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Study of Shrub and Grassy Herbal Diversity in Natural Stand and of forestated Stands in Caspian Forest

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ABSTRACT

Biodiversity is necessary for mankind life duration, economical issues and for ecosystems stability and function . The most important aspect of this study is determining evenness and diversity important indexes for the herbal and shrub layers in natural and afforestated stands. In this study the diversity of grassy and shrub species in natural and afforestated stands of forests in north of Iran were studied and compared from the view point of diversity and evenness indexes. In order to do this study natural stand which are approximately at the same height above the sea level were selected. The area of each stand was 30 hectares and the inventory was done by a random- systematic method with 10 percent intensity. In each stand 30 circle shape sample pieces with a 5R measurement (500 m^2) were selected. In order to study the herbal layer in the center of each sample piece micro plots by the measurement of 125 m^2 were made. The results showed excessiveness of diversity and evenness of herbal layer and shrub species in the natural forest.

KEYWORDS: Diversity, Natural stand, Afforestation Iran's forests.

INTRODUCTION

Biodiversity is necessary for mankind life duration, economical issues and for ecosystems stability and function [1]. The most important aspect of this study is determining evenness and diversity important indexes for the herbal and shrub layers in natural and afforestated stands. Because the quantity and number of these indexes distinguishes the ecology superiority and the stability of the forest stands. In this direction the diversity among species and the forest benth flora abundance in conifer afforestation and hard wood natural forest in Mazandaran forests in Iran were compared and the results showed that forest benth flora in natural stand compared to flora diversity in man-made forest is more and in this comparison Shannon-wiener index showed the most quantity [2]. Also the influence of afforestation on vegetative cover diversity in plain areas in east of Guilan province in Iran was studied and it was showed that the diversity of species and evenness in a natural forest is maximum but the species richness in Pinus teada afforestation is minimum [3]. The conifer forests biodiversity in north of Iran was also considered and it was determined that Simpson index along with N_2 Hill have more capability in showing the diversity among ecosystems [4]. In another study that was about considering afforestation influence on the quantity of species biodiversity in natural forests in comparison with Vegetative cover in west of Guilan province of Iran shows the amount of Shannon-wiener index diversity for herbal species in thinning afforestation and non-thinning afforestation of Pinus teada is more than natural forest and there is a significant difference between them [5]. Also another study in Iran showed that while the height form the sea level increases the species quantity (Richness) decreases but the species frequency (Evenness) increases so that most species diversity is seen in 100 to 700 meters above the sea level and the least species diversity is seen in the height of 700 meter and above [6]. The comparison of a pure alder species afforestation with a pure Picea species afforestation also showed that in alder stand a various diversity is observed in herbal and shrub species and this diversity is lesser in Picea species [7]. The study of forest benth plants changes and the trees restoration in the blended mountainous forests with a great slope in Bavaria area in Germany also shows that in the open areas of the forest which is filled with afforesstation, although by afforestation with different species the trees combination of that area changes but the forest benth plants condition doesn't change considerably [8]. A study of the influence of over storey on the form and structure of plants community in Pinus teada un-even aged stands also showed that in un-even aged stands the plant species are mostly seen in an individual manner [9]. In another study that was done on a plant analysis of a full-grown forest in Franklin, Texas in America it was showed that three separate stories that include tree with dominant canopy, the species under the dominant storey and the herbal layer are seen and the most diversity exists in shrub layer and the least diversity exists in canopy layer [10]. The purpose of this study is also to study the quantity of herbal and shrub species diversity in natural stand.

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MATERIALS AND METHODS

Siyahkal forests are located in north of Iran and because of having natural communities of Fagus orientalis (Beech), Quercus castaneifolia (Oak), Alnus subcardata (Alder) and Carpinus betulus (Hornbeam) it has become an appropriate place for this type of studies .In order to accomplish this study series 2 and 3 from Siyahkal forests were selected and it was tried that natural stands to have an acceptable homogeneousness. From the view point of geographical situation these series are between 47° 50' 49" longitude and 30° 50' 36" latitude and their average height from sea level is between 400-500 meters and their general slope is towards north (fig.1). This area has a semi-humid and temperate climate and its average amount of precipitation is reported more than 1000 millimeters. The maximum average heat degree is 30.2° centigrade and its minimum heat degree is 5.5° centigrade. The soil PH of the under study area is neutral and it is disposed towards acidic soil.

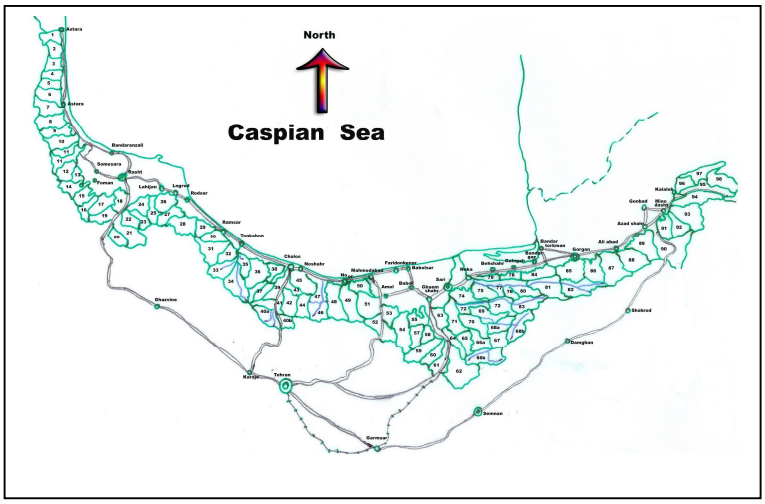

Fig.1. study area map.

Method

In this study first by sprayer forest series 2 and 3 from Siyahkal forests in north of Iran that include natural forest community and afforestated community were selected set 2 included natural species such as *Alnus subcordata (Alder), Quercus castaneifolia (Oak) and Carpinus betulus (Hornbeam)*. communities had an acceptable homogeneousness and the area of each of them was about 30 hectares and their general slope is towards north . Inventory was done by random- systematic method and with 100 percent intensity [11]. In each stand 30 circle shape sample pieces with a measurement of 5R (500 m^2) were selected. The diameter, number and the tree and shrub species type were recorded in related forms. Also in order to study the herbal layer in the center of each sample piece micro plots by the measurement of 125 m^2 were made and the needed features were collected. Since on of the main purposes of this study is to survey the herbal and shrub layer in both natural and man-made stands after collecting the data by using Ecological methodology software richness indexes such as Simpson, N_2 Hill, Shannon-wiener and Mc- Arthur and also evenness indexes such as Smith-Wilson, Camargo's, Simpson's and Nee in each stand were calculated and compared with each other [12]. The significant difference between the indexes was calculated by the use of t statistical test [13]. And was considered by Spss soft ware [14].

Evenness and species diversity indexes

Species diversity is a function of richness and also evenness [15]. For evaluating species diversity there are various indexes which in this research the most common ones are used to calculate species diversity.

Simpson diversity index [16]

$$1-\hat{D}=1-\sum_{i=1}^{s}\left[\frac{n_i(n_i-1)}{N(N-1)}\right] \qquad (1)$$

In which 1- $\hat{D}$ is Simpson's diversity index, S the number of species in the sample, n_i the number of i species member in the sample, N the number of total members is the sample. This index's domain of changes is from zero (least diversity) to almost one ($1-\frac{1}{S}$).

Hill's N_2 diversity index [17]

$$N_2 = \frac{1}{D} = \frac{1}{\sum_{i=1}^{s} p_i^{\,2}} \qquad (2)$$

In this formula N_2 is the number of numerous species ($\frac{1}{D}$), P_i the relative frequency of i species in community. N_2 varies from one to S (the number of species in the sample).

Shannon-wiener diversity index [18]

$$H^{/} = -\sum_{i=1}^{s} p_i \ln p_i = -\sum_{i=1}^{s} (p_i)(\log_2 p_i) \qquad (3)$$

In that H' is Shannon –wiener function, S the number of species, and p_i is the relative frequency of i species.

The variety of H' amount is between Log_s to $Log[N/(N-S)]$ in which MC-Arthur in 1965 by the help of Shannon-wiener function calculated the number of numerous species from another formula which formula is $N_1 = e^{H'}$. In this formula N_1 is the number of numerous species, e the basis of natural logarithm (e =2.71828) and H' is Shannon –wiener index.

Camargo's index of evenness [19]

Camargo is a new index of evenness which isn't influenced by species richness. [20,21] and is easily calculated.

$$E' = 1 - \left[\sum_{i=1}^{s} \sum_{j=i+1}^{s} \left[\frac{|p_i - p_j|}{s} \right] \right] \qquad (4)$$

In that E' is Camargo's evenness index, p_i relative frequency of i species in the whole sample, p_j relative frequency of j species, s the number of species in the whole sample.

Simpson's index of evenness

$$\hat{D}_{\max} = \frac{1}{s} \qquad (5)$$

In this formula $\hat{D}_{\max}$ is the possible amount for Simpson's index and s is the number of species in the sample [20].

Smith and Wilson's index of evenness

$$E_{\text{var}} = 1 - \left[\frac{2}{\pi \arctan\left\{ \sum_{i=1}^{s} \left[Log_e(n_i) - \sum_{j=1}^{s} \log_e(n_j) \Big/ s \right]^2 \Big/ s \right\}} \right] \quad (6)$$

In this formula E_{var} is Smith and Wilson's index of evenness, n_i the number of i species members in the sample, n_j the number of j species members in the sample, and s the number of species in all samples. This index is known as the best evenness index [20].

Nee index of evenness

$$E_Q = \frac{2\arctan(b)}{\pi} \quad (7)$$

In this formula E_Q is the reformed Nee index of evenness, b is the line tilt of Whittaker diversity–predominance. The amount of this index varies between 0 to 1 and it is independent from species richness [22].

RESULTS

The surrey of different diversity and evenness indexes for shrub layer in natural stands are shown in table 1 and 2. The most mean diversity shrub layer is related to Mc- Arthur index and the least is related to Simpson index (Table1). Also the most evenness mean is related to Smith-Wilson index and the least is related to Nee index (Table 2).

Table 1. Mean, Standard of deviation, Standard of error of different diversity indexes for shrub layer.

The type of Index	Parameter / The type of forest	Mean	Standard of deviation	Standard of error
Simpson	Natural	0.432	0.243	0.057
N_2 Hill	Natural	1.636	0.881	0.0208
Shannon-Wiener	Natural	0.896	0.527	0.124
MC-Arthur	Natural	1.794	0.987	0.233

Table 2. Mean, Standard of deviation, Standard of error of different evenness indexes for shrub layer.

The type of Index	Parameter / The type of forest	Mean	Standard of deviation	Standard of error
Camargo's	Natural	0.623	0.301	0.071
Simpson	Natural	0.657	0.319	0.075
Nee	Natural	0.265	0.181	0.043
Smith-Wilson	Natural	0.665	0.327	0.077

The survey of different diversity indexes for herbal layer in the under study area shows that the mean of these indexes in the natural stand is much more than man-made stand. Mc- Arthur index has the most amount while Simpson index has the least amount (Table 3).

Table 3. mean, standard of deviation and standard of error different diversity indexes for herbal layer

The type of Index	Parameter The type of forest	Mean	Standard of deviation	Standard of error
Simpson	Natural	0.757	1.3	0.031
N_2 Hill	Natural	4.81	1.609	0.379
Shannon-Wiener	Natural	2.477	0.523	0.123
MC-Arthur	Natural	5.881	1.815	0.428

Table 4. Mean, Standard of deviation, Standard of error of different evenness indexes for herbal layer.

The type of Index	Parameter The type of forest	Mean	Standard of deviation	Standard of error
Camargo's	Natural	0.56	0.11	0.042
Simpson	Natural	0.561	0.14	0.033
Nee	Natural	0.194	0.059	0.014
Smith-Wilson	Natural	0.554	0.135	0.032

The analysis results of comparing different diversity index means for shrub species in the natural stand shown in (Table. 5) as observed there isn't a significant different between the diversity index means for shrub species.

Table 5. The comparison of shrub species different diversity index means in natural

The type of Index	Natural Forest Mean	Mean of diference	t
Simpson	0.432	0.134	1.75 $^{n.s}$
Shanon-Wiener	0.896	0.282	3.411 $^{n.s}$
N_2 Hill	1.636	0.423	1.509 $^{n.s}$
MC-Arthur	1.794	1.549 $^{n.s}$	

n.s= non-Significant

Studying (Table 6) also shows that comparing different diversity index means for herbal layer in natural shows a significant difference for Simpson index at the level of 0.01 and for the other indexes at the level of 0.001.

Table 6. The comparison of herbal layer different diversity index means in both natural by t-test.

The type of Index	Natural Forest Mean	Mean of diference	t
Simpson	0.757	0.163	3.219**
Shanon-Wiener	2.477	0.722	4.017***
N_2 Hill	4.81	1.9	4.037***
MC-Arthur	5.881	2.273	4.332***

** Significant at the level of 0.01 . *** Significant at the level of 0.001 .

The results obtained from this research shows that the number of species that exist in natural forests are more. Different shrub evenness and diversity indexes show that the mean of all indexes is natural forest is more than man-made stand. The results are the same the results that mention species diversity and evenness in natural forests is maximum but species richness in Pinus teada afforestation is minimum [3]. The mean of herbal layer diversity indexes in natural stands is much more than man-made stands. Since soil in a forestation with soft wood moves toward being acidic therefore the deduction of forest benth layer diversity isn't unexpected. Under this condition those species that can tolerated the present condition will grow and practically it is possible that in these areas a limited number of species to cover a wide area and this increases the evenness. Also in this research it is determined that in the understudy afforestated stand. Because of the existence of the dead layer at the bottom of the forest (Niddle pine). The richness and the percent of frequency of forest plant species to decrease. Because the studies

have shown that after 30 years afforestation with soft wood the chemical features of the soil changes [23]. On the other hand the deciduous broad- leaf species increases the soil organic materials and causes the fertility of the soil but soft woods are mainly green [24]. In this study it was determined that since natural forests are multi-storeies they cause diversity in growing environments an this makes each species according to its specific ecologic need to select its specific ecological niche so this can be known as a reason for herbal species diversity in under study natural stand [25,26]. Also according to the studied that have been done in tropical forests, one of main reasons that influences the frequencies of the existing tree species in afforestation is the closeness and adjacency with the natural forest [27]. Therefore it is suggested that in order to increase the species diversity and to protect the stability of the forest to use local species in Iran's north afforestation.

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