**Process-based estimation of ecological niches and range dynamics from demographic data and large-scale abundance variation**

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**Abstract:**
The geographical distributions of species are determined by the dynamic interplay of reproduction, mortality and dispersal in a spatially and temporally heterogeneous environment. Yet, widely applied species distribution models (SDMs) take a phenomenological and static approach to the estimation of species' ranges and ecological niches.
Dynamic Range Models (DRMs) are a process-based alternative to SDMs (Pagel & Schurr 2012, Schurr et al. 2012). They statistically estimate of ecological niches and range dynamics from demographic and species distribution data. DRMs integrate Hutchinson's niche concept with spatial population dynamics in a hierarchical Bayesian state–space model to estimate the environmental response of demographic rates, local population dynamics and dispersal rates conditionally upon each other while accounting for various sources of uncertainty. The approach thereby jointly infers species' niches and spatio-temporal population dynamics from data and provides probabilistic forecasts of range dynamics under environmental change. Parameters of the model are related to demographic rates that can be measured in the field or in experiments. DRMs thus enable the quantification of niches and range dynamics from a combination of demographic measurements and biogeographical distribution data.
In a case study, we investigate niches and range dynamics of serotinous shrubs (Proteaceae) in the South African Fynbos. For the quantification of species' niches in terms of demographic response functions we assembled a dataset that describes how demographic rates (mortality, fecundity, recruitment) vary among more than 3000 populations across the ranges of 26 Proteaceae species. These field data are combined with information on long-distance seed dispersal and data on range-wide variation in population size from the Protea Atlas citizen-science project to estimate DRMs and to analyze how interactions between demographic response functions and spatial population dynamics drive the formation of species' ranges.

**References**

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