

The spatial and age structure of the regeneration of oaks (*Quercus robur* and *Q. petraea*) in the Carpathian Foothills in the context of the selected environmental factors

In the light of previous studies, the question about the conditions of the effective oak (*Quercus robur* and *Q. petraea*) regeneration remains valid. Based on the assumption of a relative stability of species composition of natural stands, a typical assessment of oak regeneration usually involves the survey and measurements of oak seedlings and saplings in in mature or old stands with canopy oaks. Such an approach ignores, however, the very complex system involving diverse evolutionary adaptations allowing oaks it to fit their regeneration strategy to present environmental conditions. This system defines an extremely extensive oak regeneration niche, in which the option of developing an oak saplings in forest may be the result of a slightly probable scenario (Fig.1.).

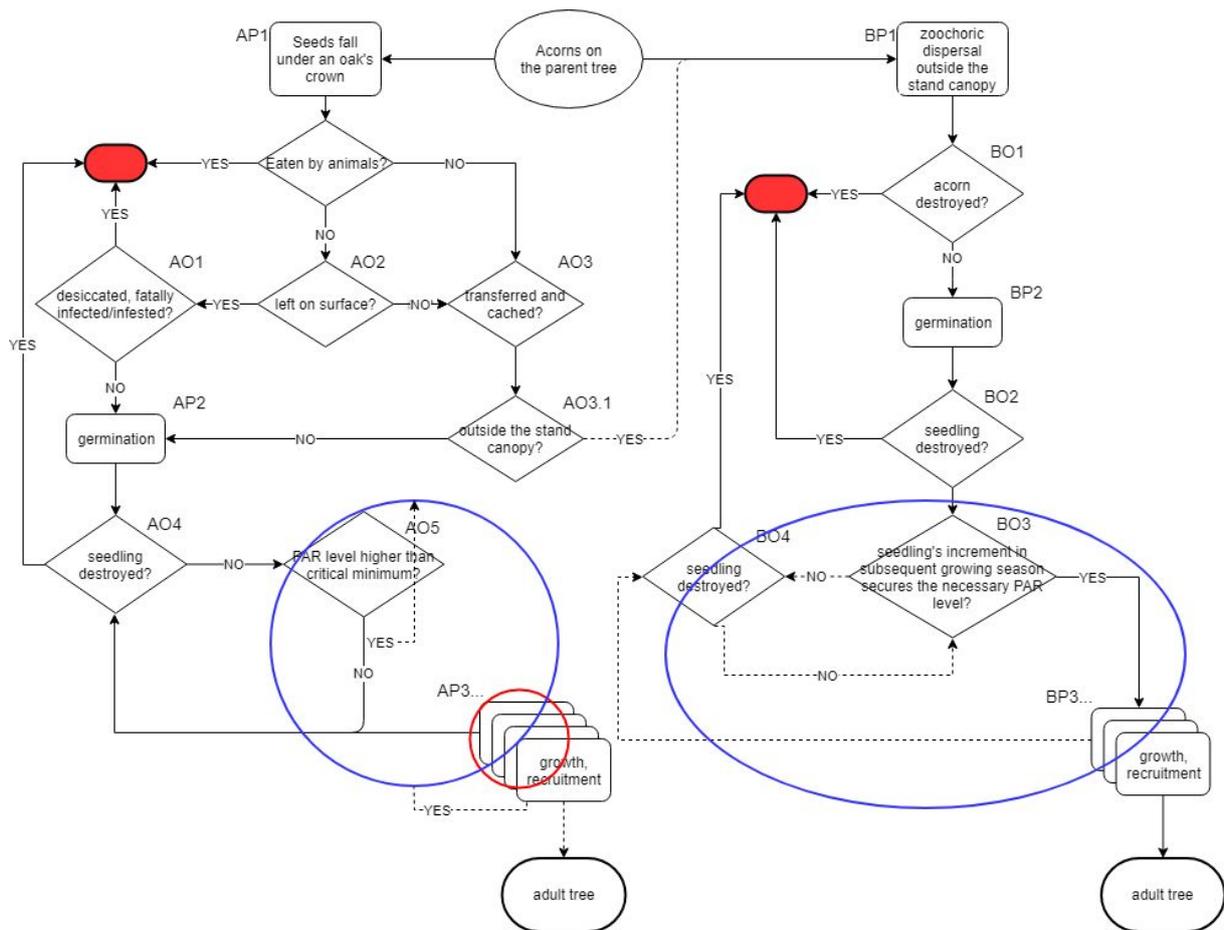


Fig.1. A conceptual model of oak regeneration in a forest (A) and non-forest (B) environment. AP, BP - processes, AO, BO - options; red fields - death of acorns/seedlings/saplings; red circle refers to the scope of a typical study of oak's regeneration success; blue circle and ellipse - the scope of the present study; dashed lines - slightly probable trajectories

Therefore, a research area dedicated to the assessment of the fullest possible realisation of the oak's regeneration niche, should involve the appropriate landscape structure, securing the highest possible diversity of habitats and processes influencing the regeneration process. Such conditions are met in the rural landscape of the Przemyskie foothills, consisting of a heterogeneous mosaic of woods, groves, grasslands and successional scrubs.

The main work's objective was the assessment the oak's regeneration potential in the forested and non-forest landscape patches of the Carpathian Foothills. The research focused on determining the environmental and ecological conditions of oak regeneration. The particular aims included:

- determination of species composition and spatial structure of woody area with the participation of oak;
- determining the role of disturbances (fire and animal damages) on oak regeneration;
- characterising the oak regeneration centres in the context of landscape mosaic structure;
- determining the rate of development of oak seedlings in forest and non-forest habitats;
- characterising the light conditions necessary for the proper development of oak regeneration.

Due to the very heterogeneous subject of the research (regeneration parameters, character of the research area), it was considered that it could not be carried out following the methodology entirely based on the rigour of strict quantitative approach, including sampling randomness and the rule of the minimum sample size. Hence, the work is mainly descriptive and documentary, and the obtained values of indicators are rather an illustration than a strict evidence. Although the subject of the study was the natural regeneration of oak in the variegated rural landscape of the Carpathian foothills, in order to better understand certain phenomena, auxiliary observations were carried out in two other geographical areas - in the Sandomierz Basin and in Prykarpattya, W Ukraine.

The methods involved included: measurements of the photosynthetically active radiation (PAR), inventory of oak regeneration under different habitat conditions, characteristics of spatial relationships between young oaks and other woody species, dendrochronological evaluation of the natural rate of oaks recruitment in non-forest environment, oak seedlings survival and growth analysis in partially controlled conditions.

Considering the landscape's wooded patches, a much higher density of oak renewal occurred in the Prykarpattya marginal woods (total density 11,500 seedlings & saplings ha⁻¹) than in the Przemyskie Foothills (1,300 seedlings & saplings ha⁻¹), where saplings taller than 50 cm hardly occurred. The results of PAR measurement proved the disadvantageous photoclimatic of the forest habitats in the Foothills being responsible for failure of oak regeneration. The relative PAR intensity in the Foothills' woodlots, 1.3 m above the ground,

was on average 6% comparing to 16% in Prykarpattya, where the continuous oak regeneration has been favoured by recurring ground fires, inhibiting the dense undergrowth succession.

In Przemyskie Foothills, numerous places of oak regeneration are found in slightly wet meadow communities, often evolving towards xerothermic grasslands, usually from a dozen to several dozen meters from the nearest adult fruiting oaks. Despite the high and quite dense herbaceous vegetation such habitats provide a very favourable vertical photoclimate for oak seedlings development. While the average relative PAR on the ground level equals 16%, 15 cm above the ground (=height of oak seedlings at the beginning of the second growing season) it reaches 50% , providing optimal conditions for oaks photosynthetic activity. Spatial analysis regeneration of oak on the majority of the investigated areas has not confirmed the causal effect the neighbourhood of potentially protective shrubs (associational resistance) on the young oaks recruitment success. While it can occur in particular, individual cases, on the scale of the whole local populations or the entire landscape of the studied area, the associational resistance is possibly not a decisive factor in the regeneration success.

Despite the seedlings post-damage resprouting potential under the favourable grasslands photoclimate, too frequent and intense fires recurring on the Foothills (compared to softer and less regular fires in the woods of Prykarpattya) prevent the oak recruitment. However, the main reason for the deficit of young natural oak groves in the Przemyskie Foothills is the systematic clearance of young woodlots stimulated by the system of environmental payments favouring permanent treeless grasslands.

To recapitulate, the study has shown that in a highly diverse cultural landscape the potential of natural oak regeneration is realised in non-forest habitats, free from overshadowing trees or tall undergrowth. This also applies to the ecotone zones, where, due to anthropogenic disturbances, such as repeated low fires, the semi-open community structure is maintained. This confirms the earlier suggestions of the definite halt of oak regeneration in the former silvopastoral groves due to the loss of the favourable photoclimate. The current land use system is responsible for the deficit of younger spontaneous woodlots in the Foothills landscape. This system, unlike the traditional integrated use of the whole cultural landscape, is based on entirely segregated approaches of forest management and agriculture. The research has highlighted the importance of a diversified cultural rural landscape in the realisation of the diverse regeneration niche of oak - a cosmopolitan, anthropophilic opportunist. Due to the preliminary character of the part of the study, the described and documented phenomena (eg. the process of oak seedlings development in various environments or the impact of fires on the formation of oak groves) they deserve further, in-depth quantitative research with a wider use of the experimental approach.