Is there whole ecosystem level synchrony in functional trait distribution?

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# Authors

We will adhere to the authorship criteria of the BE and everyone who contributes data to the analysis will be offered authorship.

# Rationale

Species traits within trophic guilds are highly correlated amongst each other, with the consequence that certain trait combinations (functional strategies) are repeatedly observed in nature. In multi-dimensional space, trait variation can often be reduced to just a few principal components (Diaz et al. 2016, Salguero-Gomez et al 2015). For example, in plants, much trait variation can be explained by a single axis differentiating between conservative and exploitative growth strategies. Functional strategies reflect adaption to environmental conditions. The diversity and distribution of strategies within a community can therefore often be seen to co-vary along environmental gradients. For instance specific leaf area (SLA) responds negatively to drought and positively to nutrient availability (REF). Similarly, the loss of functional trait diversity can occur where niche space is constricted, e.g. due to grazing, mowing or fertilization (REF Exploratories).

There is now evidence that systematic shifts in traits in response to environmental drivers occurs across multiple trophic levels, and this could be driven by either trophic linkages or shared environmental responses (. To date such evidence has been drawn from only two trophic levels, where it is seen that traits in one trophic guild often correlate with traits in adjacent trophic guilds. For instance, the body mass of predator communities is typically one or two orders of magnitude above the body mass of their prey (Brose et al 2006; Loreau ???). Similarly, pollinator phenological traits are strongly related to plant traits (REF). Such associations also extend belowground where fast turnover bacterial dominated microbial communities are associated with plant communities dominated by exploitative species and slow, fungal dominated communities with conservative plants ) De Vries et al 2012, Wardle 2002). If these interactions extend across multiple trophic levels, e.g. by the quality of plant tissue affecting both above and belowground plant communities, this would be reflected by a correlation in the trait distributions of these trophic guilds in multi-dimensional trait space. Accordingly, this variability could be reduced to a few principal-component axes describing whole ecosystem level functional axes, much in the same way that multiple species level traits can be categorized into functional strategies (Diaz et al 2016).

Based on this knowledge, we hypothesise that the community weighted means of functional traits will be synchronised across multiple trophic levels in the Biodiversity Exploratory grasslands. Specifically, we hypothesise that an increase in land use intensity will shifts plants towards an exploitative strategy, microbes towards bacterial dominance and aboveground invertebrates of primary and secondary consumer groups towards small body sizes. We are also extremely interested in extending this hypothesis into other traits and taxa if this is theoretically consistent and data is available. Would be good to have a diversity hypothesis too- systematic reduction due to niche constriction maybe? We also hypothesize that trait synchrony across functional groups is sensitive to changes in land-use intensity, resulting in less correlation in trait diversity at high degrees of grazing, mowing and fertilization.

If trait synchrony across trophic levels holds true, this will provide a new approach to relate trait variation to ecosystem function and the provision of ecosystem services.). Therefore, subsequent work will explore the potential for ecosystem level functional type measures to explain ecosystem functioning, and identify the best indicator taxa for successful measures.

# Analysis

## Principal component analysis

Within each trophic level, trait data and abundance will be used to calculate plot-level community weighted means. Of these, a matrix of CWM traits (columns) per plot (rows) will be fed into a principal component analysis to identify significant axes. The vectors on the principal component axes will serve as the response value for the further steps of the analysis.

Additionally, metrics for variation within each plot will be sought (variance, skewness, multimodality) and undergo the same procedure.

## Correlation and structural equation modeling

To correlate the vectors of multiple trophic levels, we apply path analysis.

## multi-function/trait-diversity index

We are going to explore a mathematical

# Data requirements

We plan to focus on the grassland plot data of the biodiversity exploratories, because trait data are more complete and due to the expertise of the group involved. Future work may extend to forest ecosystems.

## species trait data per functional group

We require data on species traits for multiple functional groups of the above and below ground ecosystem compartment. At minimum we would like to include plants, herbivores, predators, detritivores, and pollinators. These data have already been compiled by ... . Further functional groups could easily be included if data are available (e.g. parasitoids, root feeders).

## plot-level species abundance data (over time)

The plot-level assessments of species abundances will be used to compile community weighted means, variances and skewness metrics of functional groups for each plot at each point in time.

## plot-level data of land-use intensity factors

The standard plot data of the biodiversity exploratories provide information on grazing, mowing and fertilization frequencies which are compiled into a single the Land-Use-Index. We will explore which of those indices predicts the synchrony of changes in trait distribution.

## quantitative data on ecosystem services per plot

On the plot level, we would like to correlate the synchrony in functional-group trait-spaces with the multi-functionality of ecosystems. Therefore, we require quantitative data on multiple ecosystem services, which has already been compiled by Allan et al.

# References