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POTENTIAL FOR RATIONALIZATION OF SILVICULTURAL TREATMENT BASED ON ESTABLISHED OPTIMAL NUMBER OF TREES

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ABSTRACT

This paper presents the possibilities of rationalization in one part of the silvicultural treatment on the basis of defined optimal number of trees, on the example of a stand which, by its size and structure, is one of the finest mature beech stands in the South Kučaj area. The previously established elements of the optimal model of the stand structure have been used for designing the model number of nuclei in young stands, which will at the end of the rotation period represent the required number of trees with optimal crown size. The paper outlines a number of advantages and the importance of such procedures which will greatly reduce the cost of hiring the organization's professional and material resources with the aim of effective implementing of an optimal procedure in managing natural stands.

Key words: beech, optimal state, optimal number of trees, rationalization of stands tending.

INTRODUCTION

It is known that silvicultural measures at an early development stage in all species can significantly accelerate the growth of treated individual trees, boost their competitive ability and resistance to the action of a number of adverse factors. Despite these findings, these measures are rarely implemented properly in our forest operations, or they are even left out altogether. The most common reason for this is the lack of financial resources, manpower, machinery, time, etc. The fact that the strtcture of our forests is su#h that a sigNificant part of the growing stock are youngEr stands to be intensively cultivated, and it sHows that it is precIsely in r│ spect tO rationalization that some improvements are necessary to be made.. The rejuvenated woodland areas at the sitd3 of old forests are oFten characterized by a significant presence of coppicEd 4rees, trees /f less valuable species with rapid growth aNd a huge competitive ability (hornbeam, maple, lime tree etc.). The implementation of silvicultural measures in such areas, which among other things are rugged, exceeds the available technical and financial resources of the organizations managing the forests. One possible solution to these problems is to be based on research in mature stands in order to define the optimal number of trees at the end of the rotation, and to form "nuclei" of a certain diameter on rejuvenated areas. The number of nuclei should be equal to the projected optimal number of trees at the end of the rotation.

The aim of this paper is to show through a characteristic example the possibility and applicability of the established elements of modeled optimal conditions in order to define a sensible concept of tending young beech stands.

MATERIAL AND METHODS

In the growing stock of Serbia beech forest accounts for 40.5% of the total wood volume and 30.6% of the total volume increment (Banković et al. 2009). Wide horizontal and vertical distribution of beech on different parent rocks and evolutionary soil sequences has contributed to the presence of beech in the form of different plant communities in the surrounding area of most villages and towns in SerbiA.

StanD density has a very strong impact on the efficiency of beech forestS in meeting their various functions. It is, therefore, impoRtant to intensify the foresT management sysTem in order to approach the p/ssible level of potential economic, environmental, protective and other effacts on that site. This, primarily, me!ns maintenance of the standS in an optimum condition from the aspect of the number of trees and crown quality whiCh affects bioloGica, Stability !nD high dendromass increment. Generally, beech stands in Serbia are very far from their optimal state due to a number of adverse factors affecting them in the past (Vučković, Stajić 2005).

The research object are beech stands in the South Kučaj area which is located between 19˚19' and 19˚27' east longitude and 43˚58' to 44˚02' north latitude. The research was conducted in three sample plots in a montane beech forest (*Fagenion moesiacae montanum*). Two sample plots were formed on the medium deep, acid brown soil on phyllites. The investigated stand I was mature and about 130 years old and stand II was a pole-stage stand. Stand I had 226 stems per ha and stand II – 4,120 stems per ha.

RESULTS AND DISCUSSION

Through the procedure of defining the optimal structure, it is possible to avoid the consequences of growth process and development in trees beyond what is considered to correspond to the principles of optimality. Sometimes the stands represent, according to their visual impression and dimensions, the "typical" example of optimally structured stands which in reality, however, deviate significantly from the projected optimal model. This "unnoticeable" deviation from the required beech stand structure was established in the studies by Vučković and Stajić (2003) in a beech stand about 55 years old in the area of Petrova Gora. Namely, these authors determined that in a stand of very good appearance, with no significant presence of devitalized trees and a high amount of current volume increment (13m^3/ha), there were fairly clear signals of its adverse internal structure and devitalization, which could not be identified by sight or by stating the basic taxation elements within the regular forest inventory. In addition, Vučković et al. (2006) established significant deviations of the existing (current) and modeled (optimal) structure of a representative sessile oak stand, with considerable overgrowth and trees above average size and timber volume.

Bearing in mind the aforementioned, in our studies of mature beech stands in the South Kučaj area, which Vučković et al (2011) used as the basis for determining of the optimal structure model, we firstly established the exact coordinates of the trees in the area and made a map of all the trees (current structure) and the position of the optimal number of trees in the future (projected optimal pattern) - Figure 1. The optimal state of the investigated beech stand was determined by Vučković et al. (2011). Namely, based on the dependence of diameters at breast height of trees on the estimated crown diameter sizes of 184 beech trees (1472 crown radius), the authors first determined the crown size needed for achieving a certain diameter at breast height. Finally, these authors showed that with differently set production parameters, basal areas (≈ 40 m^2) of the investigated stands could be achieved with a much lower number of trees (≈100 trees per hectare instead of 240) and a significantly higher mean diameter (65 cm instead of 45 cm) i.e. a much better assortment structure would be achieved. The target diameter was defined as the diameter, for the achievement of which crowns have such a dimension which allows the best use of growing space, i.e. the most favorable ratio of the produced wood volume and the space taken up by a tree.

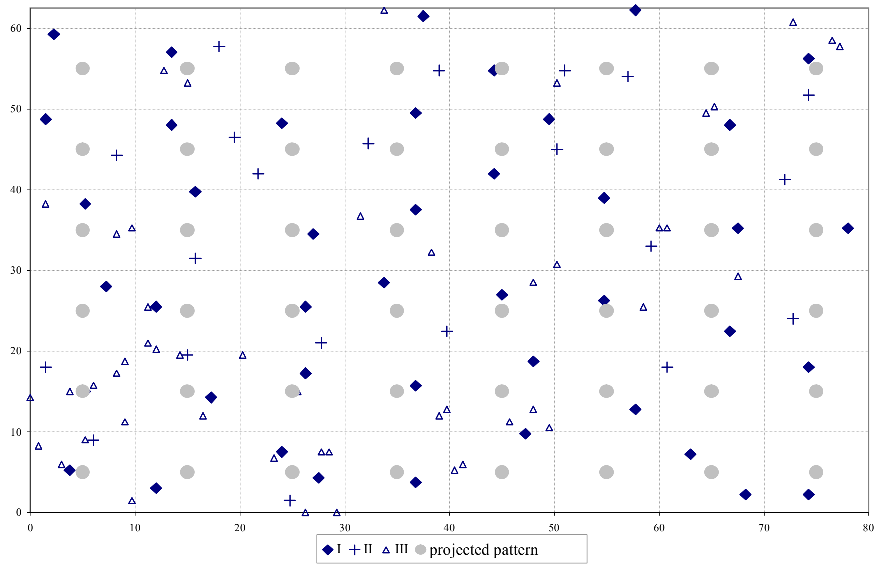

Figure 1. Real and projected spatial distribution of trees I biological position (I), II biological position (II) and III biological position (III) - SPP 1

On the attached layout of the real and modeled (acc. to instructions of Vučković et al. (2011)) distribution of trees (Figure 1.), it is possible to observe that in a mature stand it is hard to apply with delay any model of optimal stand condition, because the existing stand condition can no longer be influenced practically. Stand structure is such that it consists of trees of I biological position (I b.p.), unevenly distributed on the surface, with various crown sizes. A significant number of I b.p. trees for many years grow under competition of adjacent trees of the same social status, or during their ongoing growth there has been too much available growing space, which in terms of growth and production has resulted in the creation of too large and assimilation-wise inefficient trees.

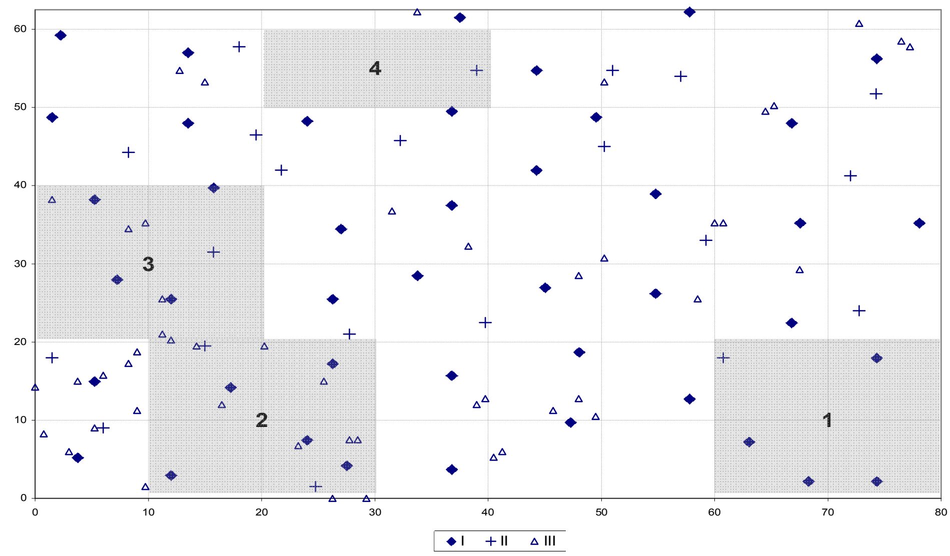

Figure 2. Spatial distribution of trees of first biological position (I), second biological position (II) and third biological position (III) - SPP 1

In general, I b. p. trees in mature stands should be the future trees which were selected at a young age and nurtured by the end of the rotation, in order to achieve optimal quality and quantity of production. On the example of SPP 1 stands (Figure 2.), we can see that the I b.p. trees are often found too close or too far from each other. This reduces the level and quality of stand production, whether it is a form of permanent conflict present in growth due to competition among the trees, or in terms of inefficient use of growing space due to excessive canopy or clearings. Situations like these in the stand SPP 1 are illustratively presented by shaded quadrants 1, 2, 3 and 4. The example of absence of I b.p. trees at the end of the rotation at distances up to 20 m is represented by the shaded quadrant No.4, while the existence of too many I b. p. trees in a small mutual distance is illustrated in shaded quadrants 1, 2 and 3. The graphical display of the position of I b.p. trees in the shaded quadrant 1 illustrates the presence of their excessive number in one part of the area, but also too much distance among them in another part of the same area. A good example of unfavorable structure in one part of the stand is the quadrant 3, from which it can be seen that two I b.p. trees in the lower quadrant are too close together. Since these trees have been under the influence of mutual competition and interference with each other's growth for many years, in this concrete example, forest operators' hands are partly "tied". This is to say, that if several years before one tree had been removed by silvicultural measures from the stand in order to increase the growing space and care of the other tree crown, in that very part of the stand, the distance between the remaining tree and its next neighboring trees of the same category would be too large (clearings – which, due to the very reduced height growth and growth of lateral branches, do not have the possibility of completely covering the newly created free space), which subsequently would lead to inefficient use of growing space and habitat potential. In the case of such a scenario that both of the trees remained, they would continually suppress each other's growth, until the end of the production period, also with an inefficient use of growing space and habitat potential.

Therefore, in view of the foregoing, the establishment of new stands and the care of young ones require the knowledge of the optimum condition to be achieved at the end of the rotation. Established regularities are used in habitats with similar characteristics, for the planning of density and planting pattern when creating new stands (in artificially established stands) or determination of the number of future trees in natural stands within the definition of the production target and measures for its achievement. Therefore, the obtained production parameters (N, G, V, target DBH) in maturing and mature stands should be used as a landmark for management of young stands. For this purpose, we have selected a young beech stand (pole-stage stand) in the same habitat, not far from the analyzed mature stand that had been the research object by Vučković et al. (2011). In this stand, we determined the exact coordinates of the trees in the area and made a map of the position of all the trees and the position of the required number of nuclei, according to the determined optimal tree number at the end of the rotation (Figure 3.).

In this specific example, the study stand in South Kučaj, i.e, in the habitats that it represents, it would mean the establishment of 100 such nuclei. In case a 1 m radius of the nucleus is selected, intensive silvicultural treatment is carried out on a surface of about 314 m^2, or only 3% of the total area, and in the case of a 2 m radius - on a surface of 1,256 m^2, or 13% of the total area. This approach (treatment) should provide the best trees of the selected species with successful growth and development. This is largely achievable, as it should not be too difficult to concentrate the necessary professional activities on about 3-6 individual trees per nucleus that may be found in it when the separation of nuclei, or the future trees, starts "on time". Within this number of individual trees, of course, the greatest attention should be focused on the tree with the best phenotypic characteristics, which is to be found in the center of the cell, due to the maintenance of a regular schedule of future trees, to the extent practicable. In this way, in addition to savings in time and financial resources, a desired - designed optimal stand structure will be enabled, as well as the presence of the optimal number of trees at the end of the rotation that have neither too small nor too big, but optimally developed crowns. For the remaining area, silvicultural treatment can be of much lower intensity (later start, lower frequency, decision-making at a lower level of expertise, etc.).

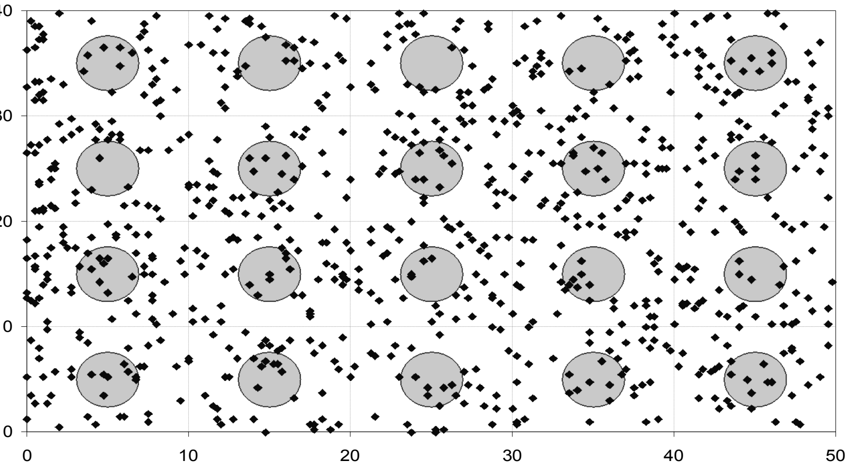

Figure 3. Example of the projected "nuclei" schedule (grey circles) for the intensive silvicultural treatment on the sample plot SPP 2, measuring 50 x 40 m.

Since the growth of trees and stands is conditioned by numerous factors, some of which are random in nature, in some cases it is impossible to completely "schematize" the distribution of trees and thus make a full use of the habitat production potential. Certain nuclei and, within them, the selected future trees may not always be in an ideal - optimal mutual distance, because it is possible that in the preferred distance defined in the nucleus it will not be possible to choose a tree of high enough a quality, which should see the end of the production period. However, the final effects of this treatment will contribute to a far greater and more efficient use of habitat potential, which is in any case much more than the current average utilization of the potential of our forest habitats of 50% or less (Tomanić 1993).

CONCLUSIONS

According to numerous studies, the condition of forests in our country is such that there is a significant discrepancy between the actual and potential level of productivity in qualitative and quantitative terms. It is known that if the stands are far from the optimal structure, the effect of forest management measures (silvicultural, protective, etc.). drastically decreases, and on the other side the damage caused by adverse exogenous factors are increased to such an extent that it may compromise the results of management, or even jeopardize the survival of stands. Consequently, in the process of achieving production and environmental functions of forests, modern forestry, burdened with cost-effectiveness of management, aims to increase the stability of production and manufacturing assortments of high quality at the lowest cost possible, so as to prevent management loss. Therefore, it is extremely important to optimize the condition of stands at all stages of their development. For this, preventive action is extremely important, based on clearly established criteria. An alternative is extensive management and dealing with adverse effects such as devitalization and tree desiccation, increment reduction, etc., which can not provide adequate results and justify invested assets.

The conducted research activities, according to the extent and degree of data processing, certainly are not sufficient to "cover" environmentally, developmentally and qualitatively different stands. However, they represent a suitable basis for further upgrading and completion. Research suggests the applicability of defining the optimal stand condition and the need for further work, which would comprise the stands of different ages and habitat conditions, in order to create a solid basis for the standardization of optimal stand structure model.

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