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Forestry and Ecological Aspects of the Broad-Leaved Forest Formation

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Abstract: Broad-leaved forests, being the dominant formation in the Pre Urals, occupy large areas and perform protective functions. Mixed, uneven-aged plantations including multi-species floristic composition are represented in the forests. Formation, growth and development of forest stands and other forest components occur under the exogenous and endogenous factors influence. As a result, the protective and environmental forests functions are reduced, the territory ecological balance is disturbed in a whole. The majority of broad-leaved forests are now represented by mature and over-mature stands where natural regenerative processes are violated forest communities are transformed and their composition is simplified. Oak and oak-lime forests are particularly intensively involved in this process. Whose area has been reduced by half in the last few decades. This problem is not fully covered by research in the region, especially, regarding the new formations forming in places where rapid changes of vegetation occur. In this regard, the aim of the research was to assess the main forest components, the species composition dynamics allowing to identify the features and structural transformations of broad-leaved forests associated with the regenerative dynamics disturbance forest stands aging at the formation stage.

Key words: Broad-leaved forests forest stand, grass cover, undergrowth, species composition, transformed, region

INTRODUCTION

Broad-leaved forests are widespread on a significant territory of the European part of Russia. Under the Pre Urals conditions, they are the dominant forest community formation, mostly attributed to protective forests performing functions variety. Forests, possessing huge ecological potential and being rich in phytocoenological diversity and multi-view structure, perform a great stabilizing and biospheric role in biodiversity preserving (Kraus and Krumm, 2013; Smirnova *et al*., 2011).

Long-term anthropogenic pressure, recreation, climatic conditions have largely influenced the broad-leaved forests formation. This is causing many variants of forest communities derivatives currently existing in small arrays among acrocyanoses and settlements and have an island character (Smirnov, 2008; Korotkov, 2017).

In unstable ecological conditions, modern broad-leaved forests should differ in species and structural diversity, better perform protective functions and be adapted to changing environmental conditions but they are repeatedly transformed, they are not able to fully implement the basic ecosystem functions (Gamfeldt *et al*., 2008).

Currently, there is an intensive forests aging, transformation into more simplified communities in composition and structure, leading to undesirable changes in the water regime, soil degradation, declining productivity and biological diversity (Popov, 1980; Schwartz *et al*., 2000; Pavlov and Bukvareva, 2012; Ciccarese *et al*., 2012). Zonal and regional forest features are primarily manifested through a change in the price-forming species composition (lime, oak and ash), the activity of the main broad-grass species determining their typological diversity as well as the derived communities specificity (Arkhipova, 2013).

Oak stands of vegetative origin mainly being old-aged plants are especially, covered by dynamic processes, resulting in a growth and stability decrease,

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they have no future in the viable undergrowth absence (Stojanovic *et al*., 2015; Korotkov, 2017). In the Pre Urals the oak forests area involving lime, elm and maple has halved for several decades and in the future the process can only accelerate, the vegetation composition is simplified and biodiversity is reduced which takes place not only in the European part of Russia but also abroad (Fischer *et al*., 2006).

Taking into account these phenomena, the aim of the research was to assess the broad-leaved forests state, species composition dynamics nature forest main components, competitiveness which allows us to identify the characteristic structural transformations associated with the natural stands aging.

The obtained results of the species composition dynamics and peculiarities occurring in the vegetation changes process may serve as a basis for developing effective methods and forest management methods in broad-leaved forests.

MATERIALS AND METHODS

Ecological and silvicultural peculiarities of the broad-leaved forests formation dynamics were studied in the Pre Urals conditions on the border of the broad-leaved Eastern European forests. The phytocoenotic method on the complex studies basis including the main forest components is applied, available literature sources industry standards are used (Sukachjov and Zonn, 1961).

The grass cover in various forest types according to the method developed by Mirkin and Naumova (2012) was studied which made it possible to establish species composition, abundance and occurrence frequency of the grass vegetation under the forest canopy.

To take into account the natural renewal, methods generally used in silvicultural practice were applied. To exclude a sampling error the number of registration sites depending on the density and nature of the undergrowth placement was chosen. Grass layer types, underbrush, tree-shrub species being unable to with stand anthropogenic impact and the most tolerant to the changed environment conditions have been identified.

Species composition characteristic of broad-leaved forests were carried out using the mass forest-protective material and registration work on the assessment of the stand species composition which allows us to draw the appropriate conclusions. Forest stands formation and modification dynamics in the broad-leaved forests natural growth has been studied for the period from 1966-2016 on the same sites in conditions of increased anthropogenic stress which is typical for the region's forests. Studies of the deciduous forests species composition dynamics and their competitiveness may be the basis for the theoretical foundations and practical recommendations development for the conservation of uneven-aged and multi-species broad-leaved forests on the continuity and balance principles in forest management.

RESULTS AND DISCUSSION

Broad-leaved forests of the Pre Ural Eastern European zone located near large cities, small settlements and agricultural lands have enormous ecological and recreational importance.

Forests perform water protection, shelterbelt, sanitary-hygienic, anti-erosion and many other functions. Forests formation, growth and natural renewal occur under the of anthropogenic factors influence, determining their "island" location. Broad-leaved forests occupy more than 60% on the initial territory in the forest fund general composition. Old-growth oak-lime forest stands and some associated species are their significant part. The forests floral composition and structure are formed in accordance with the growth conditions, human influence degree and environmental pollution level. Forests form a multi-storied vegetation cover, represented by edifiers species and their satellites. The main forest-forming species of the Pre Ural modern broad-leaved forests are *Quercus robur* L, *Tilia cordata* Mill and associated species such as *Acer platanoides* L, Elm elm (*Ulimus laevis* Pall), Elm (Ulmus) glabra Huds) less often aspen (*Populus tremula* L) and birch dangling (*Betuia pendula* Roth). The stands with the Acer platanoides maple predominance and elm (*Uimus laevis* Pall., *Ulmus glabra* Huds.) are less common, the elm in the composition predominates on the terraces in the foothill zone. The lime proportion in the composition decreases to the south of the Pre Ural zone and in the steppe zone the oak dominates everywhere, it is noted in studies on the broad-leaved forests distribution in the European part of Russia (Arkhipova, 2013).

Previous studies (Popov, 1980; Nejshtadt, 1983) found that broad-leaved forests had been formed during the Holocene first half. The immigration wave began in the Holocene pre- boreal period. At that time, broad-leaved species remains were found in the area of Belaya River downstream in the following period the oak forests continued their migration to the west, creating a broad-leaved steppe landscape. Lime populations penetrated farther to the east from all non-moral species are powerful environmental agents being able to grow in a wide range of ecological conditions.

Recently, 50-80 years dynamic transformations occur in the broad leaved forests structure of the Pre Ural

Table 1: Forest-typological characteristics of broad-leaved plantations

Forest types	Woody species	Relief elements	Grass storey dominants
Cereals	*Quercus robur, Acer platanoides, Tilia cordata, Ulmus glabra, Ulmus laevis*	The hill peaks, plateaus and gentle slopes of southern expositions	*Festuca sylvatica* L., *Pteridium aquilinum* L., *Rubus saxatilis* L., *Fragaria vesca* L. , *Geum urbanum* L
Broad-grass	*Quercus robur, Acer platanoides Tilia cordata, Ulmus glabra, Ulmus laevis, Populus tremula*	Plains and lowlands, gentle hillsides, watersheds	*Aegopodium podagraria* L., *Aconitum septentrionale* Koelle, *Polygonatum odoratum* Mill., *Asarun europaeum* L., *Glechoma hederacea* L., *Lathyrus vernus* L., *Pulmonaria obscura* Dumor., *Stellaria holostea* L., *Paris guadrifolia* L
Dewlap	*Quercus robur, Acer platanoides, Tilia cordata, Ulmus glabra, Ulmus laevis, Populus tremula*	Elevated plateaus, gently sloping hills, watersheds	*Aegopodium podagraria* L. *Polygonatum odoratum* Mill. *Rubus saxátilis* L, *Asarun europaeum* L. *Geranium sylvatica* L, *Lathyrus vernus* L *Viola mirabilis* L., *Glechoma hederacea* L. *Stellaria holostea* L
Nettle-spiraea	*Quercus robur, Tilia cordata, Ulmus, glabra Populus tremula, Salix alba, Populus nigra*	The river valleys and meadows. The lower parts of gentle slopes.	*Urtica urens* L. *Filipendula ulmaria* Carex, *Geum rivale* L. *Equisetum* pratense, Bromus inermis Leyss
Blackberry	*Quercus* robur, *Tilia cordata, Ulmus glabra, Salix alba, Populus nigra,* Alnus glutinosa	Flood terraces, river valleys	Rubus caesius-abundantly, *Carex cespitosa* L.-rarely
Floodplain	*Ulmus glabra, Salix alba, Quercus robur, Alnus incana*	Floodplains of rivers and streams	*Carex cespitosa* L, *Bromus inermis*, Leyss. *Rumex confertus willd*

forest-steppe without regard for typological conditions, mostly affecting oak plantations which area has been halved. Lime plantations do not significantly decrease, on the contrary, there is an increase in its area, it occupies a leading position in the region forest fund.

In order to assess the dynamics of forest vegetation specific features on the Pre Ural central part with high population density where the anthropogenic and recreational loads are higher, the features of the broad-leaved forests formation growing in different typological conditions are studied.

Forests typological diversity is not rich, largely due to relief elements and edaphic conditions. Forests grow on quite rich soils chernozem (black soil), dark gray forest soils and less rich gray and light gray forest soils which clearly illustrates the grass vegetation composition. The forest structure due to the forest typological characteristics is closely related and affects the natural renewal level forest cultures growth success and it is important in forest management practices. Table 1 shows the characteristics and distribution of broad-leaved forests by their types. In the study cereal, broad-grass, dewlap, nettle-spiraea, blackberry and floodplain forest types were identified.

Cereal forest stands are confined to elevated plateaus, slopes of southern exposures and hills, they occupy on the whole no more than 10-15% of the territory. The most part of broad-leaved forests is characterized by broad-grass and dewlap forest types having the highest forestry and taxation characteristics. They occupy plains and lowlands, gentle hillsides, watersheds. The nettle-grassland, blackberry and floodplain forest types are confined to the river valleys and terraces, floodplains.

Grass cover is formed in accordance with the forest typological structure. Taking into account that long and broad-grass forests are spread over a considerable area, the grass cover composition was studied thoroughly in forests growing under these typological conditions. In the dredge-wide-grass typological group, 46 herbaceous plants species were identified, the projective coverage is 40-70% and depends on the canopy closeness. The grass stand height ranges from 0.2-0.6 m. The grass cover with a significant share of broad-grassed species is developed in an average degree, being unevenly distributed over the area. Typical broad-leaved forests representatives are widespread with a high score of abundance: *Aegopodium podagraria* L. *asarun europaeum* L., *Glechoma hederacea* L, *Stellaria holostea* L., *Urtica urens* L., *Paris guadrifolia* L., *Festuca sylvatica* L., *Geum urbanum* L., *Lathyrus vernus* L., *Geranium sylvatica* L. *Chelidonium majus* L. *Ficaria verna* Huds., *Sonchus palustris* L. *Phlomis tuberosa* L. are less common.

Anthropogenic impact promoted the introduction and expansion of synanthropic species such as *Chelidonium majus* L., *Geum urbanum* L., *Plantago major* L. and others. These species presence in the grass cover indicates the human impact on the forest community, the forest ecosystem becomes less stable, typically forest species being not adapted to conditions created by human intervention are replaced by species having greater adaptive potential and resistance. The occurrence frequency and abundance of these species in the grass cover allow us to draw conclusions about the human influence level and this community disturbance degree.

Broad-leaved forests ecological potential forming character, species diversity are closely related to the

renewable process characteristics, due to the undergrowth presence and condition under the canopy, being one of the most important ecosystem sustainability indicators. The future stands formation depends on the undergrowth state. The undergrowth presence contributes to the natural formation of trees biogroups and ensures the natural environmental relations preservation. Norway maple takes a large part in the undergrowth consisting of lime and Oak stands. The amount per 1 ha is 13-19 thousand and only the change in the stand completeness affects its number. The maple composition is represented by several age generations. The maple undergrowth height ranges from 0.3-2.3 m, it occurs everywhere and often closes into a continuous canopy.

The amount of lime undergrowth is much lower from 1.2-4.0 thousand copies per hectare but its quantity increases proportionally to the decrease in completeness. Undergrowth is not represented by the full age individuals spectrum both vegetative and seed origin (Sultanova *et al*., 2010).

The oak undergrowth is less common (0.5-1.0 copies/ha), mainly they are Oak trees with a height of more than 0.4-0.7 m of seed origin. In the conditions of strong shading, unstable climatic conditions, anthropogenic pressure, the Oak undergrowth does not stand competition with rapidly conquering free space but less valuable species and intensively growing undergrowth.

Studies of renewal under the Oak and lime plantations canopy have shown the Oak ability to give sufficient number of shoots for species reproduction forming a viable undergrowth with appropriate care and sufficient light under appropriate conditions. Weak growth and periodic die-off of oak apical shoots, struggle for light and moisture affect its further growth, determining the formation features of the younger generation growing under the canopy (Konashova, 2007).

As it is noted in some studies (Harchenko and Harchenko, 2013; Chistyakova, 2017), the Oak shoots (self-seeding) under the forest canopy die at the age of 3-5 years, the oak does not form a viable undergrowth and in case of its surviving it does not exceed 0.5-1.5 m.

Free space is formed in forest stands during the old trees dying and cutting down process. It is quickly absorbed by lime (*Tilia cordata*), acicular platanoides and elm (*Ulmus laevis*) tolerating a light lack in the early ontogenesis stages as noted in studies in the European part of Russia (Chistyakova, 2017). By height and age the undergrowth develops unevenly with a maximum of specimens under the age of 10 years and a minimum of older age.

Analysis of the broad-leaved forests renewal capacity illustrates the emerging prerequisites for the woody vegetation replacement, being especially, evident in oak forests while the lime has maximally developed ability for vegetative reproduction and high competitiveness causes the possibility of sustainable lime existence in forest communities which significantly affects the shift some edificators by others.

It is believed that, the climate is the common cause of changes in the broad-leaved forests vegetation on a global scale but an equally important factor stimulating the shift is related to the species bioecological features, their relationships affecting the change of one community character to another (Pavlov and Bukvareva, 2012; Kalinichenko, 2000). In the Pre Ural forest-steppe conditions, broad-leaved forests reached the mature age and older are gradually thinned, the oak dies, the released niches occupy satellite species, the lime dominates in this process (Musievsky, 2010; Chebotarjov *et al*., 2017).

The process main features on the same sites through a transformation comparative analysis over 50 years using the possibility of the species composition comparative dynamics of oak-lime stands have been studied. Mixed uneven-aged oak-lime stands with the participation of 50-90 aged maple, elm aspen trees, growing in dewlap forest were the initial material. For the first time the forest stand taxation was carried out in 1966, the oak in the composition was represented by share participation at the level of 60-80%, lime -20-30% and other species not more than 10-20%. After two decades the stands species composition changed insignificantly, only the oak participation decreased, the of lime share increased due to the young growth formed from the undergrowth, the elm participation in the composition decreased. The forest stand assessment carried out in 2016 showed that old-aged lime and oak trees due to natural causes, climatic phenomena and anthropogenic factors are gradually dying off. The oak age is 110-130 years, the lime older generation age is 90-100 years. There are significant changes in the stands composition, the gaps have formed, the undergrowth grows strongly, the lime young growth occupies a leading position. During this period, the oak participation in the composition is reduced and is 20-30%, oak satellites occupy the vacant niches forming lime-oak and maple-lime forest stands with the oak participation where oak is not the community dominant. Figure 1a-d illustrate transformations taking place in broad-leaved forests. Describing the results obtained, it can be noted that, the lime dominant position during the communities

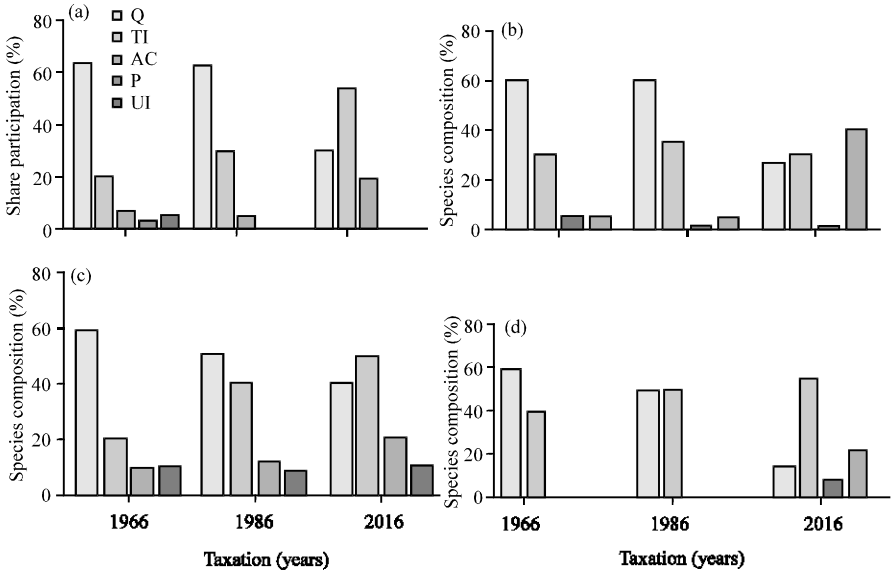

Fig. 1a-d: Dynamics of species composition of broad-leaved forest stands over a 50 years period

change is characteristic of the majority of stands including other broad-leaved forest areas where oak is highly competitive with the satellites and undergrowth under the parent forest stand canopy practically does not form (Musievsky, 2010; Harchenko and Harchenko, 2013).

The change of oak forest stands by maple is less common and the maple share in the composition does not exceed 50%, usually it occurs where the man influence is more intensive, the maple with different of participation share in broad-leaved forests is found everywhere. The maple sustainable existence is due to its ability to grow under the forest canopy, abundance of self-seeding and resistance to frost and mechanical damage. These biological properties and the ability to various environmental conditions adaptation cause a high maple tolerance.

It should be noted that in contrast to lime, Norway maple forest stand is characterized by low forest-taxation indicators (the height is not more than 15 m, the diameter is 12-16 cm). Density and dense closeness provide it with a stable existence which is also, observed in other broad-leaved forests areas (Chebotarjov *et al*., 2016).

In protective forests where only selective sanitary fellings are carried out with the cutting down shrinking and diseased trees, renewal from the stump cannot develop, oak seed undergrowth is single with each subsequent generation the share of this valuable species in the forest stands canopy decreases with each subsequent generation (Musievsky, 2010).

Shadow-tolerant species in favorable climatic and soil-ecological conditions supplant less shade-tolerant species at an opposite rate to the life-span of the species being replaced. Species ability including lime to compete and occupy a leading position in the community to retain the territory is largely determined by the species life expectancy and dimensional parameters. Lime is characterized by an average life expectancy, it occupies a subordinate position relative to oak in height but having high shade tolerance and the ability to exist under the other tree species canopy for a long time, its bioecological identity determine successful growth possibility in a multi-species community where herbs dominating the grass and shrub storey form shading for light-loving oak shoots (Sultanova *et al*., 2010; Fischer *et al*., 2006).

Current forest management practices do not ensure objectives achievement set by rotective forests. It is obvious that the preservation and restoration of uneven-aged multi-species forests allow us to recreate the forest landscapes being close in their characteristics to preagricultural ones, it is impossible to do it using a modern single-species planting practice. The main ecosystem functions such as climate optimization, hydrological and temperature regimes as well as maintaining a high level of biological diversity and productivity are carried out effectively only by natural forest cover (Smirnova *et al*., 2011).

Obviously, it is impossible to achieve the desired result without forest crops creation and appropriate care arrangements for multi-species stands, self-sowing, undergrowth of the most valuable species. A practical solution to this problem is accomplished by replacing shrinking and diseased trees removed in the sanitary felling process with simultaneous care for oak self-sowing

and undergrowth, care for the lime young growth. To ensure the development of lime seed renewal under the stand canopy, it is necessary to carry out the upper layer thinning to the fullness of 0.7-0.6 while maintaining the stand, simultaneously creating the conditions necessary for seed germination (Martynova *et al*., 2016).

It is recommended to plant forest cultures of oak or other species for example, spruce in oak stands without natural growth with a fullness of 0.3-0.5. The experience of creating forest spruce cultures in the Pre Ural conditions is available (Martynova, 2014). However, there is an opinion that the main way to restore Oak groves, should still be a seed renewal (Kostrikin, 2013). We can agree with this statement but an integrated approach to solving the conservation problem of ecologically valuable forests is more rational in the conditions of the Pre Urals where measures for oak and lime undergrowth seed conservation combined with forest cultures are used.

CONCLUSION

Broad-leaved forests are complex multistoried and multispecies communities having a rather high stability. Forests species diversity is maintained due to the successful growth and formation of lime forest stands with the associated species participation, dense undergrowth, understorey and grass storey presence. Oak remains as a part of forest stand composition but its edificatory role is gradually decreasing, the high age and lack of reliable oak undergrowth don't leave any alternative to restore forests in the future. The areas of oak forests in the Pre Urals are rapidly decreasing and forest cultures are not created. The problem is not only to restore lost positions but to preserve the natural characteristics of broad-leaved forests. Forests multispecies composition and uneven-aged structure contribute to the stable existence and ability of forest ecosystems to withstand external changes in the environment while preserving protective functions.

The obtained data on the current state of broad-leaved forests of the Pre Ural forest-steppe represent new knowledge about the species composition dynamics in the process of vegetation rapid changes and allows us to approach the problem of forest management optimizing. Taking into account the high productivity of uneven-aged, oak, oak-lime and lime forest stands, it is evidently desirable that they should be used in a system of continuously producing forests. The task of forming sustainable, continuously functioning protective forests affects many aspects of the biological process, therefore, it is necessary to develop the basic directions for improving the forests ecological potential based on the principles of continuity and balance forest use which will preserve the species habitat conditions and increase the ecological potential.

The ultimate aim of the activities is multi-species, uneven-aged continuously producing forest communities performing ecological and environmental functions and serve as objects for further study of forest dynamics in order to preserve them as unique natural objects.

REFERENCES

Arkhipova, M.V., 2013. The analysis of the actual deciduous forests state in Central Russian upland using landsat satellite images. Fundam. Study, 11: 1181-1185.

Chebotarjov, P.A., V.V. Chebotarjova and V.G. Storozhenko, 2016. Structure and health of oak forests in tellerman experimental forest entity. For., 5: 375-382.

Chebotarjov, P.A., V.V. Chebotarjova and V.G. Storozhenko, 2017. [Formation of the oil sea floor in various methods of creating forest crops in Tellerman experimental forestry (In Russia)]. For., 6: 403-410.

Chistyakova, A.A., 2017. Dynamic of tree populations and horizontal structure of the old-growth nemoral herb broad-leaved forest with domination of *Quercus robur* and *Tilia cordata* according to the results of long-term monitoring, Penza region. Russ. J. Ecosyst. Ecolo., 2: 1-9.

Ciccarese, L., A. Mattsson and D. Pettenella, 2012. Ecosystem services from forest restoration: Thinking ahead. New For., 43: 543-560.

Fischer, J., D.B. Lindenmayer and A.D. Manning, 2006. Biodiversity, ecosystem function and resilience: Ten guiding principles for commodity production landscapes. Front. Ecol. Environ., 4: 80-86.

Gamfeldt, L., H. Hillebrand and P.R. Jonsson, 2008. Multiple functions increase the importance of biodiversity for overall ecosystem functioning. Ecol., 89: 1223-1231.

Harchenko, N.A. and N.N. Harchenko, 2013. About natural regeneration of Pedunculate oak under the canopy of the parent stand. For. Eng. J., 4: 42-53.

Kalinichenko, N.P., 2000. Oakeries of Russia: Monograph. Scientific Research Publishing Center, Moscow, Russian, Pages: 532.

Konashova, S.I., 2007. The condition and growth of oak groves in the Eastern European part of Russia. For. Bull., 6: 43-47.

Korotkov, V.N., 2017. Basic concepts and methods of restoration of natural forests in Eastern Europe. Russ. J. Ecosyst. Ecol., 2: 1-18.

Kostrikin, V.A., 2013. To the question about the gene pool of oakeries. For. Bull., 6: 138-143.

Kraus, D. and F. Krumm, 2013. Integrative Approaches as an Opportunity for the Conservation of Forest Biodiversity. European Forest Institute, Joensuu, Finland, ISBN:9789525980066, Pages: 283.

Martynova, M.V., 2014. Regularities in Growth of the Cultures of Norway Spruce on Logging and Lime Under the Canopy of the Forest. AIC News, Ufa, Russia,.

Martynova, M.V., R.R. Sultanova and A.F. Khajretdinov, 2016. Features of forest-forming process in of the middle preduralja linden forests. Proc. Saint Petersburg For. Res. Inst., 1: 55-61.

Mirkin, B.M. and L.G. Naumova, 2012. The Current State of the Basic Concepts of the Science of Vegetation. GILEM Publisher, Ufa, Russia, Pages: 488.

Musievsky, A.L., 2010. [The main results of 80-year observations of the restoration and formation of seed oak forests of the shipova forest (In Russian)]. For. J., 6: 14-21.

Nejshtadt, M.I., 1983. To the question of some concepts in the section of the Holocene. News USSR. Acad. Sci. Ser. Geogr., 2: 103-108.

Pavlov, D.S. and E.N. Bukvareva, 2012. Climate-regulating functions of terrestrial ecosystems and an ecologocentric concept of nature management. Biol. Bull. Rev., 2: 105-123.

Popov, G.V., 1980. Forests of Bashkiria. Bashknigoizdat, Ufa, Russia, Pages: 144.

Schwartz, M.W., C.A. Brigham, J.D. Hoeksema, K.G. Lyons, M.H. Mills and P.J. van Mantgem, 2000. Linking biodiversity to ecosystem function: Implications for conservation ecology. Oecogia, 122: 297-305.

Smirnov, I.A., 2008. Features of distribution, state and stability of broad-leaved forests in Novgorod oblast. News St. Petersburg State Agrar. Univ., 11: 43-46.

Smirnova, O.V., N.A. Toropova, D.L. Lugovaya and A.A. Aleinikov, 2011. Populations paradigm in ecology and ecosystem processes. News Moscow Soc. Naturalists Biol. Department, 116: 41-47.

Stojanovic, D.B., T. Levanic, B. Matovic and S. Orlovic, 2015. Growth decrease and mortality of oak floodplain forests as a response to change of water regime and climate. Eur. J. Forest Res., 134: 555-567.

Sukachjov, V.N. and S.V. Zonn, 1961. Guidelines for the Study of Forest Types. 2nd Edn., The Academy of Sciences of the USSR, Moscow, Russia, Pages: 144.

Sultanova, R.R., S.I. Konashova and N.V. Mihajlova, 2010. The formation of nectar forest plantations of the small-leaved lime. Achiev. Sci. Technol. Agro Ind. Complex, 2: 32-33.