

Co-occurrence based measure of plant species habitat specialization: What does it really mean?



David Zelený

Department of Botany and Zoology, Masaryk University, Brno, Czech Republic; zeleny@sci.muni.cz; www.sci.muni.cz/botany/zeleny

Introduction

Co-occurrence based estimation of species niche width, as introduced by Fridley et al. (2007), is based on a simple principle: the niche width of the species corresponds to the pattern of its co-occurrence with other species. **Habitat specialists**, e.g. species with narrow niche, could be in different localities found with still the same group of species, indicating that different localities are likely to be ecologically similar. **Habitat generalists**, in contrast, co-occur with wide range of species across localities, indicating that these localities are ecologically heterogeneous. If we have vegetation dataset large enough to realistically represent the co-occurrence pattern, Fridley's algorithm offers rather robust estimation of species habitat specialization.

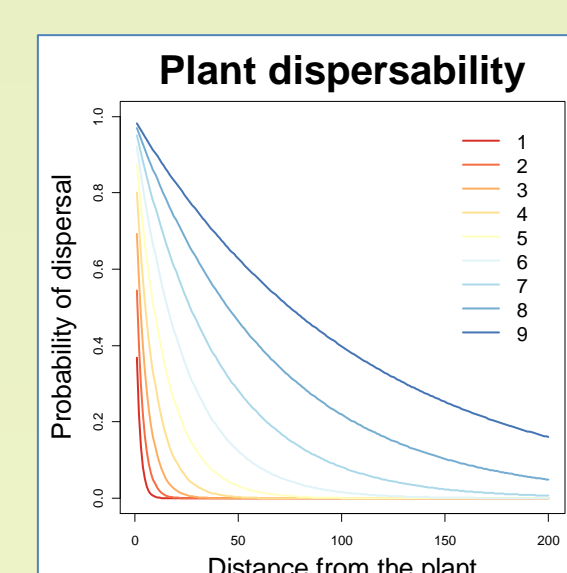
Indeed, the method estimates realized, not fundamental species niche. The shape of realized species niche is, however, influenced by number of other processes. Perhaps the most important one is the **sink-source species dynamic** (seed mass effect), which allows species to occupy sink habitats outside of the species fundamental niche due to strong dispersal link to source populations. It could be hypothesized that sink-source dynamic will be, in turn, influenced by species dispersal ability, and as a result the realized species niche will be influenced by species dispersal ability.

Main question

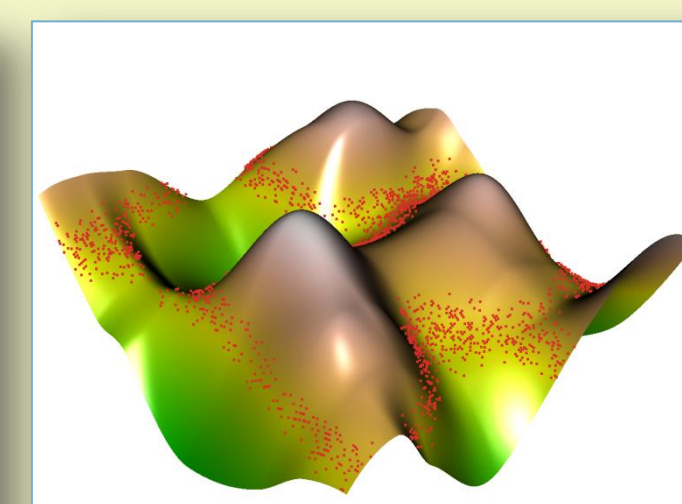
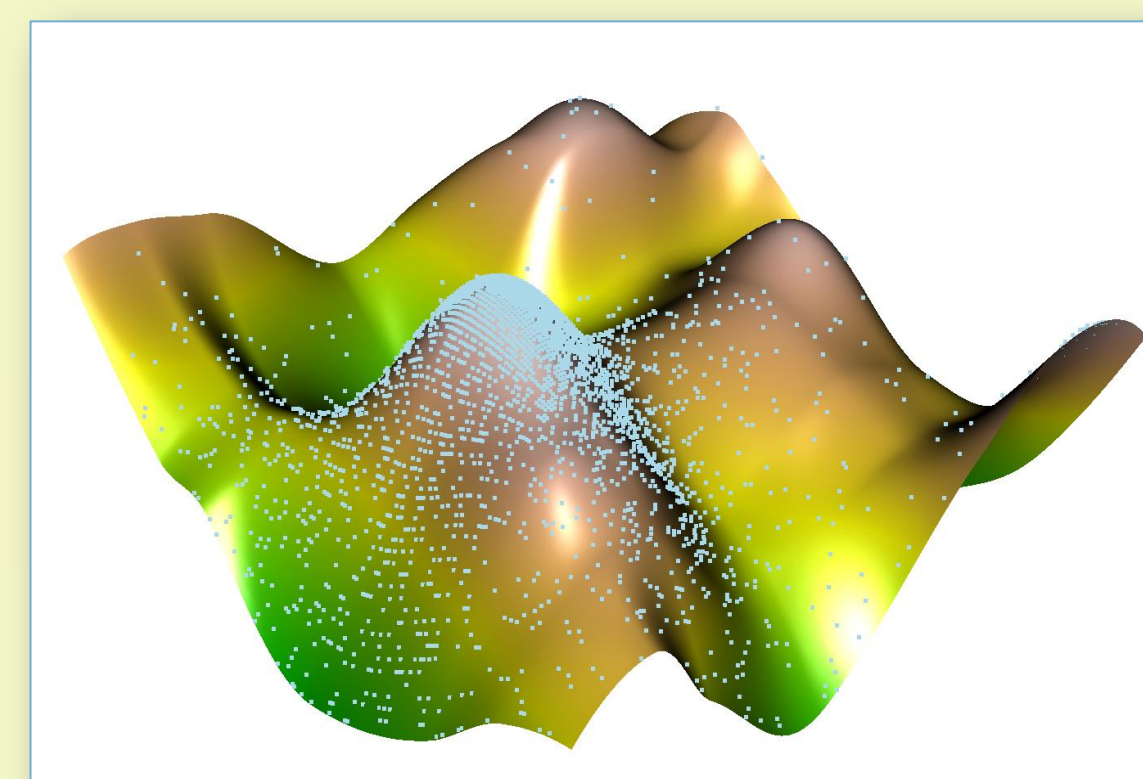
How is the realized species niche influenced by species dispersal ability?

Methods 1 Simulated data

To simulate the effect of dispersal on the plant co-occurrence pattern, I build **spatially explicit, individual-based model**, which combines niche and neutral processes. All species have the same niche width, but they differ by dispersal ability.



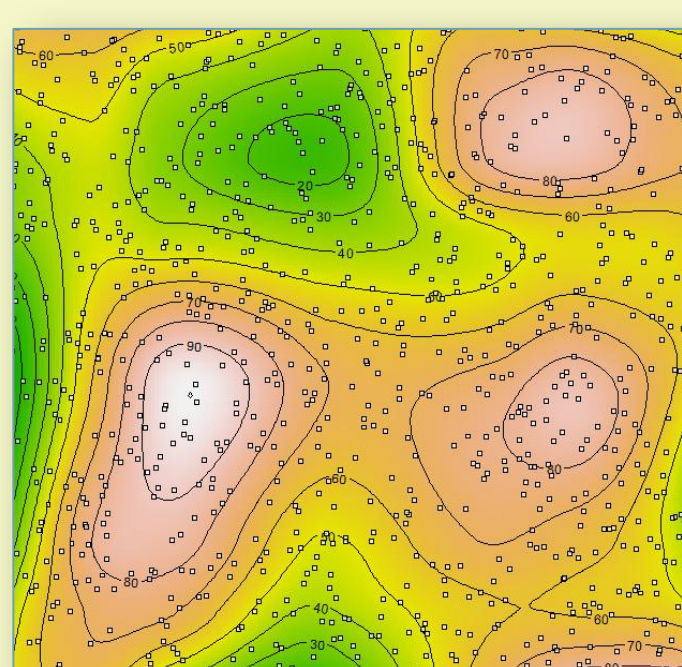
Species were randomly distributed into artificial landscape, where the main gradient is elevation. The first step was niche filtering – all species occurring outside their simulated niche died. The second step was dispersal event – each surviving individual species dispersed according to its dispersal kernel. First and second step repeated n -times.



Distribution of species in simulated landscape. **Left** – species with high dispersal ability, with species optima in high elevation. **Above** – species with low dispersal ability with optima in middle elevation.

Simulation run for 3 cycles. Consequently, 1000 cells were randomly selected and their species composition was recorded. Resulting matrix of species co-occurrences was used to estimate species niche width, using algorithm of Fridley et al. (2007), modified by Zelený (2009).

Below – distribution of 1000 randomly localized virtual sample plots (each sample = 1 cell).



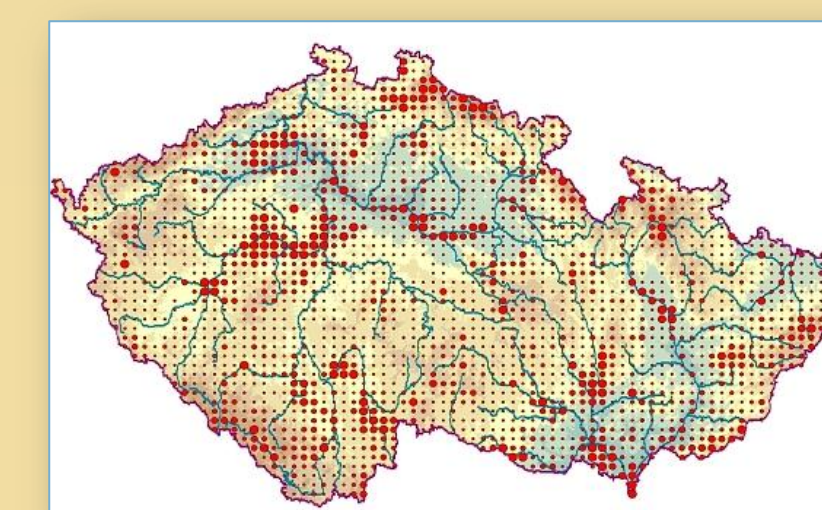
References

- Chytrý, M. & Rafajová, M. (2003) Czech National Phytosociological Database: basic statistics of the available vegetation-plot data. *Preslia*, 75, 1-15.
- Frank, D. & Klotz, S. (1990) Biologisch-ökologische Daten zur Flora der DDR. *Wiss. Beitr. Martin-Luther-Univ., Halle-Wittenberg*, 32, 1-167.
- Fridley, J.D., Vandermaast, D.B., Kuppinger, D.M., Manthey, M. & Peet, R.K. (2007) Co-occurrence based assessment of habitat generalists and specialists: a new approach for the measurement of niche width. *Journal of Ecology*, 95, 707-722.
- Kleyer, M. et al. (2008) The LEDA Traitbase: A database of life-history traits of Northwest European flora. *Journal of Ecology*, 96, 1266-1274.
- Zelený, D. (2009) Co-occurrence based assessment of species habitat specialization is affected by the size of species pool: reply to Fridley et al. (2007). *Journal of Ecology*, 97, 10-17.

Methods 2 Real vegetation data

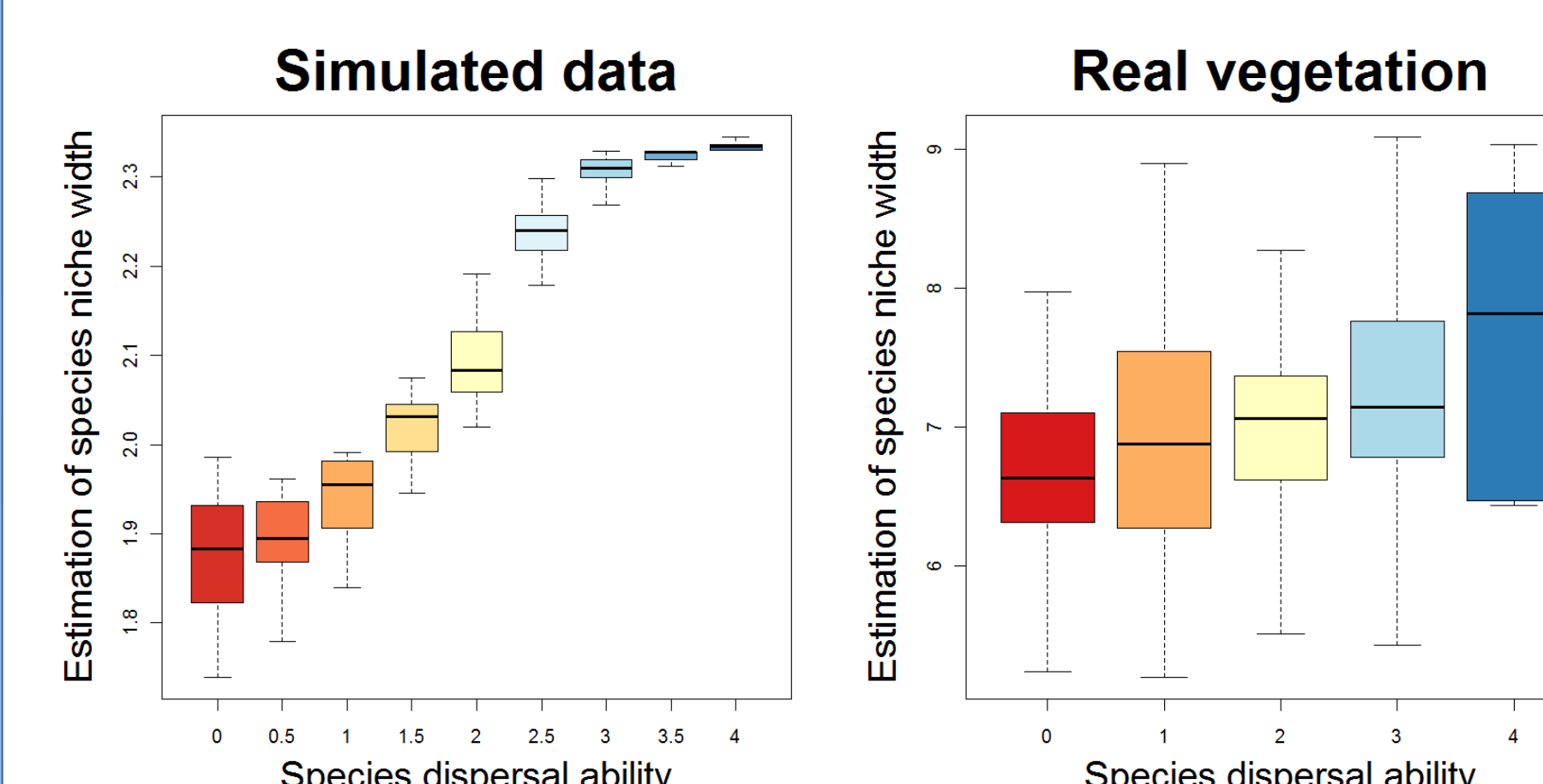
To reveal the relationship between species niche width, estimated using co-occurrence data, and species dispersal ability, I combined available datasets of vegetation plots and species traits data. **Vegetation dataset** was derived from the Czech National Phytosociological Database (Chytrý & Rafajová 2003), recently containing more than 90.000 vegetation plots (see the map). Altogether 8.239 **forest vegetation** plots with complete record of all vascular species were selected. Only **herb species** were included in further analysis.

Vegetation dataset was used to calculate the estimated niche width using algorithm of Fridley et al. (2007) modified by Zelený (2009).



Species traits relevant for **plant dispersal** were compiled from LEDA traitbase (Kleyer et al. 2008) and Flora DDR (Frank & Klotz 1990). Index of species dispersal ability (values 0-4) results from the combination of four traits, relevant for plant dispersal ability: seed weight, seed terminal velocity, prevailing dispersal mode and number of seeds per shoot.

Results



Discussion

Both simulated and real vegetation data show similar pattern – **positive relationship between species niche width and species dispersal ability**. Contrary to simulated data, in the real vegetation data the pattern is much weaker. When analyzed separately, the relationship between species niche and dispersal ability is in some families clearly positive (e.g. *Poaceae*, *Lamiaceae* or *Fabaceae*), in others negative (e.g. *Liliaceae*, *Caryophyllaceae*) and in yet others not clear (e.g. *Asteraceae*).

Index of seed dispersal ability combines together seed weight, seed terminal velocity, prevailing mode of dispersal and number of seeds per shoot. If tested separately, the one with the highest predictive ability for estimated niche width was the number of seeds per shoot, which itself is closely related to seed mass effect.

Main conclusions

In both simulated and real vegetation data, there is an evidence of positive relationship between species dispersal ability and the width of its realized species niche. The width of realized species niche, as estimated by Fridley's algorithm, in reality reflects not only the real ecological amplitude of the species, but also its dispersal ability and potential for seed mass effect.

Acknowledgement

I would like to thank to my colleagues Ching-Feng Li and Milan Chytrý for discussion and helpful recommendations. My research and conference presentation was supported by the long-term research plan MSM0021622416.