Modeling post-agricultural forest regeneration using the forest maturity index

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Secondary succession towards forests on abandoned farmland is widespread in many regions. Population displacements in the 1940s led to large-scale agricultural abandonment in the Polish Eastern Carpathians, triggering spontaneous and partly forestry-assisted succession. As a result, extensive post-agricultural forests developed, expanding the already vast area of predominantly well-preserved ancient forests. Previous studies indicate that understory regeneration in post-agricultural forests is faster near ancient forests and on soils similar to those of ancient sites. However, most research has focused on lowlands, leaving the role of topography in mountainous areas unclear. This study aimed to assess understory regeneration in mountainous post-agricultural forests and identify the key factors influencing this process, with a particular emphasis on topography.

We quantified the understory regeneration rate of post-agricultural forests through extensive phytosociological relevé surveys conducted during a single growing season. Data were collected from 294 randomly selected plots in post-agricultural and ancient forests, representing diverse topographic conditions. Using the Forest Maturity Index (FMI) and a parameterized multiple regression model, we identified the key factors driving regeneration. The resulting regression formula was used to model forest regeneration rates across the entire study area (40,975 ha).

The FMI values showed that the degree of understory regeneration in post-agricultural forests located under favorable environmental conditions can be comparable to the median value of ancient forests. However, a substantial proportion of post-agricultural forests in the region remains affected by factors limiting understory regeneration. The results indicated that the degree of regeneration decreases with increasing elevation, pine share in the tree stand, and distance from the ancient forest, while it increases with slope steepness. Based on these relationships, a map of the modeled regeneration degree was developed for the entire study area. The results enable the identification of well-regenerated, and thus ecologically valuable, post-agricultural forests. Evidence of the negative impact of pine on understory regeneration in Carpathian post-agricultural forests can inform improved management and conservation planning.

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