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Comparison of the *Quercus brantii* and *Pyrus glabra* boiss species structure in Zagros forests (Case Study: Ghalehgol Forest, Khoramabad City, Iran)

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Key words: Ecosystem, forest species, forest stand structure, neighbor hood tree, structure indices.

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Abstract

Understanding the condition of forest species and Knowledge of the evolution of ecosystems that have the ability auto regeneration, before any plan to take a principle in stand is necessary and can serve as a good model to select the correct methods of silviculture to be considered. In this research, furthermore introduce some of Structural indices, *Quercus brantii* and *Pyrus glabra boiss* structure in Khoram abad Ghale gol region (part of Zagros forests, Iran) were studied. In this study uniform angle (UAI), mingling (DM_i), crown canopy dominance (TD_i) and crown canopy differentiation (T_{ij}) indices applied to investigate of positioning, mingling and crown canopy status among neighborhoods trees. In order to calculate of mentioned indices, Crancod (ver.1.3) Software used. The average values of Uniform angle, mingling, crown canopy dominance and crown canopy differentiation indices *for Quercs brantii* calculated, 0.47, 0.06, 0.51 and 0.48 respectively and 0.38, 0.86, 0.56 and 0.44 for *Pyrus glabra* boiss respectively. The result of mingling index clearly showed the difference between *Quercus brantii* and *Pyrus glabra boiss* species. Whereas the values of UAI, TD_i and T_{ij} were approximately the same for the studied species. The values of absolute discrepancy algorithm, which employed to quantify difference between *Quercus brantii* and *Pyrus glabra boiss* species spatial structures, were 10.8%, 85.4%, 25.2% and 22.1% for UAI, DM_i, TD_i and T_{ij} respectively. These indices have a high ability in precisely demonstrate of differentiation of forest stand structure in succession stages and their applicability for comparing the studied stand with others, therefore they're useful tools for sustainable management.

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Introduction

In recent years, are obvious with increased advances in science and natural science, importance of biodiversity different aspects (Memarian *et al.*, 2007). High biodiversity maintains not only as a shield against disorders of Bvmsazgan normal, but also to increase their fertility (Ghomi Avili *et al.*, 2007). Structure, one of the most important factors affecting the biodiversity of forest ecosystems (Pommerening, 2002). In general, the forest ecosystems investigate the word "structure" spatial layout features a number of trees, Such as tree age, dominance, species, sex (The species dioecious) (Graz, 2004). In order to describe the structure of the forest investigate, three aspects positioning, mingling and also tree dominance differentiation relative to each other (kint *et al.*, 2004). Tree positioning show a regular, random, cluster patterns or state is in between those, mingling investigate putting together the various species and dominance differentiation show place putting characteristics such as diameter breast height and height (Pommerening, 2006; Aguiree, 2003; Kint, 2000).

To study the tree structure and biodiversity have been developed many indices, which investigate different levels of biodiversity and measuring them is far easier than other indices (Motz *et al.*, 2010). It indices developed for the first time in 1992 by the institute of forest management, University of Göttingen, Germany, with Molecules having similar chemical structure of each tree are neighbors (figure 1) (kint *et a.l*, 2004).

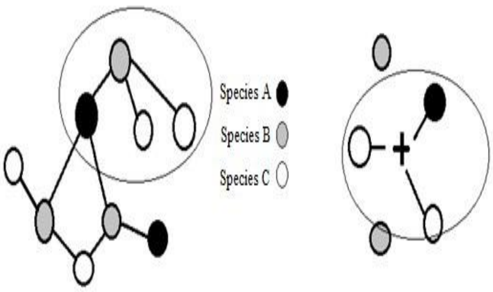

Fig. 1. structure group base on three trees neighbor (right figure base a define point; left figure base on tree (Each structure group includes a reference tree and a few surrounding neighbors).

One of the barriers to the correct decision to improve forest structure is, lack insight about the relationship between the structure and management and biodiversity (kint, 2005), in order to solve this problem Ruprecht *et al.* (2010) recommend using a combination of structural indices that would include all three aspects. Kint *et al.* (2000) insist on ability to indices the description of the forest stand structure and also investigate evolution of stand. Aguirre *et al.* (2003) Describe the structure of a set of indices based on the nearest neighbor, have these indicators the advantage and Expressed these indices need to be measured to calculate the distance between trees or no trees registration and these indices are calculated by reference only tree of neighboring trees and can easily be compared with other forests. Also Alijani *et al.* (2012) cited other advantages of these indices to high accuracy, low cost and high flexibility in choosing the number of neighboring trees. In other study Graz (2004) expressed these indices are not only able to show the current status of biodiversity, But also are described the ecological needs of different species.

Zagros Mountains are expanded of Iran to the south of the North West these Country, Rain clouds due to the moisture source regions of the western Mediterranean, has led to Conditions necessary for the establishment and expansion of forest cover (Marvie mohajer, 2006). Zagros forests with of 5 million hectares of approximately area, has Iran forest habitat the widest and is not production of wood products, the commercial forestry, But are unique in terms of soil and water conservation, production of byproducts and environmental value, importance (Jaziree and ebrahimi, 2003). Therefore, the importance of forest is needed in order to management should be enough information about the structure of the species collected and disposed in that forest managers. Therefore, in this study, in addition to quantifying the *Quercus brantii* and *Pyrus glabra* boiss species structure, investigated nearest neighbor index is based on the ability to show the differences between these species structure

Materials and methods

The study area

These study done in Ghale Gol forests of Khoramabad (part of Zagros forests, Iran) which has an area of 9491 hectares located in 35 km southwest of the city (figure 2). The total area was selected for hundred percent inventories for the study 32 hectares. According to weather station Khorramabad, Average annual rainfall in the region is 725.24 mm. The topography of the area has plenty of ups and downs with most of the southern slope, Minimum and maximum altitude respectively of 1500m and 2500m. The region trees are mostly single storey and habitat coppice (Nuroaldini *et a.l*, 2012)

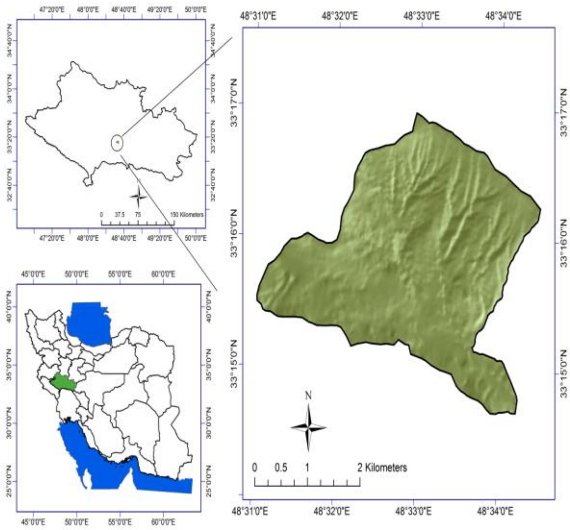

Fig. 2. Local perk allotments Ghale gol region in city of Khorramabad.

Study methods

In these study, in order to quantify *Quercus brantii* and *Pyrus glabra* boiss species structure after a tour of the forest and the Ghale gol region forests situation awareness the range of 32 ha was selected so that is representative of the region forests and was inventory hundred percent. Then with attention to distance and azimuth trees to a Specified point, position *Quercus brantii* and *Pyrus glabra* boiss trees and also was determined neighborhood trees.

Since it has been previous research, in forests with low density, using from three neighbor hood the nearest neighbor approaches based is better on the four neighborhood (Pomerening, 2002; kint *et a.l*, 2004; Gadow *et al.*, 2012), In this study, Investigated the characteristics of positioning, mingling and crown canopy dimension *Quercus brantii* and *Pyrus glabra* boiss species into neighborhood trees three itself.

Applicated indices

In this study, in order to quantify *Quercus brantii* and *Pyrus glabra* boiss structure used from Uniform angle, Mingling, crown canopy dominance indices and also Crown canopy differentiation index.

Table 1. Nearest-neighbor structure indices description.

Name Index	Feature analysis	Formula	Description	Range
Uniform angle	positioning	$W_i = \frac{1}{3}\sum_{j=1}^{3} v_{ij}$	$v_{ij} = \begin{bmatrix} 1 \rightarrow & \alpha_j < \alpha_0 \\ 0 \rightarrow & \alpha_j \geq \alpha_0 \end{bmatrix}$	$W_i \in [0,1]$
Mingling	Species diversity	$DM_i = \frac{1}{3}\sum_{j=1}^{3} v_{ij}$	$v_{ij} = \begin{bmatrix} 1 \rightarrow Species_j \neq Species_i \\ 0 \rightarrow Species_j = Species_i \end{bmatrix}$	$DM_i \in [0,1$
Crown canopy dominance	Tree dimension	$TD_i = \frac{1}{3}\sum_{j=1}^{3} v_{ij}$	$v_{ij} = \begin{bmatrix} 1 \rightarrow & cc_i \geq cc_j \\ 0 \rightarrow & cc_i < cc_j \end{bmatrix}$	$TD_i \in [0,1]$
Crown canopy differentiation	Tree dimension	$T_{ij} = 1 - \frac{1}{3}\sum_{j=1}^{3} v_{ij}$	$v_{ij} = \frac{\min(CC_i, CC_j)}{\max(CC_i, CC_j)}$	$T_{ij} \in [0,1]$

Uniform angle index investigate trees positioning. This index compares the angle between neighboring trees (α_1) and standard angle (α_0) Investigate being a regular source tree location of self neighborhoods.

Equation: 1 $$\alpha_0 = \frac{360}{\text{number of neighbour}+1}$$

Uniform angle index amount When using three neighboring trees (pomerening, 2002; kint *et a.l*, 2004; Gadow *et al.*, 2012), obtained one of values Zero, 0.33, 0.67 and 1, with Averaging from calculate values for all groups structural, concentration average amount ($\overline{W_i}$) calculate for all stand. The low value W_i reflects regular pattern the high value that represents the cluster patterns. Therefore we can say that the values this index in stands with a cluster distribution over all and decline in random and regular stands (Corral *et al.*, 2010).

The second index is used to check the alignment of different species together, is species mingling index (DMi). Also this index values when use in the three neighboring in one group structure, obtained one from values zero (all neighborhood same as reference species), 0.33 (one neighbor's is different from Reference tree), 0.67 (different two neighborhood with tree reference) and or 1 (None of the neighbors are not the same as the reference species) (Gadow *et al.*, 2012).

The studies that have been conducted since the indices, In order to dimension differences trees use from diameter and height attributes. But in this paper, with attention the most of the Zagros forests is coppice and are not able to Industrial wood production (Erfanifard,2008), also with attention the protective roles this Forest, crown canopy is important factor (Zobeiri, 2007; Soosani, 2008). Therefore, in this paper to study the structure of the third aspect (dimensions diversity), was used from property crown canopy, in order to that used from crown canopy dominance and crown canopy differentiation indices. The calculated values for crown canopy dominance index like two previous indices when use from three neighboring trees is one of the four values zero, 0.33, 0.67, 1.

When the reference trees crown canopy area ratio to other adjacent species is dominate, this index value move the 1 and on the contrary. Also crown canopy differentiation index values variable is between zero and 1; In order to Facilitate the interpretation of results these index, values it Categorize into four categories; small differences (0-0.3), average (0.3-0.5), big (0.5-0.7), very big (0.7-1) (Pomerening, 2002).

Quantify the differences between the various species structure

One of the important targets from quantifying of various species structures is determination of difference between their populations to be in order to compare with each other (Aguirre *et al.*, 2003). In order to used can from absolute discrepancy algorithm (AD).these algorithm amount calculate from equation 2.

Equation 2 :

$$AD = \frac{1}{2}\sum_{i=1}^{n}|P_{1i} - P_{2i}| \qquad AD\epsilon[0,1]$$

In equation top P_{1i} is relative frequency values first population in distribution categorize 1 to n and P_{2i} is relative frequency values second population cite categorize. AD amount represents the relative percentage have the first distribution will be exchanged between the classes, this distribution is similar to the second population distribution. If AD amount is equal to zero, represents the absolute similarity between the two distributions are compared. While this algorithm is calculated equal to 1 if the value Indicates that the two distributions are not have no shared categorize with each other (Pomerening, 2002).

Results

In this study using a set of indices was describe and compare the structure two *Quercus brantii* and *Pyrus glabra* boiss species. In table 2 showed Quantify information is provided about these two species.

Uniform angle index average amount for *Quercus brantii and Pyrus glabra* boiss species calculated 0.47 and 0.38,

Indicating a random arrangement with very little tendency to form regular for this two species. In order to better interpret these index were studied distribution of the values of these index (Figure 3). According to total value of the in zero and 0.33 categories for *Pyrus glabra boiss* (76.9) and *Quercus brantii* (66.5) there is *Pyrus glabra boiss* than *Quercus brantii* tend to show a regular distribution.

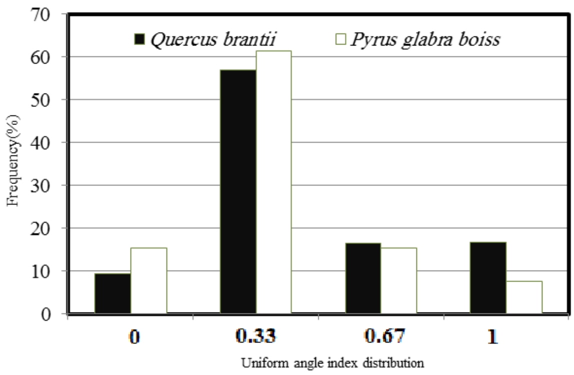

Fig. 3. distribution of values uniform angle index for *Quercus brantii* and *Pyrus glabra boiss* species.

Accumulation distribution two *Quercus brantii* and *Pyrus glabra* boiss species it has been shown in order to better comparison in table 3. Absolute discrepancy amount (AD) the cumulative distribution two *Quercus brantii* and *Pyrus glabra* boiss species calculated 0.108 indicates that if a 10.8% of the value of each class *Quercus brantii* or *Pyrus glabra* boiss be transferred to other classes, distribution will be similar in both species.

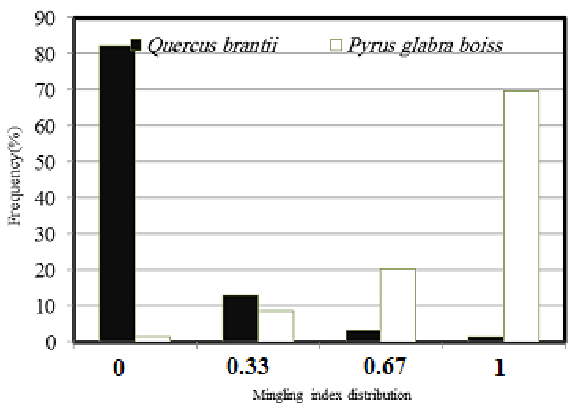

Fig. 4. distribution of values mingling index for *Quercus brantii* and *Pyrus glabra boiss* species.

Mingling index is an arrangement of different species together. Average amount these index for two *Quercus brantii* and *Pyrus glabra* boiss species calculated 0.06 and 0.86. Results these index represent *Pyrus glabra* boiss species besides other species (except *Pyrus glabra* boiss); while the *Quercus brantii* is besides the ground itself kind. Figure 4 well reflect differences in the distribution mingling index for two *Quercus brantii* and *Pyrus glabra boiss* species. The values of the distribution curve mingling index (table 4) well reflect differences in the structure these two species is the presence besides other species. Also absolute discrepancy algorithm results indicative difference 0.85 or 85% mingling index distribution in two species.

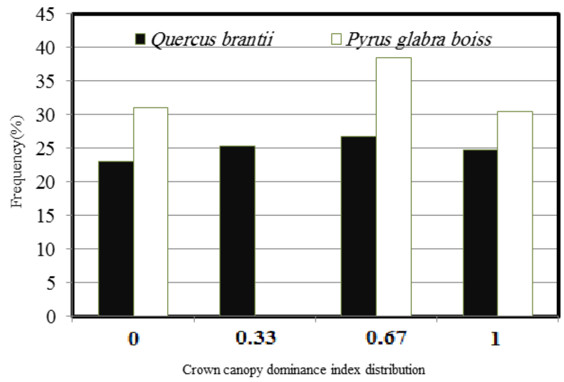

Fig. 5. distribution of values Crown canopy dominance index for Quercus brantii and Pyrus glabra boiss species.

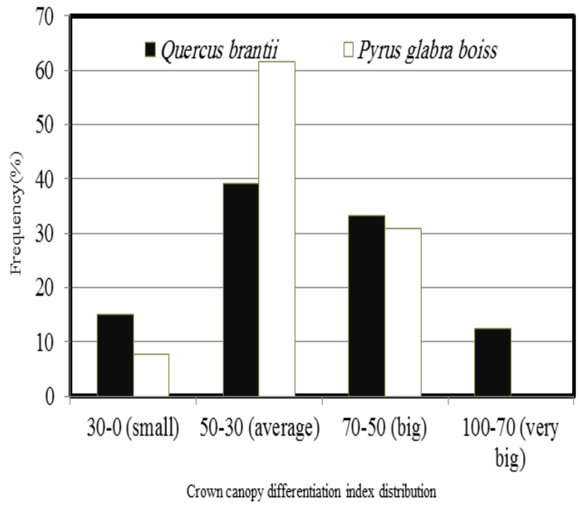

Fig. 6. distribution of values Crown canopy differentiation index for Quercus brantii and Pyrus glabra boiss species.

The third structure aspect was this study, crown canopy state is *Quercus brantii* and *Pyrus glabra boiss* species than adjacent trees. Crown canopy dominance index (TDi) values for *Quercus brantii* and *Pyrus glabra* boiss species calculated 0.51 and 0.56. As figure 5 shown these index for *Pyrus glabra* boiss species in 0.33 Category is frequency of zero .But values these index distribution average in difference categories for two species shows very little difference. Also with using Absolute discrepancy algorithm difference between distribution *Quercus brantii* and *Pyrus glabra boiss* calculated 0.252.Crown canopy differentiation index (Tij) average for *Quercus brantii* and *Pyrus glabra* boiss species derived 0.48 and 0.44, is illustrated *Quercus brantii* species And neighbors are the greater heterogeneity of the crown canopy than *Pyrus glabra* boiss species and neighbors. In figure 6 it has been shown relative frequency percent T_{ij} in different categories. Also absolute discrepancy values distribution these index for both species calculated 0.221.

Table 2. Quantitative information on species *Quercus brantii* and *Pyrus glabra* boiss in Region Ghale gol Khoram abad, Iran.

Percent Crown canopy	Average Crown canopy (m²)	Maximum Crown canopy (m²)	Minimum Crown canopy (m²)	Number of Hectare	Species
47.87	29.83	178.98	0.79	160.51	*Quercus brantii*
2.09	36.16	110.07	0.81	5.78	*Pyrus glabra boiss*

Discussion and conclusions

One of the important objective modern forestry is Conservation of structure and ecosystems biodiversity. Therefore, tools needed for proper management of the forest that can lower the cost and time to evaluate the current status and also changes due to forest management activities and natural evolution (Alijani, 2011). Forest evolves over time, and activities including silviculture and utilization have a direct impact on forest structure and biodiversity. In this study, in addition to quantify *Quercus brantii* and *Pyrus glabra* boiss species structure try to examine the ability of these indices is discussed to show the difference between these species.

Uniform angle index average for two *Quercus brantii* and *Pyrus glabra* boiss species represents a random arrangement state with very little tendency regular for the two species than adjacent trees; indicate natural forest the study. But with check the index distribution curve is observed for both species *Pyrus glabra* boiss species are more likely to have a regular distribution. In addition to ecological factors, forest management also has an impact on species distribution. Kint *et al.*, (2000) expressed involved in the stand with low density clusters to favor high quality trees, goes positioning the regulation.

Also in other study Pomerening (2002) did on a stand of oak and beech express oak more likely to have random mode. The results of the mingling index well indicate structure difference two *Quercus brantii* and *Pyrus glabra* boiss species, so that absolute discrepancy amount distribution diagrams of between these two species calculated 85.4. The results of using this index in ghale gol region expression that *Quercus brantii* species is of within the species competition while the Pyrus glabra boiss competition with other species. Pomerening (2002) in addition description oak trees structure expression Species mingling the trees will be directly affected positioning. Beech tends to have a positioning cluster patterns that is the most basic of these adjacent trees of the same species. While the random spatial pattern of *Quercus* species the mixing of other species. In order to investigate crown canopy dimension *Quercus brantii* and *Pyrus glabra* boiss species than adjacent trees was used from Crown canopy dominance index. The index of the distribution diagrams is for the two species studied that frequency percent *Pyrus glabra* boiss species at second category (0.33), is zero, but the results of the mean values of this index for two *Quercus brantii* and *Pyrus glabra* boiss species are very few differences from each other.

Importance notes the higher relative frequency categories 0.67 and 1 in *Quercus brantii* species than *Pyrus glabra* boiss species, the light demanding oak and presence of this species besides trees with smaller crown canopy is justifiable. Kint *et al.* (2000) A study performed on the rise diameter different between oak in period 1993-1998 stated that because of the increased diameter differences of these species, harvest Thick bases *Cerasus avium* L. Adjacent oak and replaced to the base of young trees. Also results crown canopy differentiation index represents a more heterogeneous *Quercus brantii* species tree than their neighbors, while *Pyrus glabra* boiss species shows fewer heterogeneous. Based on the results observed Indices and function is used high capacity to describe the current status of forest structure and tree species have ecological features. These indices due to advantages such as easy of measurement, low cost and high accuracy are better than other methods (Pommerening, 2002; Aguiree, 2003; Kint *et al.*, 2003; Pommerening, 2006). Since the forest structure are associate with habitat directly and indirectly many different animal and plant species, thus, the quantification of forest structure can be considered as a useful tool to study biodiversity (kint *et al.*, 2000).

Quantitative description of the structure of forest species can be considered one of the most important tools used in forest management. Studies conducted in the study area revealed forest structure and biodiversity are not suitable condition. Important point this is The investigation of the structure of natural forests can be revealed a way to achieve the desired structure, So that suitable silviculture operation can paying maintain biological diversity, dynamism and sustainability of forests. In the end recommended due to the functionality of the application of these indices showing the structure and has created species differences in their structure over time, with specifying the current structure of the existing species in ghale gol region and deviations to determine every species than ideal conditions, paid Proper management species and avoid from extinction of species and loss of biodiversity.

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