The confirmation of the natural forest type in stands from Podu Iloaiei Forest District (Iași County Forest Administration) a source of positive externalities for neighboring rural communities

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Abstract One of the principles of management planning is centered on the idea that a certain type of structure is closely correlated to a stand’s ability to fulfill a given function. When asked to fulfill simultaneously a number of functions, as a result of diversified demand regarding forest products and services, foresters must answer to society’s needs using a sustainable management approach. Since the first studies on the structure of the natural forest, as early as the 18th century, scholars came to the conclusion that the diversity and structural complexity of natural stands is what confers their multifunctional character. The present paper analyzes the stand structure of two natural reserves “Ghiorghița aia” and “Frumușca” in comparison to what was already determined as being a typical natural stand, “Humosu” Old Growth Forest, all these forests being part of the area managed by the Iași County Forest Administration. The comparison uses common characteristics found in all natural forests, no matter the mix of species, the aim being the reflection of the forest potential in the area, a source of positive externalities for the community and a basis for future forest management.

Key words stand structure, natural forests, sustainable development, communities

The sustainable development of communities depends largely on the type and amount of resources available, very important also being the efficient management, second by a favourable legal and administrative climate. Forests supply the communities with a wide range marketable or unmarketable products and services, in different amounts, that become more and more sought after as they were scarce. Forestry was the area of activity the concept of sustainability first appeared in, over 300 years ago, when it became more and more evident that the harvesting rate would affect the availability of the forest resource to future generations. Deforestation had two main determining factors that went hand in hand, first the need for wood and second reclaiming the forestland for agriculture. As a result, few of the prime forests survived to the present time, what was preserved in some parts being arguably called “virgin” forests, but still of great importance to the future of sustainable forest management. So different authors argue about the usage of the phrase “virgin forest”, considering it as inexact, and use other terms as “pristine” or “old growth”, “natural”, because it’s obvious that man through his actions has “succeeded” in influencing to a certain degree, even the remotest places on Earth. A natural forest “…is a natural biosystem, the result of long term organizing, functioning and perfecting of trophic relations and matter and energy exchanges, which usually possesses a high capacity to self-sustain itself and ensure a state of dynamic equilibrium”(15). Frohlich describes the old growth forest as being “a combination of different age classes and diameter categories of natural origin, that hasn’t been subjected to systematic human intervention”(1). Studying the way pristine forests or forests close to a primary pattern are structured, enables the access to a mechanism of structural and functional stability (1) perfected in millennia of evolution, which Mayer argues is the correspondent of “climax forest” (12) These forests represent natural laboratories from which we must learn new methods to optimize the functionality of managed forests (7). So scientists came to the idea that the study of natural forests will unveil a pattern for the future of managed forests (11, 14). Romania is among the few countries in Europe that still has a natural forest heritage, although harsh historic conditions could have given a different outcome. The decreasing trend of natural forest coverage in Romania is clearly indicated by data from the end of the 19th century that showed a total area of 2 million hectares, of which only 0.7 million were reported at the beginning of the Communist era, the decrease continuing until in 1984,
A recent study conducted by I.C.A.S. Simeria concerning genetic diversity of oak populations revealed for Moldavia a clear distribution pattern of haplotypes from north to south. Because haplotype 5 is characteristic to the northern areas of Moldavia and haplotype 4 to the south, there is a clear argument against the mix of genetic material between north and south in the process of forest regeneration (13). Drastic area reduction of provenance regions for genetic material will contribute to an uncontrollable transfer of seed materials between different geographical areas, with consequences very hard to establish, mostly regarding the evolution and stability of the newly created stands (13). These aspects gain even higher importance because of a directive from the newly adopted 2012-2016 National Forest Administration’s strategy, regarding the restoration of oak stands from 34,000 hectares due to deforestations (9). Situated at the intersection of three major landforms: the Suceava Plateau, the Moldavian Plain and the Bălăț Plateau (18) the area where the two natural reserves considered in this paper are located is 70% agricultural land. The two reserves represent high value mature stands with ages over 140 years, according to the management plan, that have been managed in the past as seed-source stands, because of their genetic value. Frumușica Natural Reserve covers 97.3 ha and Ghiorghițoaia Natural Reserve 202.3 ha (2). The County Forest Administration has placed under its direct authority both natural reserves, in conformation with a Ministerial Order (1533/2008) as “natural sites of community importance” and established a set of rules for the future management of the two protected areas (2).

Material and Methods

The paper is based on data collected from two stands, one (“Ghiorghițoaia Natural Reserve”) located in a
state forest area managed by “Podu Iloaiei” Forest District, part of “Iași” County Forest Administration and the other (“Frumușica Natural Reserve”) situated inside a privately owned/administrated forest area. For comparison reasons, results of previous research work was used, namely a structural analysis conducted in plot no. 62, part of Humosu 3rd Production Unit, administrated by the Iași County Forest Administration, in an old growth beech (Fagus sylvatica L.) forest stand, part of the natural reservation “Humosu Old Growth Beech Forest” (17), (4). In each of the two natural reserves a 1 ha, rectangular shape (100 by 100 m) experimental plot was delimited. The first plot P1-Frumuşica was placed in compartment 38A, a high productivity mixed oak hilly stand type (20), part of Frumușica Management Unit, which is entirely privately owned and administrated. The second 1ha plot was placed in compartment 31B, a superior productivity oak stand (19), part of the 5th Management Unit -“Ghiorghițoaia”, which is entirely owned by the state and administrated by Podu Iloaiei Forest District. The placement was chosen in order to represent as close as possible the stand’s structure and be easily accessible when visits would be made to follow the stand’s evolution in time. Plot delimitation, placement and data inventory was made according to the forest structure research methodology based on structural profiles (6), (7), (17), (4). The 1 ha experimental plots were divided each into 10 m by 10 m quadrates to enable data collection, consisting of:

- Tree number (Figure 2);
- Tree species;
- Diameter at breast height (dbh)-the mean of two diameters measured with a forest caliper on two perpendicular directions.
- Position inside the stand according to the Kraft classification (8)
- Quality- was determined visually. Each tree was analyzed and integrated in a class between I (high quality) and IV (lowest quality), judging by the presence of various defects and the percentage of workable wood from the whole trunk (10).
- Total height- using Vertex IV (precision 0.01 m)
- Natural pruning height-using Vertex IV (precision 0.01 m)
- Canopy diameter- the measurement of two perpendicular diameters of the canopy projection on the ground.
- Tree positioning- x, y, z coordinates- using the 10 m by 10 m quadrates network.

Roibu (2010) acknowledges the trends of the last years citing Zasada şi Cieszewski, 2005; Gove et al., 2008 regarding the use of a two Weibull functions mixture, to reflect complex multimodal structures of mixed stands as is the case of “Humosu” Old Growth Forest, with irregular shapes indicating an uneven aged stand or “rotated sigmoid” shape the mark of a “virgin” or pristine forest (17). Experimental distributions of number of trees per diameter category, for the S1-Frumuşica and S2-Ghiorghiţoaia plots, also present such a structural diversity, with positive asymmetry and irregular shape, close to that of uneven aged or pristine forests. The comparison’s aim is to see the degree of structure modification the human intervention has brought, on the idea that these reserves must be managed with the purpose of restoring or conserving the initial structural state of a natural forest.
Results

The distribution of number of trees per diameter category was chosen for the comparison purpose in the paper, because it reflects competition (interspecific and intraspecific) and the stand structure, horizontally (10). Authors consider and use it as an efficient tool to describe the structure of the natural forests (1),(7),(17). In table 1 are presented the values of the main indicators for the experimental distribution of tree number per diameter categories. The experimental distribution for the two natural reserves has a positive asymmetry value, higher for S₂-Ghiorghițoaia than S₁-Frumușica and a negative excess index. Figure 3 and 4 represent the comparison between the experimental distribution of tree number per diameter category with Beta and Exponential theoretical distributions, the “chi-squared” test indicating the lack of concordance between the experimental and theoretical distributions, which underlines that this type of structure can’t be evaluated using unimodal functions (1).

<table>
<thead>
<tr>
<th>Experimental Plot</th>
<th>Min (cm)</th>
<th>Max (cm)</th>
<th>Average (cm)</th>
<th>Variance</th>
<th>Standard deviation</th>
<th>Variation Coefficient</th>
<th>Asymmetry coefficient</th>
<th>Excess coefficient</th>
<th>Tree no. per ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humosu-transect</td>
<td>4.0</td>
<td>128</td>
<td>35.5</td>
<td>29.5</td>
<td>83.1</td>
<td>1</td>
<td>-0.3</td>
<td>307</td>
<td></td>
</tr>
<tr>
<td>Ghiorghițoaia</td>
<td>6.0</td>
<td>102</td>
<td>30.22</td>
<td>464.48</td>
<td>21.55</td>
<td>71.31</td>
<td>0.79</td>
<td>-0.19</td>
<td>349</td>
</tr>
<tr>
<td>Frumușica</td>
<td>6.0</td>
<td>98</td>
<td>35.38</td>
<td>358.6</td>
<td>18.94</td>
<td>53.53</td>
<td>0.56</td>
<td>-0.44</td>
<td>349</td>
</tr>
</tbody>
</table>

Source: Roibu, 2010; Barbir, 2010

Fig. 3 Comparison between the experimental distribution of tree no. per diameter category with Beta and Exponential theoretical distributions S₁-Frumușica

Fig. 4 Comparison between the experimental distribution of tree no. per diameter category with Beta and Exponential theoretical distributions S₂-Ghiorghițoaia
Bândiu et al. (1) uses the phrase “age waves” to describe the typical distribution of tree number per diameter categories in the natural forests of Romania, referring to the shape of the modulated curve that expresses graphically the distribution, having between 3 or 5 maximum points. In the case of “Humosu” Old Growth Forest (Figure 5) the distribution of tree number per diameter category is bimodal, slightly decreasing in the middle classes area, as a result of continuous and simultaneous processes of tree size growth and tree elimination (17). The first few diameter categories in the $S_2$-Ghiorghiuțoaia (Figure 6) distribution have an exceeding number of individuals, followed by deficitary categories, that resemble the ”Humosu” pattern, the second Weibull curve having a different degree of flatness due to ongoing competition in the higher storey. Because of extractions made by foresters according to the management planning the rightful place of the oak in the higher storey has been occupied by other species. For $S_1$-Frumușica (Figure 7) the exceeding number of individuals appears after the 20 cm diameter category and the shape being developed differs from the classical ”age waves” of the natural structure, being closer to an uneven age type pattern.

Fig. 5 Graphic comparison between the experimental distribution of tree no. per diameter category with a two Weibull functions mixture—“Humosu” Old growth Forest

Source (17)

Fig. 6 Graphic comparison between the experimental distribution of tree no. per diameter category with a two Weibull functions mixture—$S_2$-Ghiorghiuțoaia

Fig. 7 Graphic comparison between the experimental distribution of tree no. per diameter category with a two Weibull functions mixture—$S_1$-Frumușica
The complex structures presented above have the capacity to contain high standing volumes that vary according to different authors in European forests between 300-1200 m$^3$ per hectare, but can reach as high as 1500 m$^3$ per hectare (12). The total above ground volume per hectare is 735.77 m$^3$ for S$_2$-Frumușica and 632.04 m$^3$ for S$_1$-Ghiorghița oai (2), Humosu over 900 m$^3$/ha (4), (17). This capacity is directly linked to the quantity of sequestrated carbon inside the woody biomass (5). Natural forests are also characterized by the presence of deadwood on the ground, a result of the elimination process at different levels of the canopy. In all the three stands extractions have been made targeting the on the ground or standing deadwood biomass. Because of legal restrictions and harder accessibility, over 50m/ha of deadwood standing/on the ground was identified in “Humosu” plot, in different decomposing states (17). For the two natural reserves the deadwood volume is scarce under 4 m$^3$ per hectare and in a high state of decomposition, because of the extractions programmed by the management plans and the proximity of logging roads that facilitate the access for the locals and sometimes illegal logging.

**Conclusions**

Located in an area dominated by an agricultural land use regime, the two natural reserves Ghiorghițaia and Frumușica, are somewhat of a “living proof” for the great potential forestry has in Iași County, being the remains of the pristine forests covering the Moldavian territory before the 1800’s. The aim of the paper was to underline the value of these forests by comparison to an established natural stand structure, that of Humosu Old Growth Forest. Ghiorghițaia and Frumușica natural reserves, over 140 years of age that have been managed by the forest district under the norm restrictions given by their “genetical/seed-source” status. So stand extractions have followed the path given by the natural elimination process. A relevant fact is that one of the reserves (Frumușica), before the 1949 nationalization process was privately owned. The comparison used the distribution of number of trees per diameter category. The values of the main indicators for the experimental distribution of tree number per diameter categories indicated a complex structure, as for Humosu Old Growth Forest, with positive asymmetry and irregular shape, close to that of uneven aged or pristine forest. After conducting the “chi-square”, obtained values revealed a lack of concordance between the experimental distribution and theoretical ones generated by Beta and Exponential functions which underlines that this type of structure can’t be evaluated using unimodal functions. Structure in S$_1$-Ghiorghița oai resembles the typical shape of the distribution of tree number per diameter categories in the natural forests of Romania, a modulated curve that expresses graphically the distribution, having between 3 or 5 maximum points that create so-called “age waves”. The Weibull mixture used for S$_2$-Ghiorghița oai resembles “Humosu” pattern, the second Weibull curve having a different degree of flatness due to ongoing competition in the higher storey. For S$_1$-Frumușica the shape developed differs from the classical “age waves” of a natural structure, being closer to an uneven age type pattern, a clear indication of altering interventions that didn’t only aim at the extraction of deadwood. Data presented in the present paper confirms the structural complexity of two natural reserves, that can determine the future of second growth forests and communities in the surrounding areas. First as sources of local, high productivity genetic material, then as structures with a capacity to produce high standing volumes, sequestering large carbon inside the woody biomass.

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