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**Long-term changes in the herbaceous plant of beech forests in the Polish part of the Eastern Carpathians in connection with the development of stands and their use**

**Summary**

The doctoral dissertation consists of a series of three works published in the journals *Biology, Forests* and *Forest Ecology and Management* devoted to (1) the impact of forest management on the temporal dynamics of herbaceous plant diversity in the Carpathian beech forest over 40 years, (2) the factors related to the structure of the forest and climate which have an impact on changes in herbaceous plants in the Carpathian beech forest, (3) the impact of the development of stands on long-term changes in the herbaceous layer in the semi-natural Carpathian beech forest.

The long-term changes in the vegetation of the herbaceous plants of beech forests in the Polish part of the Eastern Carpathians connected to the development of stands and their use over 40 years were analyzed based on phytosociological relevés from semi-permanent sampling plots located in the Sanocko-Turczańskie Mountains (1970s, 2000s, 2010s). These sampling plots were located in forests managed by the Forest Districts of Brzozów, Lesko and Ustrzyki Dolne. The data from phytosociological relevés was supplemented with data from the inventory of stands prepared for the forest management plans. The analysis also took into account climatic data (average temperature and precipitation during the growing season) recorded by the meteorological station in Lesko. The focus was on the changes in the herbaceous layer of plants against the changes in the structure of aging stands. In particular, the dynamics of changes in the species composition and diversity of vegetation in relation to the development stages of the stand and forest management were analyzed.

Over the years, forest cover has increased and forest fragmentation has decreased. Less invasive methods of forest management were introduced, and non-productive use by the population decreased. The age and spatial structure of the stands has changed. Conversion from the regular shelterwood system to the irregular shelterwood system initiated the development of stands with complex overstorey structure. At the same time, in the last period of the research, the processes of cutting trees intensified in connection with the regeneration period of the stand. The aforementioned processes altered the lighting and moisture conditions

of the forest floor between the research periods, which was noticeable in the change in the herbaceous plant species composition.

The average frequency of species at the community level was the highest in the 2000s, and the lowest in 2010s. Similar results were obtained when analyzing the average species richness at the level of the sampling plot. In general, in 2010, the average number of species in the distinguished groups was lower than in the previous research periods. Over the years, the number of species associated with forest clearings has not changed, but their coverage has increased significantly.

The overall decline of species in 2010s has been linked to the aging of beech forests, greater intensity of management in terminal stage of forests, competition of the shrub layer, and lower soil moisture. Among herbaceous plants, in the research period of 2010s, there was a lower share of species with a plant strategy C, and a greater share of species with a plant strategy S.

The change in species diversity over the years was quite noticeable. Alpha diversity was highest in 2000s and lowest in 2010s. Beta diversity was highest in 2010s and lowest in 2000s.

In each research period, three broadly defined development stages of the stand were distinguished and characterized: growing, optimum and terminal. The analysis of herbaceous plants revealed differences in species composition and diversity between these stages. At the optimum stage, the highest alpha diversity and the lowest beta diversity were recorded, while in the adolescent and terminal stages, beta diversity was high. Strategy C was dominant in the herbaceous plants of the optimum stage. This dominance is probably the result of the high habitat stability of this stage of forest development.

The results presented in the doctoral dissertation show a significant influence of the stage of development of stands on the changes taking place in the species composition and vegetation diversity of the herbaceous layer of plants of beech forests in the Polish part of the Eastern Carpathians.

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