Synchrony in trait distribution across trophic groups

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24-02-2016

# 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 functional groups are highly correlated amongst each other with the consequence that particular trait combinations (functional strategies) are repeatedly observed in nature. In multi-dimensional trait space, variation can often be reduced to few principal components (Diaz et al. 2016, Salguero-Gomez et al 2015). For plants, this plane separates the fast-growing vs. slow-growing strategy. Assessing the trait distribution of ecological communities can serve as a metric of the diversity of functional strategies (Petchey ..., REF Jena?).

Functional strategies reflect adaption to environmental conditions. The diversity and distribution of strategies within a community are therefore often seen to covary along environmental gradients. For instance specific leaf area responds negatively to drought and positively to nutrient availability (REF). Similarly, the loss of functional diversity due to grazing, mowing or fertilization is reflected by reduced trait variation in insect communities (REF Exploratories). Thus monitoring the trait distribution of ecological communities along gradients of environmental stress informs about the risks to functional diversity of ecosystems (REF).

Traits in one trophic group correlate with traits in adjacent trophic groups. For instance, body mass in the predator community 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). Thus, interactions across trophic levels, e.g. by feeding or pollination, would be reflected by a correlation of species distribution along the principal-component axes in multi-dimensional trait space.

Based on this knowledge, we hypothesise that functional trait diversity will be synchronised across multiple trophic levels. 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.

The finding of a synchronous distribution of functional traits across trophic levels would reflect the ecosystem-level functional strategy in response to environmental conditions. For instance, the 'fast-growing' plant strategy would have it's corresponding trait-set in herbivores and pollinators. Trait shifts due to environmental changes would propagate to the other trophic groups. Thus, the overall distribution of traits is characteristic for the ecosystems state. With this study, we aim at defining novel metrics for the response in functional trait distribution at the ecosystem level.

If trait synchrony across trophic levels holds true, this also provides a new approach to relate trait variation to the provision of ecosystem services. Community-wide shifts in trait diversity propagate to ecosystem level and are expressed as changes in multi-functionality (Soliveres et al. in preparation).

This observational approach does not assume unidirectional cause-consequence relationships between functional groups. Rather it views trait distribution as an emergent pattern of ecosystem dynamics. By describing correlations in trait-space across functional groups we get a better understanding of how multiple functional groups respond to each other in the wider

ecosystem context and how those changes propagate to ecosystem function and services.

# Analysis

## Principal component analysis

Within each trophic level, trait data will be coerced to plot-level community weighted means. Of these, a matrix of 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 indices of land-use are applicable. We will investigate if an inflation of the approach with forest plot data is feasible.

## 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