Submitted Abstract

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First Author First Name / Last Name	Lisa Samira (1,2) Geres
Submitting Author First Name / Last Name	Lisa Samira Geres
Correspondence	lisa.geres@npv-bgd.bayern.de
Co-Authors >> E-Mails will be not listed	Bässler, Claus (2,4); Seibold, Sebastian (1,3)
Organisations	1: Berchtesgaden National Park, Berchtesgaden, Germany 2: Goethe University Frankfurt Faculty of Biological Sciences, Institute for Ecology, Evolution and Diversity, Department of Conservation Biology, Frankfurt am Main, Germany 3: Technical University of Munich TUM School of Life Sciences, Ecosystem Dynamics and Forest Management in Mountain Landscapes, Freising Weihenstephan, Germany 4: Bavarian Forest National Park, Grafenau, Germany
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Abstract

The ability of a species to track favourable conditions by shifting its range may be crucial to cope with global warming. Vertical (upslope) range shifts are frequently reported as the main mechanism for tracking climate change in mountainous areas. However, horizontal range shifts from sun-exposed to shaded habitats at constant elevations are an often neglected alternative mechanism. In the present study, we quantify the vertical and horizontal dimensions of species ranges in temperate European mountain forests. We investigate the potential of horizontal range shifts to counteract upslope shifts and how this changes our understanding of novel species assemblages under climate change.

We used data from biodiversity surveys in the Bavarian Forest National Park and adjacent areas in 2006 and 2016 at locations between 660-1400 meters above sea-level. The area features dynamic montane forests with a variety of microclimatic regimes. Elevation and canopy cover served as proxies for the local climate and microclimate, respectively. We calculated species-specific elevation (vertical) and canopy cover (horizontal) optima (abundance-weighted mean) and niche breadths (abundance-weighted standard deviation) for species that occurred in both survey years. We then used generalized linear models to compare the links between species abundance, niche optima, and niche breadths among several taxonomic groups.

Most species exhibited a shift in either their elevation or canopy cover optimum, or both of them. Most taxonomic groups showed mean shifts towards cooler climates, i.e., upslope or towards higher canopy cover, although responses were highly diverse at species level. Niche breadths increased with both horizontal and vertical shifts to cooler climates, indicating species experienced range-expansion at their upper range boundaries rather than range-contraction at their lower range boundaries. We found a negative correlation between vertical and horizontal range shifts, confirming our hypothesis that shifting towards higher canopy cover offers an alternative mechanism to track climate change besides shifting upslope.

Using a two-dimensional concept of antagonistic horizontal and vertical range shifts can improve predictions about future species assemblages, as response trajectories entail both dimensions to a species-specific extent. Our findings imply an increased likelihood of community reassembly both at the vertical and the horizontal dimension, potentially resulting in novel species interactions or impaired ecosystem functioning. However, the possibility of a species to track climate change within a given elevation may increase its overall ability to track climate change, highlighting the importance of diverse landscapes to safeguard mountain biodiversity.