THE ASSESMENT OF VEGETATION DIVERSITY IN BLACK ALDER WOODLAND KEY HABITATS IN ZEMGALE

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Abstract
The article focuses on vegetation diversity in the black alder *Alnus glutinosa* (L.) Gaertn. woodland key habitats in Zemgale, Latvia. Together nine sample plots were established on these habitat types, where next stand South – South West (S-SW) side at the age 1-10; 20-30 and 40-50 years. The vegetation survey has been made in vegetation period of 2010 and 2011. Braun – Blanque method has been used to estimate the projective coverage (%) of tree layer (E3), shrub layer (E2), herb layer (E1) and moss layer (E0) in order to assess the edge effect impact on vegetation diversity according to different ages classes in a next stands of sample plots. The analysis of edge effect verifies that there is a significant influence from the edge in 1st and 3rd zones of sample plots, which lies at S-SW side at the ages 1-10 and 20-30. In sample plots several indicator species of black alder woodland key habitats have been found: *Vaccinium myrtillus* L., *Lycopus europaeus* L., *Iris pseudacorus* L., *Comarum palustre* L., *Plagiomnium ellipticum* (Brid.)T.kop. Ordination confirmed that composition of species are relatively close, which demonstrate that species are able to live in similar type growing conditions. Protective species *Circaea lutetiana* L. and *Plagiothecium undulatum* (Hedw.) B., S. et G were found on the study sites. Also, adventive species *Impatiens parviflora* DC was found. Comparing the analysis by zones and sample plots and different age classes, the impact on edge effect has been distinguished in black alder woodland key habitats.
Key words: edge effect, *Alnus glutinosa*, vegetation survey, woodland key habitats, swamp woods.

Introduction

As a result of increasing forestry activity, the forest fragmentation has raised up (Aune et al., 2005), which leaves an impact on woodland key habitat types, structural elements and species (Hallanaro and Pylvanainen, 2001). Forest as ecosystem can be characterized by vegetation – plant communities, dominant species, sinusial or dominant association (the combination of vegetation stands) (Priedītis, 1999). Black alder *Alnus glutinosa* (L.) Gaertn swamp woods have been affected by permanent or seasonal changes in water fluctuations (Auniņš et al., 2010). Inherent characteristic feature is a great diversity of species. The naturally rugged stand is a significant element in black alder swamp woods (Angelstam et al., 2005; Priedītis, 1993). The natural succession has been a long term process, whilst decayed trees and dead wood are found infrequently; almost no changes in composition of tree species and wind fallen trees have occurred quite rarely (Auniņš et al., 2010). Both important structural elements in these habitats are runts and decayed trees and particular mosaic – structure of relief. Mosaic structure provides various moisture levels in alder swamp woods, where on the typical stem spots there are meadow, nemoral and boreal type species, whereas in a lowland sites swamp and nitrophilous type species dominate (Priedītis, 1999). The high moisture level is a significant factor in swamp woods (Orzewska, 2009) and species are incredibly sensitive to the changes of microclimate (Ek et al., 2002; Madžule and Brūmelis, 2008; Priedītis, 1997). The mosaic structure on mounded places make the microrelief with typical plant communities without dominant plant species in herb layer and moss layer. The impact of determinant moisture level and light micro gradient provides high diversity of species (Ek et al., 2002). The major limited factors in herb layer and shrub layer in forest ecosystems are light and ability to adapt to obstacles in swamp woods (Tabaka, 2001); therefore, in lighter patches light tolerant species could be found, but in darker patches – shade tolerant species are located (Packham et al., 1992). The black alder swamp woods are endangered by such factors as drainage (Priedītis, 1999) and harvesting, which change equilibrium in the existing microclimate. As a result, the structure of stand is degraded, and it leaves a relevant impact on the further growth of trees. The degradation of such key habitats is also increased by the vast clear cuttings in the stands close by and beaver activities, which result in the change of species composition – reed, sedges, several willows and buckthorns are taking over it, and the natural regeneration on swamp woods is pressed out (Priedītis et al., 2002; Auniņš et al., 2010). The aim of research is to estimate the edge effect impact on the vegetation of black alder swamp wood key habitats.

Materials and Methods

Site description and vegetation survey

The research has been performed in two woodland types: *Dryopterioso caricosa* and *Filipendulosa* on wet peat soils. The research was carried out in nine different black alder woodland key habitats located in the territory of joint – stock company (JSC) 'Latvia state forests' in Zemgale region. During the vegetation seasons of 2010-2011, in each forest tract there were nine vegetation sample plots arranged and surveyed (the area of each sample plot 20×50 m), which have been divided into five 10m wide zones from the side of stand. To the south and south west side of sample plots there are stands that correspond to 3 different groups: 1-10, 20-30 and 40-50 years old stands (in each age group there are three sample plots). The vegetation was surveyed in the first zone, third zone, and fifth zone (each zone is 200 m^2). The Braun – Blanquet method has been used to describe the plant communities (Pakalne and Znotiņa, 1992): the total projective coverage of tree (E3), shrub (E2), herb (E1) and moss (E0) layer, as well as the coverage of each separate species was evaluated in the sample plots according to the percentage. The nomenclature of vascular plants – Gavrilova, Šulcs, 1999, bryophytes – Āboliņa, 2001 was assessed.

Data processing methods

The descriptions of vegetation were summarised in the data base of MS Excel. The occurrence of plant species is characterised by the constancy class which is calculated by referring to the number of those sample plots where the species have been identified to the number of the whole group of sample plots: I - < 21, II - 21-40, III - 41-60, IV - 61-80, V - 81-100% (Muller – Dombois and Ellenberg, 1974). Data processing has been performed by means of *Community analysis package* (Pisceas Conservation Ltd.) PCA (Principal component analysis). The statistical method was applied for the evaluation of validity: one way analysis of variance (SPSS) (Arhipova and Bāliņa, 1999).

Results and Discussion

The total number of species in nine sample plots was 98, out of which seven were tree species, four - shrub species, 61 - vascular plant species and 26 - bryophytes. In the tree layer – 6, shrub layer – 5, herb layer – 69 and moss layer – 26 species were established. The total number of vascular plant and bryophyte species and sample plots by zones are shown in Figure 1.

In the 1st zones of all sample plots, 76 vascular plant and bryophyte species, out of which 5 – in the tree layer, 5 – in the shrub layer, 60 – in the herb layer and 15 species – in the moss layer were identified. In the sample plots, where the next stands on S-SW side are at the age of 1-10 years, the total number of species is 44, from which in the tree layer – 3, in the shrub layer – 4, in the herb layer – 32 and in the moss layer – 11. In the 1st zones of sample plots, where the next stands on S-SW side are at the age of 20-30 years, in general, 41 species, from which in the tree layer – 3, in the shrub layer – 5, in the herb layer – 42 and in the moss layer – 8 were found. In the sample plots, where the next stands are at the age of 40-50 years, in the 1st zones there were 41 species found in total, from which in the tree layer – 4, in the shrub layer – 5, in the herb layer – 34 and in the moss layer – 7.

In the 3rd zones of all sample plots there were 78 species identified in total, out of which 4 were in the tree layer, 5 – in the shrub layer, 57 – in the herb layer and 21 – in the moss layer. In the sample plots, where the next stands are at the age of 1-10 years, there were 50 species found in total, out of which in the tree layer – 3, in the shrub layer – 4, in the herb layer – 37 and in the moss layer – 12 species. In total there were 46 species found in the sample plots, where the next stands are at the age of 20-30 years, including 4 species in the tree layer, 4 – in the shrub layer, 36 – in the herb layer and 10 species in the moss layer. In the sample plots, where the next stands are at the age 40-50 years on S-SW side, there were 45 species found in total, out of which in the tree layer – 4, in the shrub layer – 5, in the herb layer – 32 and in the moss layer – 10 species were found.

The total number of species in the 5th zones of all sample plots is 73, out of which in tree layer – 4, in

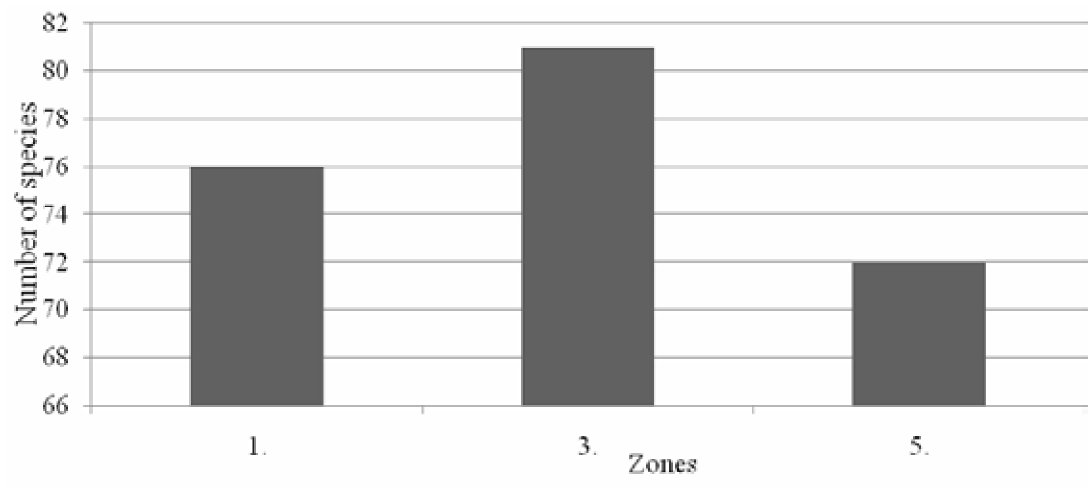

Figure 1. The number of vascular plants and bryophytes by zones. (1. – the number of species in the 1st zone; 3.- the number of species in the 3rd zone; 5. – the number of species in the 5th zone).

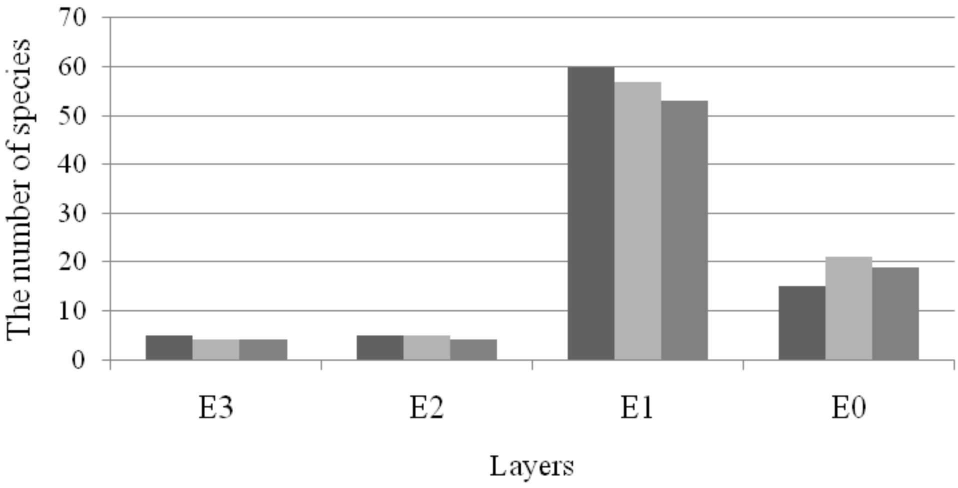

Figure 2. The division of vascular plants and bryophytes by zones.
(■ – 1st zone; ■ – 3rd zone; ■ – 5th zone; E3 – tree layer; E2 – shrub layer; E1 – herb layer; E0 – moss layer).

the shrub layer – 4, in the herb layer – 53 and in the moss layer –19 species were found. In the sample plots, where the next stands on S-SW side are at the age of 1-10 years, there were 34 species found in total, out of which in the tree layer – 4, in the shrub layer – 3, in the herb layer – 25 and in the moss layer – 8 species. In the sample plots, where the next stands on S-SW side are at the age of 20-30 years, there were 52 species found in general, out of which in the tree layer – 4, in the shrub layer – 2, in the herb layer – 39 and in the moss layer – 11 species were found. In the sample plots, where the next stands on S-SW side are at the age of 40-50 years, there were 37 species found in total, out of which in the tree layer – 3, in the shrub layer – 4, in the herb layer – 27 and in the moss layer – 8 species were found. In total, the comparison of the number of species by zones is shown in Figure 2.

Constancy

In all sample plots *Alnus glutinosa* and *Picea abies (L.)* H.Karst were found that create an important composition of species in black alder woodland key habitats (Angelstam et al., 2005). The dominant species (constancy class V) in sample plots are *Padus avium* Mill., *Betula pubescens* Ehrh., in the herb layer – *Oxalis acetosella* L., *Rubus idaeus* L., *Lycopus europaeus* L. It is frequently possible to find the following species (constancy class IV): *Equisetum sylvaticum* L., *Paris quadrifolia* L., *Filipendula ulmaria* (L.) Maxim., *Maianthemum bifolium* L., *Milium effusum L.*, *Vaccinium myrtillus* L., *Pteridium aquilinum* (L.) Kuhn. In the moss layer (constancy class III) – *Plagiomnium affine* (Bland.) T.Kop., *Polytrichum juniperinum* Hedw., *Pleurozium schreberi* (Brid.) Mitt. and *Thuidium tamariscinum* (Hedw.) B., S. et G.

All the other species have been found rarely - only in one or two sample plots or separate zones, where the environmental conditions are favourable. The swamp wood species are found only in those alder swamp woods, where the high level of moisture is characteristic also during the summer period. The characteristic indication of black alder swamp woods is a mosaic form structure with various plant communities, for example, on the stem relief there could be species that are typical for different forest ecosystems (Ek et al., 2002). But on the ground layer typical swamp species, for example, *Viola palustris* L., *Iris pseudacorus* L. (constancy class III) have been found, uncommon species : *Comarum palustre* L. (constancy class II), *Typha angustifolia* L., *Equisetum fluviatile* L. and *Menyanthes trifoliata* L. (constancy class I) were identified.

Projective coverage

The projective coverage analysis enables to draw a conclusion that the most average projective coverage (89.2%) is in the herb layer, where the next stands on S-SW side are at the age of 1-10 years. In the sample plots, where the next stands on S-SW side are at the age of 40-50 years, the average projective coverage is 76.1%. The smallest projective coverage in the herb layer (70.3%) is observed in the sample plots, where the next stands on S-SW side are at the age of 20-30 years. In the tree layer the most average projective coverage is 69.9%, where on S-SW side the stands are at the age of 40-50 years. In the sample plots, where the next stands on S-SW side are at the age of 20-30 years, the average projective coverage is 64.7%, but in the sample plots, where the next stands on S-SW side are at the age of 1-10 years, the average projective coverage is 62.4%.

In the moss layer the most average projective coverage is 49% in sample plots, where the next stands on S-SW side are at the age of 20-30 years. In the sample plots, where the next stands on S-SW side are at the age of 1-10 years, the average projective coverage is 45.8%. In the moss layer, the average projective coverage is 35.8% in the sample plots, where the next stands on S-SW side are at the age of 40-50 years.

In comparison, the smallest projective coverage is observed in the shrub layer. In the sample plots, where the next stands on S-SW side are at the age of 1-10 years, the average projective coverage is 31.6%. The smallest projective coverage in the shrub layer (14.7%) is in sample plots, where the next stands on S-SW side are at the age of 40-50 years. The dominant species in the shrub layer is *Padus avium*, the most often observed in the sample plots of the first and third zones. The average projective coverage (%) by stands and sample plots with different age classes are shown in Figure 3.

The average projective coverage in the tree layer is 65.7%, in the shrub layer – 24.1%, in the herb layer – 78.56% and in the moss layer – 43.5%. The projective coverage (%) of vegetation indicates the location of species and composition structure in the sample plots. The availability of light in the sample plots, the composition, adaptation and structure of species in the shrub, herb and moss layers depend on the projective coverage of tree layer (Johansson, 2005). The dominant species in the tree layer is *Alnus glutinosa* that provides the soil nitrification (Rydin et al., 1999), but the 2nd common species in the sample plots *Picea abies* makes the soil acid. In the black alder swamp woods are no mono-dominant species in the herb layers, which typical mosaic structure on the ground layer and stem form micro relief promoted the diversity of species. And the projective coverage in the herb layer is not constant. The particular spatial structure and fragmentation in the habitats are adaptive for different vegetation types (Priedītis, 1999; Auniņš et al., 2010), for example, the uncharacteristic species are spreading and could be found in the sample plots. The significant threatening factor is drainage and, as a result of it, the composition of species changes (Priedītis, 1999; Auniņš et al., 2010; Johannson, 2005). Frequently occurring species are adaptive to different environmental conditions. In the first zones of sample plots, it is possible to observe species that are not typical for the forest ecosystems. This fact is an evidence for the significant impact of edge effect (Grime, 2001).

The analysis of the average projective coverage by zones enables to draw a conclusion that the 1st zones herb layer projective coverage is 78.8%, for the tree layer it is 70.7%, for the moss layer – 49.9% and for the shrub layer – 25.2%. In the 3rd zones of sample plots the average projective coverage in the herb layer is 75.8%, in the tree layer – 63.7%, in the moss layer – 35.9% and the shrub layer – 18.2%. The average projective coverage of the 5th zones of sample plots in the herb layer is 81.1%, in the tree layer – 62.7%, in the moss layer – 45% and in the shrub layer – 28.9%. The average projective coverage (%) in the sample plots by zones is shown in Figure 4.

According to the analysis of projective coverage by zones, the dominant species in the tree layer are *Alnus glutinosa* (nitrophyllous type species), *Picea abies* (boreal type species) and *Betula pubescens*. The dominant species in the shrub layer are *Padus avium* (nitrophilous type species), *Sorbus aucuparia* L. (boreal type species) and *Corylus avellana* L. (nemoral type species). The most dominant species in the herb layer is *Oxalis acetosella* (boreal type species). This species is identified in all sample plots; it is one of the most widely spread species in these habitat types. *Urtica diotica (L.)* (nitrophilous type species) is frequently found in the sample plots.

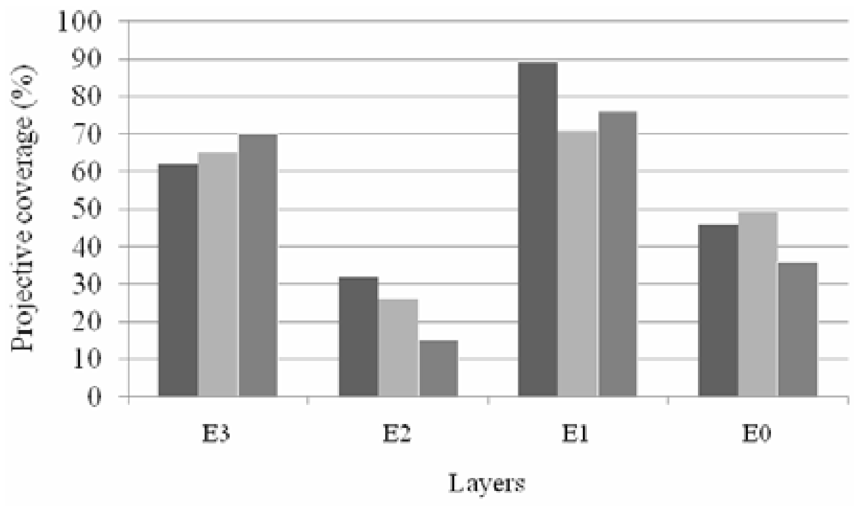

Figure 3. The comparison of projective coverage (%) by stands and within different age classes.
(■ – 1-10 years old stands; ■ – 20-30 years old stands; ■ – 40-50 years old stands;
E3 – tree layer; E2 – shrub layer; E1 – herb layer; E0 – moss layer).

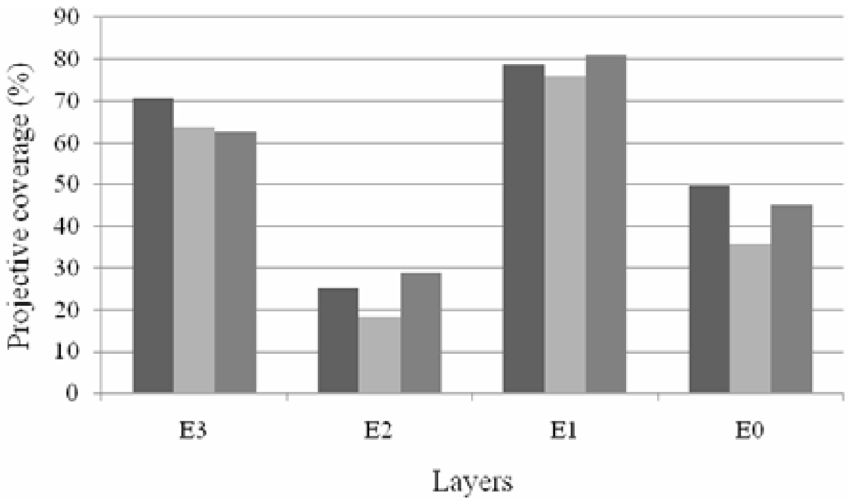

Figure 4. The average projective coverage (%) by zones.
(■ – 1st zone; ■ – 3rd zone; ■ – 5th zone; E3 – tree layer; E2 – shrub layer; E1 – herb layer; E0 – moss layer).

In the sample plots of black alder woodland the key habitat type indicator species have been found, for example, in the herb layer - *Milium effusum* L., *Solanum dulcamatra* L. and *Lysimachia vulgaris* L. (Priedītis, 1999; Auniņš et al., 2010). The most common species with average projective coverage (%) in the moss layer are *Thuidium tamariscum*, *Dicranum polysetum* Sw. and *Calliergonella cuspidata* (Hedw.) Loeske. In the moss layer the indicator species have been also found, for example, *Plagiomnium elatum* and *Climacium dendroides* (Hedw.) Web. Et Mohr.

The results of the one – way analysis of variance showed that the projective coverage (%) differences among the sample plots within different age classes of the next stands and among the zones have not been significant for the impact of edge effect on vegetation diversity (with credibility level 95%).

The impact of edge effect on the vegetation diversity is explicit in the sample plots, where the next stands on S-SW side are at the age of 1-10 years; there have been species identified that are uncharacteristic for these habitats. There is regularity among the locations of habitats. In the sample plots that are located near the roadsides or open patches, it is observed that diversity and composition of species are untypical for these habitat types (Packhman et al., 1992). Several studies have been performed to find out the impact of edge effect on the vegetation diversity; however, the results and conclusions are slightly different. In each location the assessment of the edge effect is evaluated separately, but it is more explicit, if the territory is on the edge that links different habitat types or ecosystems (Peterken, 1996). To analyze the width of edge effect and width of buffer zones establishment as an important factor is the age of next stand. As an important factor in forestry planning is the fact, that the structure of vascular plants and bryophytes depends on forest structures (Larsson, 2001), the composition of tree species and micro climate (Barrera-Lopez et al., 2007).

PCA analysis

PCA analysis shows the growth differences in black alder woodland key habitats. The ordination of species has defined the soil fertility and the gradient of moisture. The most closely by ordination of soil fertility is *Oxalis acetosella*. This species is located with mid moist and mid fertility soils. Also, *Picea abies*, *Maianthemum bifolium* and *Viola palustris dominate* closer to the soil fertility gradient.

On the right side of ordination more species, characteristic to the soil rich in nutrients, for example, *Milium effusum* and *Quercus robur* L as well as nitrophilous - *Naumburgia thyrsiflora* (L.) Rchb. on the herb layer and in a shrub layer *Alnus glutinosa* have been located. Closer to the middle point boreal forest type and meadow type species, for example, *Vaccinium myrtillus* and *Fragaria vesca* L have been identified. In the centre of ordination in the tree layer – *Picea abies*, the shrub layer – *Padus avium* and the herb layer – *Urtica dioica* have been found.

In general, all species are located quite closely to each other, which indicates demand for similar growth condition. In black alder woodland key habitats with the indicator and characteristic species (Priedītis, 1999; Ek et al., 2002) have occurred. Mostly the diversity of other species are identified in sample plots, where next stands S-SW side at the age class 1-10, for example *Cirsium arvense* (L.) Scop. (meadow type species) *Urtica dioica* L. and *Stellaria nemorum* L. (both - nitrophilous type species). Particularly, in one sample plot all 3 zones *Impatiens parviflora*- adventives species with rapid distribution has been identified. Due to the result of drainage, the soils are getting richer (Priedītis, 1999) and there is a change in plant communities and composition of species. Due to the climate changes (the amount of nitrate has increased in atmosphere), during the last century there are changes in forest growth types; mesotrophic forests have increased (Bambe and Donis, 2008).

Conclusions

The vegetation analysis shows that the number of species and composition in sample plots in different zones are variable; particularly the influence from the edge is noticed in the herb layer. In sample plots several plant communities, especially in the 1st and 3rd zones identified as untypical species for black alder woodland habitats have been found. Several meadow type species *(Fragaria vesca, Agrostis stolonifera* L.) and also one adventives species- *Impatiens parviflora* have been identified. However, most study sites have been observed in habitats characterized by mosaic structure with indicator species: *Solanum dulcamara, Dryopteris cristata* L. A.Gray and others. In study sites vascular plant and bryophyte indicator species have been identified, as well as protected species: *Circaea lutetiana* in one site and *Plagiothecium undulatum* in three sites. The differences among the sample plots within different age classes of next stands and among the zones have not been significant for the impact of edge effect on vegetation diversity (with credibly level 95%). Black alder woodland key habitats is the import and priority protected habitat type whose preservations can be achieved in implementation of several preventative activities, for example, buffer zone creation around habitats, decrease of drainage impact and others.

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