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LOWER STOREYS OF MAIN TREE SPECIES IN PIONEER DECIDUOUS TREE STANDS OF FERTILE FORESTS HABITATS. CASE OF LITHUANIA

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Introduction

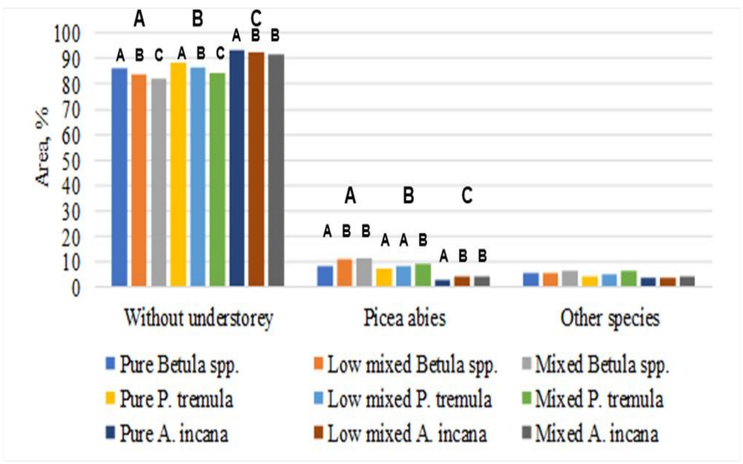
Due to climate change, the migration of tree species from the south-west is likely, with more favorable conditions for deciduous tree species (except *Alnus incana*) and worse for conifers. It is most likely that suitable conditions in Lithuania will be formed primarily for European beech (*Fagus sylvatica L.*), as well as for field maple (*Acer campestre L.*), plantain maple (*Acer pseudoplatanus L.*), black poplar (*Populus nigra L.*) and wild cherry (*Prunus avium L.*) (Ozolinčius et al. 2014). The main native tree species (*Pinus sylvestris*, *Picea abies*, *Betula pendula*, *Alnus glutinosa*, *Populus tremula*, *Quercus robur*, *Fraxinus excelsior*) have a sufficiently high potential to adapt to the changing climatic conditions due to the existing genetic diversity (Verbylaitė et al. 2019).

The study represents forests in the territory of Lithuania. As there is not a sufficient number of highly fertile habitat research objects, a stand-wise forest inventory was used (Instructions for the performance of forest management works 2021).

The aim of the study is to find out how the middle storeys of stand pioneer tree species of highly fertile habitats develop in the context of local natural conditions and farming history.

Two main objectives can be distinguished:

1. To determine a prevalence and a diversity of second storey and understorey of stands;
2. To analyze interrelationships between indicators of main and lower storeys of stands.



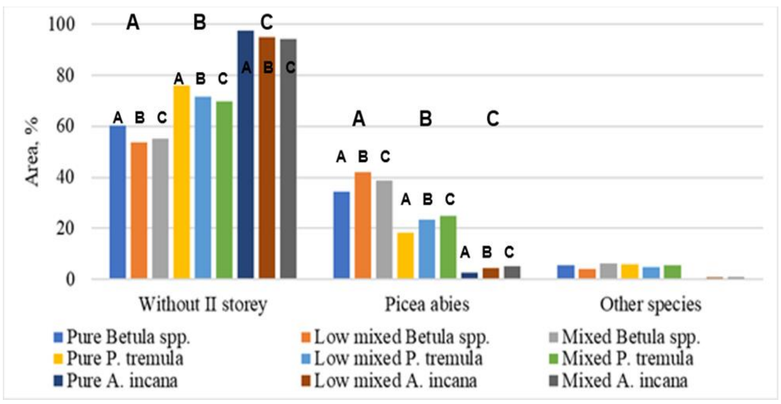


Figure 1. Distribution of understorey in *Betula spp.*, *Populus tremula* and *A. incana* stands of different composition.

Figure 2. Distribution of predominant understorey tree species in *Betula*, *Populus tremula* and *Alnus incana* stands of different composition.

Figure 3. Prevalence of 2nd storey in *Betula spp.*, *Populus tremula* and *Alnus incana* stands of different composition.

Methodology

The study covers forests in the territory of Lithuania, on the eastern shore of the Baltic Sea (53° 54′-56° 27′ N; 20° 56′-26 °51′ E), altitude does not exceed 300 m. The average annual air temperature is 6.9 ° C (monthly: -3.2–17.9 ° C), annual precipitation is 695 mm (Climate avarages for Lithuania 2021). Sample of the study: birch (silver birch (*Betula pendula Roth.*) and downy birch (*Betula pubescens Ehrh.*) was accounted together), European aspen (*Populus tremula L.*) and grey alder (*Alnus incana L.*) stands of highly fertile forest stands (61, 41, 41 years old) and older stands, respectively. Stand-wise Forest inventory data (updated in 2019) (Instructions for the performance of forest management works 2021) was used. Taxation indicators were used for the analysis: predominant tree species, plot area, habitat, age class, species composition and stocking level of first storey, species composition and stocking level of second storey, species composition and density of understorey (trees up to 4 m high which could replace the main storey of stand), density of underbrush. The stands were grouped:

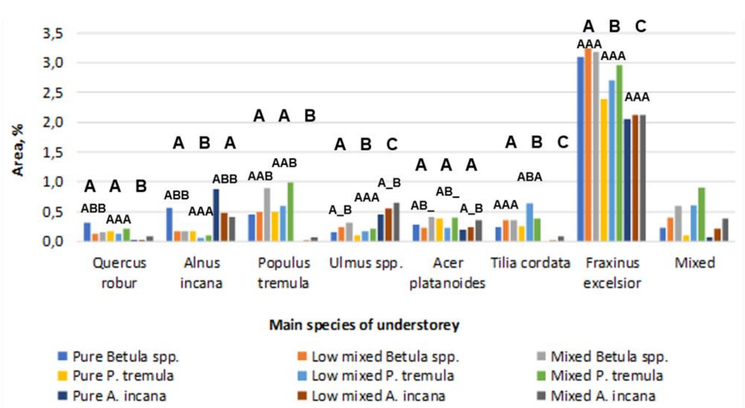
1. According to the mixing of the first storey into: pure (predominant tree species is 9-10 tenths or 86-100%), low mixed (7-8 tenths or 66-85%) and mixed (≤6 tenths or ≤65%).
2. By species composition of the second storey: stands with the predominance (≥5 tenths or >45%) of one tree species, by predominant tree species, stands with a mixed second storey and stands without a second storey.
3. According to the species composition of the understorey (analogous to the second storey).

Results

Picea abies understorey is the most common (on average 8.1%), less *Fraxinus excelsior* (on average 2.7%), the average frequency of understorey of other tree species reaches up to 0.5%, but the analysis of stands according to individual indicators reveals regularities. The highest frequency of stands without understorey was in *Alnus incana* stands - 92.4%^{B}, in *Populus tremula* significantly less – 85.5%^{C}, the lowest in *Betula* stands - 83.1%^{A} (^{1} χ^2=3200.9; df=8; α<0.001). We found that with the increase of stand mixture in the stands of all studied tree species, the frequency of stands without understorey decreases: in pure *Betula* stands - 86.1%^{C}, in low mixed - 83.7%^{B}, in mixed stands - 82.0%^{A} (^{2} χ^2=241.2; df=18; α<0.001); in pure *Alnus incana* stands 93.4%^{B} significantly more than in low mixed - 92.2%^{A} and mixed - 91.5%^{A} (^{3} χ^2=174.2; df=18; α<0.001); in pure *Populus tremula* - 88.5%^{C}, in low mixed - 86.6%^{B}, in mixed - 84.5%^{A} (^{4} χ^2=104.7; df=18; α<0.001).

The highest frequency of *Fraxinus excelsior* understorey (Figure 2) was found in *Betula* stands - on average 3.2%^{A}, significantly less in *Populus tremula* - 2.8%^{C}, the least in *Alnus incana* stands - 2.1%^{B} (^{1}). No significant differences in the frequency of *Fraxinus excelsior* understorey were found in the analysis of stand mixture. Judging by habitats, the most *Fraxinus excelsior* understorey was found in Lf forest site - 7.0%^{D}, significantly less in Nf - 3.2%^{C} and Ld - 2.7%^{C}, even less in Nd - 1.8%^{B} and the least in Šd - 0.4%^{A} (^{7}) The distribution of *Fraxinus excelsior* understorey by habitats was similar in stands of different tree species.

The 2nd storey was found more often in very fertile soft deciduous stands than understorey, *Picea abies* also predominated here (on average 24.1%) (Figure 3). *Tilia cordata* 2nd storey was found in 1.3% stands, the average frequency of other tree species was up to 0.6%. The highest frequency of stands without the 2nd storey in *Alnus incana* stands was 95.5%^{B}, in *Populus tremula* significantly less – 71,0%^{C}, the lowest in *Betula* stands - 55.4%^{A} (^{8} χ^2=22366.8; df=10; α<0.001). With the increase of stand mixture in stands of all studied tree species, the frequency of stands without the 2nd storey decreased: in pure *Betula* stands - 60.2%^{C}, in low mixed stands - 53.7%^{B}, in mixed stands - 55.1%^{A} (^{9} χ^2=372; df=10; α<0.001); in pure *Alnus incana* 97.4%^{C}, in low mixed 94.9%^{B}, in mixed 94.1%^{A} (^{10} χ^2=242.1; df=10; α<0.001); in pure *Populus tremula* – 76,0%^{C}, in low mixed - 71.8%^{B}, in mixed - 69.8%^{A} (^{11} χ^2=126.4; df=10; α<0.001). Analyzing the distribution of the 2nd storey according to the forest habitats, it was found that the 2nd storey is found the least in the Šd habitat (without the 2nd storey 96.5%^{A}).



Main conclusion:

The understorey and the second storey of mature *Betula*, *Populus tremula* and *Alnus incana* groves are weakly forming in most of the very fertile undisturbed habitats. *Picea abies* second storey and understorey are most frequent, *Tilia cordata* and *Carpinus betullus* second storey and *Fraxinus excelsior* understorey are less common. The lower storeys of other tree species develop rarely, episodically.