Dynamics of medical plants in the course of regeneration successions after clear cutting

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Abstract. The goal of the study was to elucidate the peculiarities of changes in the coverage of medical plants in the course of regeneration successions after clear cutting. 650 sample plots of different stages of succession and types of forest growing conditions were analyzed. It appeared that some species increased their coverage and some of them decreased it. The large group of species did not react to the cutting of the stand.

1. Introduction
Despite the presence of several publications devoted to the study of vegetation changes after clear cutting of forest the problem of changes of the resources volume of medical plants remains poorly studied [1]. The goal of the study was to elucidate the peculiarities of changes in the coverage of medical plants in the course of regeneration successions after clear cutting. The following tasks have been solved in the work: 1) determining the medical plant species role in forests using literature sources; 2) field data collection that could characterize the changes in plant species composition after clear cutting; 3) the analyses of changes of coverage of medical plants.

2. Methods and Materials

2.1. Research area

2.1.1. Basic information. Territory of Leningrad region is the subject of the Russian Federation, located in the northwest of the country’s European part. Area is 83,900 km². From west to east, the region stretches for 500 km, and the largest length from north to south is 320 km [2].

2.1.2. Geology. The region is located at the junction of two largest tectonic structures. The northwest of the region is located on the Baltic crystalline shield, where surface of Archean and early Proterozoic rocks is located. On the Finnish gulf’s and Ladoga Lake southern shores in the Cambrian period, thick strata of blue clays with sandstone interlayers were formed. In the eastern part of the region, the rocks are located close to the surface, that were formed in the Carboniferous period [2]. There are deposits of bauxite, limestone and dolomite. The north-west of the region is located on the Baltic crystalline shield, where Archean and Early Proterozoic rocks come to the surface [2]. In the Ordovician period,
there was the formation of sheath sandstones containing deposits of phosphorites and oil shale (west of the region). In the south of the region, rocks of the Devonian period come to the surface.

2.1.3. Relief. The topography of the region was finally formed in the Quaternary period as a result of four glaciations and interglacial epochs successively replacing them [2]. Therefore, the largest part of the region is occupied by the deposits of peat, clay and sand [2]. The terrane is flat with insignificant absolute heights (mainly 50-150 meters above sea level). The territory of the Karelian Isthmus is characterized by rugged terrane, numerous rocky outcrops and a large number of lakes. The Karelian Isthmus is part of the Baltic Crystalline Shield. The highest point of the Karelian Isthmus is Mount Kivisyurja 203 m above sea level. Lowlands are mainly located along the shores of the Gulf of Finland and Lake Ladoga, as well as in the valleys of large rivers. The largest uplands are the Lembolovskaya, Izhora, Lodynopolskaya, Vepsovskaya uplands and the Tikhvin ridge [2]. The highest point of the region - Mount Gapselga (291 meters above sea level) - is located on the Vepsovskaya Upland [2].

2.1.4. Climate. The climate on the territory of Leningrad region is transitional from maritime to continental, formed under the influence of the Atlantic Ocean and the Baltic Sea. Relatively mild winters with frequent thaws and moderately warm, sometimes cool summers are caused by the sea air masses. Ladoga Lake and Onega Lake also have a softening effect on the climate [2]. Increased cyclonic activity (especially in autumn-winter period) causes a predominance of western and south-western winds, bringing heat (in winter) and precipitation. Average temperatures in January are from −7 to −11 °C, in July 15–18 °C. The territory of the region is located in a zone of excessive moisture, precipitation is 600-850 mm per year, the largest amount of them falls in July and August and the least is in February and March. Permanent snow cover is forming in the period from the 2nd half of November until the 1st half of December and melt in the 2nd half of April [2].

2.1.5. Zonal position. According to [3] the region is located in southern and middle parts of two boreal (taiga) subzones. There are also extrazonal territories located at deposits rich with calcium carbonate with hemi-boreal vegetation (spruce forests with nemoral species) [3].

2.2. Methods of sample plot description
We have analyzed 650 sample plots laid in different landscapes of the region. We described forest areas that differ from the neighboring ones in location, soil and vegetation, maximally homogeneous in the BGC components. For the purpose of studying dynamics, we compiled relevés of short-derivative forests and heaths resulting from clear cutting located near the climax forest at the same elements of topography and similar hydrological regime.

The area of sample plots was about 1000-3000 m. Such an area made it possible to measure the basal area of trees and estimate the composition of the stand using a Bitterlich’s relascope at 3-5 points.

The average diameter and height of tree species were determined by the elements of the forest as arithmetic mean values from 4-10 (for the dominant species) or 1-3 (for the rest) measurements of average-sized trees. The age was determined by counting year rings on the cores taken by an age drill from several trees. The timber stock (in terms of 1 ha) was calculated according to the local standard table. The height of the undergrowth, it’s number and age, as well as the crown density and, in most cases were determined visually.

A list of all vascular plants, ground mosses and lichens that were found on the sample plot was compiled, and the coverage was calculated for species and layers as average from coverage determined on 20 subplots 1 m² each.

2.3. Forest types identification
The groups of sample plots with similar floristic composition and soils were joint to the particular type of forest growing conditions (forest site type, series of forest types), climax and short-derivative
forestsand cutting areas [4]. Series of forest types were identified using the guide for forest types [1]. A forest type unites forest biogeocenoses (ecosystems within the boundaries of a phytocenosis) of the same type of forest growing conditions and with the same predominant tree species [4].

2.4. Forest medical plant species
The list of forest medical species was compiled using illustrated guide for plants of the Leningrad region [5], in which three types of uses of medicinal plants were distinguished: in folk medicine, in homeopathy, in scientific medicine.

3. Results and Discussion

3.1. Vegetation dynamics on the strongly drained sands

3.1.1. Characteristics of habitats on drained sands. Ecotope - sandy and sandy loam soils (the proportion of physical clay is up to 15%), ground water is at a depth of 1.5 m and more.

3.1.2. Potential natural vegetation (PNV) on strongly drained sands. The native vegetation on the drained sands is the green moss spruce forests of the Vacciniosa series in the middle taiga, and the Psammophytoso-Myrtilliosa series in the southern taiga. In the region on the strongly drained sands pine forests of Cladinosa and Vacciniosa series predominates. They are maintained by the periodical surface fires. We consider them as long-term derived forest types.

3.1.3. Medical plants. At the habitats on the strongly drained sands occurred the next medical species: Antennaria dioica (L.) Gaertn., Arctostaphylos uva-ursi (L.) Spreng., Calluna vulgaris (L.) Hull, Cetraria islandica (L.) Ach., Juniperus communis L., Herniaaria glabra L., Hieracium umbellatum L., Jasione Montana L., Knautia arvense (L.) J.M. Coult., Sedum acre L., Thymus serpyllum L.

3.1.4. Dynamics after clear cutting. The species composition of felled areas Cladinosa and Vacciniosa series was similar to the communities that were before cutting. Only the occurrence of Carexerictorum Poll., Arctostaphylos uva-ursi (L.) Spreng., Festuca ovina L., Calamagrostis epigeios (L.) Roth., Chamaenerion angustifolium (L.) Scop., Avenella flexuosa (L.) Drejer increased slightly.

After clearing of the middle and southern taiga forests of the Psammophytoso-Myrtilliosa series, in the plant communities Calamagrostis arundinacea (L.) Roth, C. epigeios (L.) Roth, Avenella flexuosa (L.) Drejer, Petriadium aquilinum (L.) Kuhn, Vaccinium vitis-idaea L., Calluna vulgaris (L.) Hull, Chamaenerion angustifolium (L.) Scop., Melampyrum pretense L. dominated. In young and middle-aged forests, the same species prevail as in clear-cut areas, as well as Vaccinium myrtillus L., Rubus idaeus L., R. saxatilis L., in the moss layer Pleurozium schreberi (Brid.) Mitt. dominated.

3.2. Vegetation dynamics on the normally drained loams and dual deposits (sandy loam on loam)

3.2.1. Characterization of habitats on drained loams and dual deposits. Unlike sands, loams have a very important property that is extremely fine porosity, as a result of which they behave like fine molecular sieves, creating resistance for the passage of solutions of high-molecular compounds through them [6]. The lowest moisture content of loams is higher than that of sands. Loams also have a higher surface area of soil particles, which ensures the retention of colloids and water in the soil body. As a result, humus accumulates more intensively in loamy soils than in sandy soils. Dual deposits are similar in their properties to loams [7].

3.2.2. PNV on the normally drained loams and dual deposits. The PNV on drained carbonate-free loam in Leningrad region is spruce forest (Picea abies (L.) H. Karst.). In the middle and southern
taiga, the zonal type is the *Piceetum myrtillus*, in southern taiga subzone it is *Piceetum oxalidoso*. In the subtaiga (hemiboreal) regions, *Piceetum nemoriherbosum* is the additional association. In the middle, southern taiga and subtaiga, natural broad-leaved forests were found, which are relics of the warmer periods of the Holocene.

3.2.3. Medical plantson the normally drained loams and dual deposits. On the normally drained loams and dual deposits many medical trees occurred such as *Betula pubescens* Ehrh., *Picea abies* (L.) H. Karst., *Pinus sylvestris* L., *Populus tremula* L., *Salix caprea* L., *Sorbus aucuparia* L. In *Myrrilosa* and *Oxalidosa* series occur *Convallaria majalis* L., *Solidago virgaurea* L., *Huperzia selago* (L.) Bernh. ex Schrank & Mart., *Lycopodium clavatum* L., *Moneses uniflora* (L.) A. Gray, *Orthilia secunda* (L.) House, *Rubus idaeus* L. All these species never showed great coverage except *Convallaria majalis* and *Rubus idaeus* L. that were abundant in the deciduous stands. *Vaccinium myrtillus* L. and *V. vitis-idaea* L. were dominants in the grass-dwarf-shrub layer in the coniferous and old deciduous forests of *Myrrilosa* series. They also occurred in *Oxalidosa* series but with low coverage. *Oxalis acetosella* L. dominated in spruce forest in pine and deciduous forests of *Oxalidosa* series with the second tree layer of spruce.

*Aconitum lycoctonum* L., *Aegopodium podagraria* L., *Dryopteris filix-mas* (L.) Schott, *Paris quadrifolia* L., *Pyrola rotundifolia* L. occurred in *Oxalidosa* and *Nemoriherbosum* series.

*Actaea spicata* L., *Ajuga reptans* L., *Anthriscus sylvestris* (L.) Hoffm., *Angelica sylvestris* L., *Corylus avellana* L., *Ficaria verna* Huds., *Galium odoratum* (L.) Scop., *Geum alleppicum* Jacq., *Glehoma hederacea* L., *Pulmonaria obscura* Dumort., *Quercus robur* L., *Stachys sylvatica* L., *Stellaria holostea* L., *Viburnum opulus* L. occurred mainly in *Nemoriherbosum* forests.

3.2.4. Dynamics after clear cutting. After clear cutting of mid- and southern taiga spruce, pine, birch forests of *Oxalidosa* series on normally drained loams and dual deposits, *Calamagrostis arundinacea* (L.) Roth, *C. epigetos* (L.) Roth, *Chamaenerion angustifolium* (L.) Scop., *Deschampsia caespitosa* (L.) P. Beauv., *Rubus idaeus* L., *R. saxatilis* L., *Cirsium heterophyllum* (L.) Hill, were abundant. Birch and aspen predominated in the young stands. The maximum coverage of the grass-dwarf shrub layer (75–80%) was observed at the age of about 10 years. In young spruce stands, total coverage of the grass-dwarf shrub layer decreased at the age of 30–40 years to 20–30%, and then increased to 40%, due to an increase in the coverage of *Oxalis acetosella* L., starting from the age of 20–30 years. In sparse spruce forests at the age of 100 or more years, the dominance of *Calamagrostis arundinacea* (L.) Roth, *Rubus saxatilis* L. was sometimes noted.

In birch and aspen forests, there was a gradual decrease in the cover of the grass-dwarf shrub layer to 40–50%. In birch forests over 30 years old (up to 130 years old), the dominance of *Calamagrostis arundinacea* (L.) Roth, *Rubus saxatilis* L., *Convallaria majalis* L., *Gymnocarpium dryopteris* (L.) Newman was noted, and starting from the age of 50–70 years, predominated also *Oxalis acetosella* L. The coverage of the moss layer decreased by 5–7 years after cutting to 5%. In spruce forests, its maximum value was observed at 50–70 years (30–40%), and then it decreased to 20–30% at the age of 100–130 years. In birch forests, the moss cover remained constant for 75–100 years (about 5%). At all stages in birch forests, there was a high abundance of species of the genera *Brachythecium* Bruch et al. and *Scirpohypnum* Hampe in the moss layer, and *Pleurozium schreberi* (Brid.) Mitt. in spruce forests. The dominance of *Hylocomium splendens* (Hedw.) Bruch et al. was noted in spruce forests over 30 years old.

After clear cutting of south-taiga and subtaiga forests of the *Nemoriherbosum* series on the normally drained loams and binomial deposits in clearings and in young stands (up to 15 years old), the predominance of *Calamagrostis arundinacea* (L.) Roth, *Aegopodium podagraria* L., *Rubus saxatilis* L., *Dryopteris expansa* (C. Presl) Fraser-Jenk. & Jermy, *Atyrium filix-femina* (L.) Roth, *Pulmonaria obscura* Dumort., *Stellaria holostea* L., *Urtica dioica* L., *Chelidonium majus* L., *Geum ranunculoides* L. was observed. Significant participation of shrubs and trees of the second size such as *Sorbus*


In the clearings of the **Nemoriferbosa** series, mainly deciduous tree species, such as birch, aspen, ash, elm and linden were renewed. Young spruce stands appeared when spruce undergrowth has been preserved, pine stands occurred in clearings that have been induced by fire. In clearings and young stands, the herbaceous layer reached 50–70%, and then, starting from the age of 6–10 years, it has decreased. When the canopy of young spruce stands became closed at the age of 30–40, just as in the forests of **Oxalidoso** series, the coverage of the grass layer decreased to 20–30%, and then increased to 40–50% due to an increase in the coverage of species of nemoral forbs. At the age of 20–40 years, **Oxalis acetosella** L. often predominated in the herbaceous layer, which often led to an erroneous assignment of young spruce stands to the **Oxalidoso** series. Just as in the **Oxalidoso** series, in deciduous young stands, as they grew older, there was a gradual decrease in the coverage of the grass layer, a change of **Calamagrostis arundinacea** (L.) Roth and other light dependent species with **Oxalis acetosella** L. and nemoral forbs. When cutting is 50 years old or more, the herb layer could be dominated by **Rubus saxatilis** L., **Oxalis acetosella** L., **Pulmonaria obscura** Dumort., **Stellaria holostea** L., **Aegopodium podagraria** L., ferns (**Dryopteris expansa** (C. Presl) Fraser-Jenk. & Jermy, **Athyrium filix-femina** (L.) Roth). All of them except **Dryopteris expansa**were medical plants. In the weakly developed moss layer, **Rhytidia delphus triquetra** (Hedw.) Warnst., **Plagiochila asplenioides** (L. emend. Taylor) Dumort., species of the genera **Brachythecium** Bruch et al. and **Scirrohypnum** Hampe occurred.

Derived forests and cutting areas, forest-edges contain meadow and weed plants characteristic of disturbed communities. Among them there were many medical plants such as **Angelica sylvestris** L., **Aguilegia vulgaris** L., **Chamaenerion angustifolium** (L.) Scop., **Chelidonium majus** L., **Conioselinum tataricum** Hoffm., **Dianthus deltoides** L., **Fragania vesca** L., **Galium boreale** L., **Geranium pratense** L., **Hierochloe odorata**(L.) P. Beauv., **Rubus idaeus** L., **R. caesius** L., **Rumex obtusifolius** L., **Stellaria media** (L.) Vill., **Succisa pratensis** Moench, **Urtica dioica** L.

3.3. Vegetation dynamics on wetland habitats

3.3.1. Habitat characteristics. The wetlands are characterized by: glelying at a depth of less than 1.5 m, increased thickness of organic horizons (more than 9 cm), in comparison with normally drained soils, and the presence of a developed microrelief. Taking into account the PNV in wetland habitats, they can be grouped into three classes of habitats by richness of soil with available nutrients and into three groups of forest type series corresponding to them (table 1).

Following [7], we distinguished three grades of drainage, differing in the thickness of the organic horizon: insufficient (10-15 cm), weak (16–30 cm); peatland (> 30 cm).

3.3.2. PNV of wetlands. The **Paludiherbosa** group included three series of forest fens: 1) **Oxalidoso-Filipendulosa** series on insufficiently drained lands; 2) **Filipendulosa** series on poorly drained lands and eutrophic peatlands; 3) **Paludiherbosa** series on poorly drained lands and eutrophic peatlands.

**Polytrichoso-Sphagnosa** group included in the middle and southern taiga 3 series: 1) **Polytrichoso-Mytrillosa** series on insufficiently drained lands; 2) **Pteridoso-Sphagnosagirgensohnii**, 3) **Mytrilloso-Sphagnosa** on weakly drained sites and mesotrophic peatlands.

**Herbosso-Sphagnosa** group included two series on weakly drained lands and mesotrophic peatlands: 1) **Caricososialiocarpae - Eriophorosa**, 2) **Caricososo-Sphagnosa.** The **Sphagnosa** group included three cycles: 1) **Ledoso-Mytrillosa** on insufficiently and poorly drained lands, 2) **Ledosa** on oligotrophic peatlands, 3) **Sphagnosa** on oligotrophic peatlands.

3.3.3. Medical plants in wetland forests. In forests of **Paludiherbosa** group **Alnus glutinoso** (L.) Gaertn., **Chrysosplenium alternifolium** L., **Filipendula ulmaria** (L.) Maxim., **Frangula alnus** Mill., **Geumrivale L., Humulus lupulus L., Impatiens noli-tangere L., Padus avium Mill., Rubus arcticus L.,**

aucuparia L., Padus avium Mill., Lonicera xylosteum L., Salix caprea L., and in the southern regions also Corylus avellana L., Sambucus racemose L., Rhamnus cathartica L. were characteristic.
Salix pentandra L., Trollius europaeus L., Ulmus laevis Pall., Urtica dioica L., Valeriana officinalis were common. Athyrium filix-femina (L.) Roth occurred also in Oxlidoso-Filipendulosa, Filipendulosa, Pteridoso-Sphagnosagirgensohii series. Comarum palustre, Menyanthes trifoliata occurred also in the forests of Paludiberbosa, Pteridoso-Sphagnosagirgensohii and Herbososo-Sphagnos series. Vaccinium myrtillus L. and V. vitis-idaea L. were abundant in the forests of Polytrichoso-Myrtillosa, Myrtilloso-Sphagnosa, Ledoso-Myrtillosa series on in sufficiently and poorly drained lands. Rubus chamaemorus usually grew in the forests of Sphagnosa and Polytrichoso-Sphagnosa groups. Ledum palustre was constant and usually dominated in the pine forests of Sphagnosa group.

Table 1. Habitat classes and groups of series of forests on wetlands.

| Habitat classes | Water regime                      | Tree dominants of PNV                     | Groups of series          |
|-----------------|-----------------------------------|------------------------------------------|---------------------------|
| Eutrophic       | Flow, from moderately to extremely wet | Picea abies (L.) H. Karst., Betula pubescens Ehrh., Alnus glutinosa (L.) | Paludiberbosa            |
| Mesotrophic     | Stagnate, moderately wet          | Picea abies (L.) H. Karst.               | Polytrichoso-Sphagnosa    |
|                 | Stagnate, extremely wet           | Pinus sylvestris L., Betula pubescens Ehrh. | Herboso-Sphagnosa        |
| Oligotrophic    | Stagnate, from moderately to extremely wet | Pinus sylvestris L. | Sphagnosa |

3.3.4. Dynamics after clear cutting. Deciduous species predominate in 60–70% of cases on clearings of forests of Paludiberbosa group without preserving spruce undergrowth: black alder (Alnus glutinosa (L.) Gaertn.), birch (Betula pubescens Ehrh.), gray alder (Alnus incana (L.) Moench). When cutting with preservation of undergrowth, spruce predominates in only 40% of young stands.

At the clearingsand in the stands of 5–10 years old Oxlidoso-Filipendulosa series, the coverage of the grass layer reaches 70–80%. In closed 30–40-year-old spruce forests it decreased to 45–55%, and then, with increasing age, it gradually increased up to 50-60%. In deciduous forests, the cover of the grass layer gradually decreased by the age of 100 years. Starting from the age of 30 Oxalis acetosella L., Athyrium filix-femina (L.) Roth usually prevails in spruce forests, and Filipendula ulmaria (L.) Maxim. in deciduous forests. Other species that often dominated in deciduous and coniferous forests, starting from the age of 30, were Aconitum septentrionale L., Aegopodium podagraria L., Geum rivale L., Gymnocarpium dryopteris (L.) Newman, Galeobdolon luteum Huds., Pulmonaria obscura Dumort., and in the middle taiga were Maianthemum bifolium (L.) F.W. Schmidt, Vaccinium myrtillus L. The coverage of the moss layer in the first 5–10 years decreased to 10–15%. In spruce forests, its cover increased by the age of 30 to 30–35%, and then remained stable. In small-leaved forests, the cover of the moss layer significantly increased to 20–25% only at the age of more than 70 years. In the moss layer, Rhytidiadelphus triquetrus (Hedw.) Warnst. most often predominated, Plagiommium medium also played a significant role. In spruce forests Sphagnum squarrosum Crome and S. girgensohnii Russow dominated, in the middle taiga subzone Pleuroziumschreberi (Brind.) Mitt., Hylocomium splendens (Hedw.) Bruch et al., Climacium dendroides (Hedw.) F.Weber & D.Mohrwere also registered as dominants. The average number of species Oxlidoso-Filipendulosa forests varied from 51 to 67. In cutting areas, it usually increased due to the introduction of weeds.
The coverage of the herbaceous layer reached a maximum (70–90%) by 5–7 years after cutting of the Filipendulosa and Paludiherbosa forests, and then, as the stand developed, it gradually decreased to 30% by the age of 100 years. In clearings and in young stands, the same species prevail as in the older forests (Athryum filix-femina (L.) Roth, Filipendula ulmaria (L.) Maxim., Equisetum sylvaticum L., Calamagrostis canescens (Weber) Roth, C. purpurea (Trin.) Trin., Scirpus sylvaticus L., Lysimaquia vulgaris L.). Menyanthes trifoliata L., Calla palustris L. and sedges such as Carex acuta L., C. vesicaria L., often predominated in the forests of Paludiherbosa series. The coverage of the moss layer at the stages of young and middle-aged stands is about 10%, and at the stage of mature forest it was 30–40%.

After clear cutting of forests of the Polytrichoso-Sphagnosa group, mainly birch predominated. Carex globularis L., Equisetum sylvaticum L., Vaccinium vitis-idaea L., which were present or dominated before cutting, prevailed in clearings and in young stands of the Polytrichoso-Sphagnosa series in the herb-subshrub layer. In the southern and middle taiga, Calamagrostis arundinacea (L.) Roth, C. epigeios (L.) Roth, C. canescens (Weber) Roth, Avenella flexuosa (L.) Drejer, Molinia caerulea (L.) Moench, Juncus effusus L., J. conglomeratus L., J. filiformis L. added to them.

In 5–7 years after cutting in young stands in place of forests of Polytrichioso-Myrtillosa series, the total coverage of the herb-dwarf-shrub layer increased from 25–30% to 50–60%, its minimum (10–20%) was observed in spruce young stands of 30–40 years old, then a gradual increase of the coverage to the initial value was observed. In birch and aspen forests, as well as in forests on normally drained soils, the restoration of the cover of the grass-dwarf-shrub layer occurred by the age of 50–70 years. The replacement of pioneer species with Vaccinium myrtillus L. occurred in birch and spruce forests at the age of 30–40 years.

Cutting led to an overall decrease in the coverage of the moss layer to 15–20% due to mechanical damage by machinery and overlapping of mosses by cutting residues. In the moss layer, it was often observed, especially in deciduous young stands, that the Sphagnum L. cover has been replaced by Polytrichum commune Hedw. The restoration of the cover of the moss layer to its original state took 10–20 years in young coniferous stands of Myrtillosa-Sphagnosa series. It lasted up to 130 years in deciduous stands. Changes of Pteridoso-Sphagnosagirgensohnii spruce forests occurred in a similar way. Athryum filix-femina (L.) Roth, Equisetum sylvaticum L., Calamagrostis canescens (Weber) Roth, and Dryopteris carthusiana (Vill.) H.P. Fuchs were among the dominants in Pteridoso-Sphagnosagirgensohnii birch forests.

The composition of species appearing in clearings of Polytrichoso-Myrtillosa is close to that of Myrtillosa-cutting areas on loams. After cutting of forests of the Sphagnosa group, the coverage of Calluna vulgaris (L.) Hull, Carex globularis L., Eriophorum vaginatum L., and Molinia caerulea (L.) Moench increased. Cuttings were renewed with pine and slight admixture of birch. It took 5–7 years to restore the coverage of the moss layer. In the early stages the coverage of Polytrichum commune Hedw., P. juniperinum Hedw., P. strictum Brid.increased. On clearings of Sphagnosa forests, the species composition not changed or appeared 1–5 new species that were absent in the original (control) community. Among these species were Juncus effusus L., J. filiformis L., Carex cinerea L., C. brunnescens (Pers.) Poir., C. leporine L., Luzula multiflora (Ehrh.) Lej., Calamagrostis arundinacea (L.) Roth, Deshampsia caespitosa (L.) P. Beauv., Chamaenerion angustifolium (L.) Scop.

4. Conclusions

Differences in the composition of natural regeneration in cutting areas were due not only to the conditions of soil moisture and richness, but also to the technological parameters of cutting, the composition and age of adjacent stands (the presence of seedlings), the amount of preserved spruce undergrowth of preliminary regeneration, and the granulometric composition of soils:

- after clear cutting of pine forests of lichen and lingenberry series, mainly pine renewed;
- after clear cutting of spruce forests, the change of prevailing tree species with pine, birch and aspen was widespread;
• types of forest on sands and loamssignificantly differ in the probability of renewal of pine (prefer sand, sandy loam), birch and aspen (prefer loam and sandy loam) and the peculiarities of succesion. Despite significant differences in the vegetation of cutting sites in different growing conditions, they have the following common features:

• in the first 1–2 years, the structure of the living ground cover, characteristic of the forest community, was preserved, but the most shade-tolerant forest plants experience stress and partially reduce their coverage;

• a decrease in the coverage of species is often observed due to their mechanical damage in the process of cutting and logging;

• among shade-tolerant forest medical plants that reduce their coverage after cutting are *Oxalis acetosella* L., *Vaccinium myrtillus* L., *Maianthemum bifolium* (L.) F.W. Schmidt, *Paris quadrifolia* L.;

• in the 2-3rd years, the growth of heliophythes, vegetatively mobile species or species with high seed productivity begins, many of them were shade-tolerant forest medical plants that reduce their coverage after cutting characteristic of cutting and young stands of different types of forest (for example, *Calamagrostis* species), which led to the convergence of plant communities that appeared in place of forests of various original types;

• among heliophytes forest medical plants that increase their coverage after cutting were *Aegopodium podagraria* L., *Arctostaphylos uva-ursi* (L.) Spreng., *Calluna vulgaris* (L.) Hull, *Chamaenerion angustifolium* (L.) Scop., *Filipendula ulmaria* (L.) Maxim., *Rubus idaeus* L., *Urtica dioica* L.

• during the first 3 years, the appearance of herbaceous species that were not characteristic of undisturbed forest stands was possible; the higher the overall synanthropization of flora, correlated with the degree of urbanization, agricultural or road development of the landscape, the higher their representation in cutting areas.

The knowledge gained on the distribution of medicinal plants by forest types and age stages makes it possible, on the basis of forest inventory materials, to optimize plans for their collection.

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