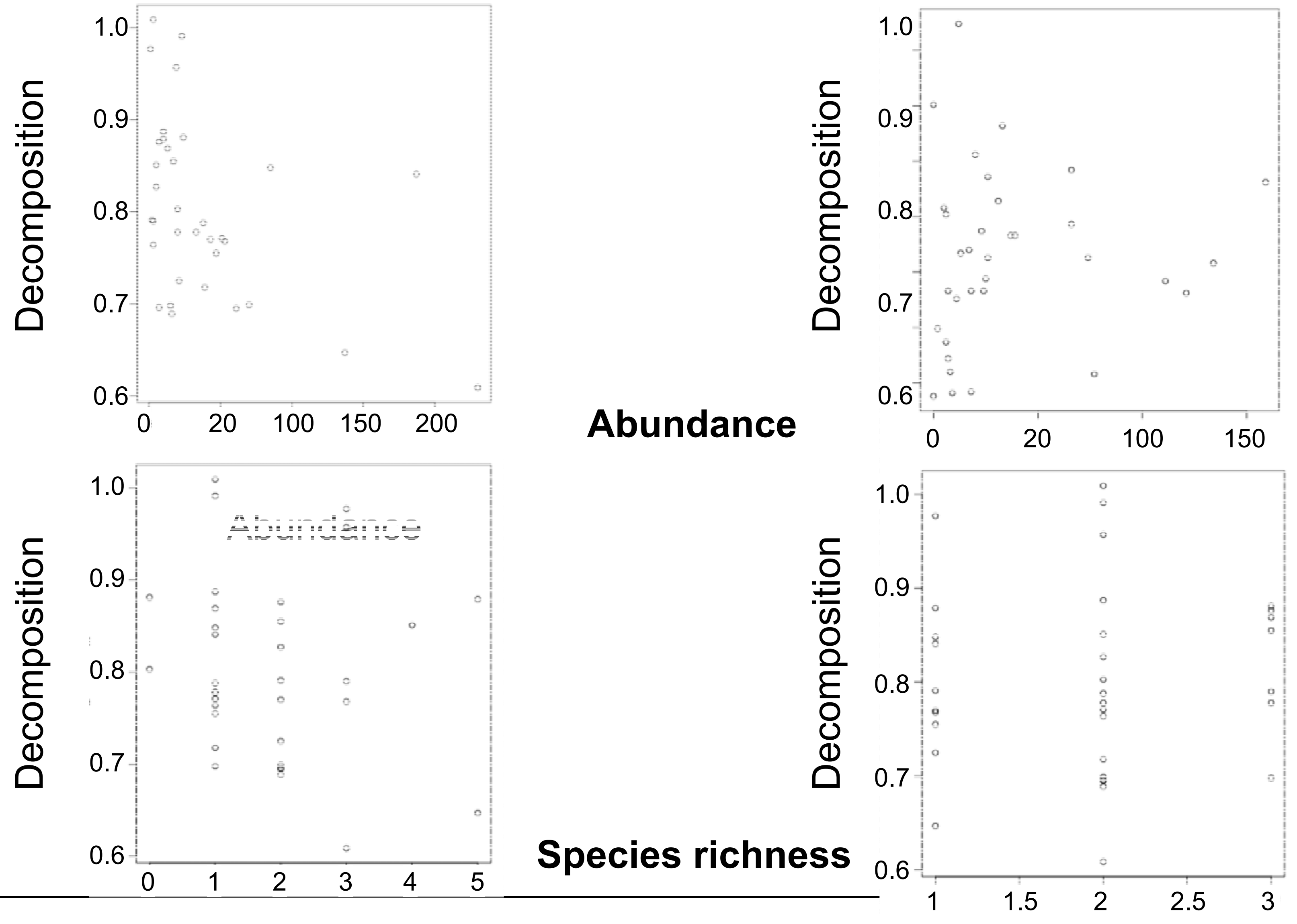
Tree-hole characteristics as driver of communities



- Environmental distance was calculated using
  pH, temperature, oxygen content, detritus amount, height
- We compared these distances with Bray-Curtis community distance using a mantel test and evaluation of pval by permutation (999)

Biodiversity – ecosystem function relationships

Primeval forest　　Managed forest



Summary and conclusions

Hypotheses

H1a: reduced habitat availability decreases abundance and diversity and change community composition

→ abundance/species richness ✓, community composition -

H1b: spatial effects are more important than niche difference

→ niche differences are more important -

H2: lower abundance and diversity result in lower decomposition rates

→ no effect of abundance and species richness on decomposition -

H3a: Spatial effects are more important managed forests due to less well connected microhabitats

→ similarly important in managed and unmanaged forests -

H3b: Biodiversity-Decomposition relationships are less steep in managed forests due to functionally impoverished community

→ no relationship -

→ Patch dynamic paradigm best explains observed patterns

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Thanks!!!

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