

## RESEARCH ARTICLE

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**Biodiversity of woody species in large-leaved lime sits in Noshahr forests (Iran)****Authors' address:**

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**ABSTRACT**

Species diversity is one of the most important indices used for evaluating the sustainability of forest. This study aims to characterize the large-leaved lime stand and to identify and compare the tree species diversity in the study area. In order to study biodiversity of woody species of large-leaved lime (*Tilia platyphyllos* Scop.) in the forests of Noshahr of Mazandaran province in the north Iran, three experimental sites in three elevations have been selected. Moreover, each selected site covers three plots with an area of one hectare (100×100 meter). In totally, 9 plots have been chosen to study. We described the population structure of the tree species using stem density, basal area, diameter at breast height (DBH) distribution, and diversity indices. Richness is defined as the number of species in the study area and abundance as the number of all individuals. To quantify the diversity of the plant species, the Shannon index and the Simpson index were considered. Duncan test was used to investigate the differences in the species richness, diversity and evenness indices among the different sampling plot areas. There were significant differences in the diversity index between sampling plot areas.

**Key words:** tree diversity, Richness, Abundance, Shannon index, Simpson index**Introduction**

The Hyrcanian (Caspian) district of northern Iran possesses a closed-canopy deciduous forest, unlike the arid to semi-arid landscape throughout most of Iran. Hyrcanian forests are located at green strip extending over the northern slopes of Alborz range of mountains and the southern coasts of the Caspian Sea. Hyrcanian forests encompass various forest types including 80 woody species (trees and shrubs). They are suitable habitats for a variety of hardwood species such as beech, hornbeam, oak, maple, alder, and large-leaved lime (Sagheb-Talebi et al., 2004).

Large-leaved lime is found in the central and southern Europe, Asia, Caucasian and north Iran (Browics, 1978). In the north of Iran, large-leaved lime (*Tilia platyphyllos* Scop.) is one of the major species, accompanying with beech, horn birch, maple tree, ash, and oak in the deciduous forest region.

Large-leaved lime is found on the lowlands of the northern slopes in Kheyroodkenar forest (north Iran) as *Tilio-Buxetum* community. Sadati et al. (2007) studied on the influence of some topographic factors on distribution of

large-leaved lime (*Tilia platyphyllos* Scop.) and its natural regeneration characteristics in "Vaz" forest (northern Iran). It consists of some tree types together with *Fagus orientalis*, *Carpinus betulus* and *Parrotia persica*, whereas the dominant type is *Tilia platyphyllos-Fagus orientalis*. In most of tree types, lime occurs in the upperstorey. Natural regeneration of lime is often observed as sprout (coppiceshoot) (Sadati et al., 2007).

Knowledge of biodiversity is a prerequisite for developing ecologically sustainable forest management strategies. Species diversity usually refers to the species richness, abundance, or a combination of both, of a community, and is the result of species interaction or community adaptation to its environment over evolutionary time (Rice & Westoby, 1982). Various hypotheses: niche differentiation, species competition and disturbance have been proposed as driving mechanisms to account for high diversity. Species diversity patterns should emerge as the consequence of any and all of these mechanisms. As a result, studying species diversity patterns should help understand the mechanisms that have generated the observed diversity in the

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community (Wang et al., 2008).

In Iran, recent studies on diversity pattern have been concentrated on Hyrcanian forests where species diversity reaches high levels. For example, Nouri et al. (2009) investigated the sustainability of tree species using common sample plots in Kheyroud forest. Kouch et al. (2009) compared the wood species diversity indices with respect to characteristics of natural lowland forests in Chalous forest. Eshaghi Rad et al. (2009) compared the species diversity with different plant community in deciduous forest. Vatani et al. (2007) studied the woody species diversity in Alder plantation in Mazandaran forests. Mahmoudi (2008) studied the species diversity in Kelarabad forests. Ravanbakhsh et al. (2007) investigated the plants species diversity of Gisoum reserve forests. Ghomi Avili et al. (2007) studied the woody plants biodiversity in two management plant association of Noshahr forests. Pourbabei & Dado (2006) investigated the species diversity of woody plants in Kelardasht forests. Hasanzad Navroudi (2003) evaluated the relationship between diversity indices of woody species and growing stock in natural Beech stands.

The objective of this study was to study the species diversity of woody plant in large-leaved lime stands in Noshahr forest in north of Iran. This study aims to characterize the large-leaved lime stands and to identify and compare the plant species diversity in the study area.

## Materials and Methods

The Noshahr forests are located in the north of Iran. Near the study stand, mean annual precipitation is about 1300 mm and the mean monthly temperature is highest in August (23.0°C) and lowest in February (1°C). Snow falls from November to April. The study stand is situated at an elevation between 500 and 1800 m on a gentle north-facing slope.

In order to study biodiversity of woody species of large-leaved lime (*Tilia platyphyllos* Scop.) in the forests of Noshahr of Mazandaran province in the north Iran, three experimental sites in three elevations have been selected. Moreover, each selected site covers three plots with an area of one hectare (100×100 meter). In totally 9 plots have been chosen to study (Figure 1). The plot was divided into 400 contiguous 5m \* 5 m quadrats. In each plot altitude, slope gradient and aspect have been recorded. All woody stems ≥12.5 cm diameter at breast height (DBH) were measured to the nearest 0.1 cm and the location of all stems was mapped. The trees were tagged, identified to species level.

We described the population structure of the tree species using stem density, basal area, DBH distribution, and diversity indices.

Richness is defined as the number of species in the study area and abundance as the number of all individuals. To quantify the diversity of the plant species, the Shannon index ( $H'$ ) as a measure of species abundance and richness is applied. The Shannon diversity index has been suggested by Margalef (1958) as a synthetic measure of community structure.

For any sample it is calculated as:  $H' = -\sum_{i=1}^s p_i \ln p_i$

Where,  $s$  equals the number of species and  $p_i$  is the relative cover of  $i$ -th species (Whittaker, 1972; Pielou, 1975). In addition, the Simpson index ( $D$ ) is considered as a measure of species dominances.

The Simpson index is defined as:  $D = \sum p_i^2$

As biodiversity increases, the Simpson index decreases. Therefore, to get a clear picture of species dominance  $D' = 1 - D$  is used.

All diversity indices were calculated using PAST version 1.39 and statistics analysis was conducted using SPSS 17.0.

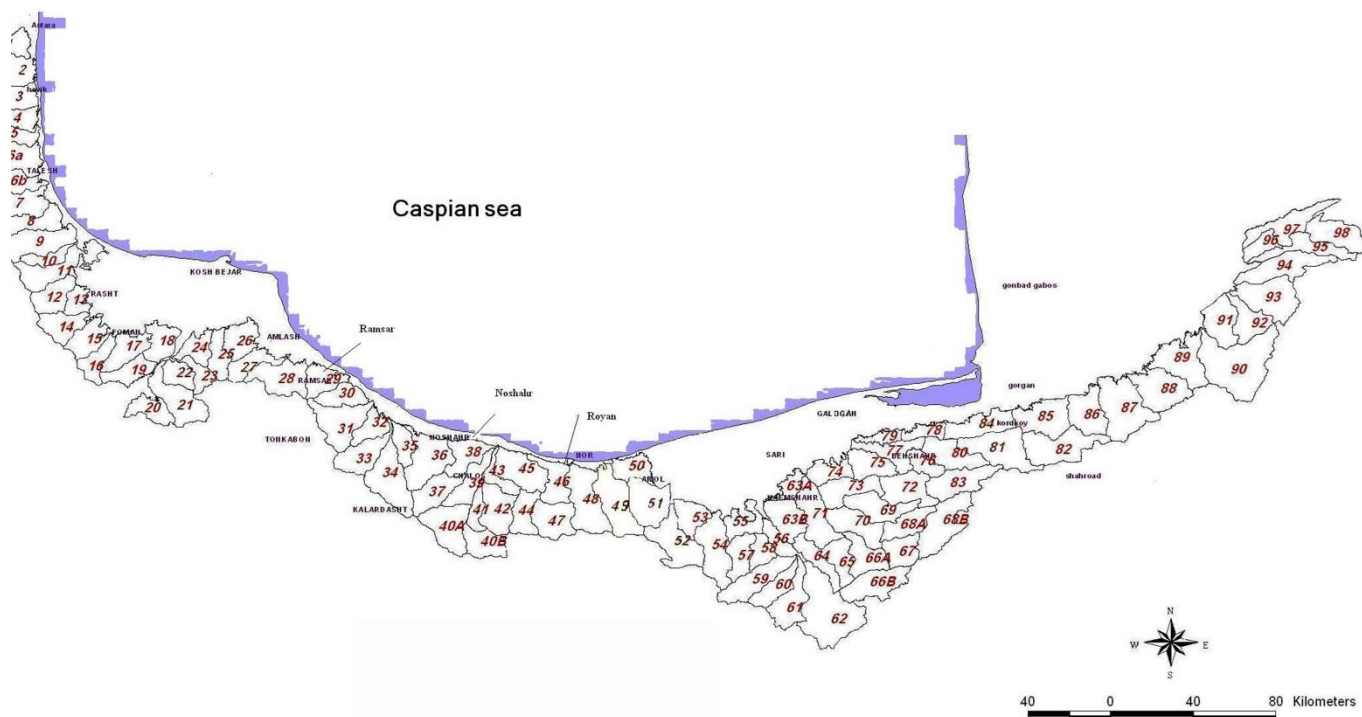
## Results and Discussion

Study plots were located in the northern slopes, with slope gradient 35-70%. 14 tree species were recorded in the study area in different plots. Some of the recorded species have a wide ecological range of distribution. Large-leaved lime grows in mixture with other species; hence, it has formed large leaved lime-Beech, Beech-Large-leaved forest types in observed study plot. Large-leaved lime trees grow in study sites with *Fagus orientalis* Lipsky, *Carpinus betulus* L., *Alnus subcordata* C.A.M., *Quercus castanefolia* C.A.M., *Acer velutinum* Boiss, *Acer cappadocicum* Gled., *Buxus hyrcanus* Pojark, and *Diospyrus lotus* L, *Cerasus avium* L. and *Ulmus glabra* Huds.

Population parameters of tree species including density, DBH and height, for each species and for each altitude showed in Tables 1 and 2 in the study areas. Dispersion maps of individual stems of each species in each altitude and plot illustrate their spatial distributions (Figure 2).

There were no significant differences in the diversity indices between altitudes in the study area, but the different sampling plot area significantly affected the diversity indices (Table 3).

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**Figure 1.** Study sites in the north of Iran.

**Table 1.** Population parameters of stems  $>7.5$  cm DBH for tree species in the 1 ha plot of the study area

Species	Stem density	DBH	Height	Basal area (m <sup>2</sup> ha <sup>-1</sup> )
		(cm)	(m)	
		Mean±S.D.	Mean±S.D.	
<i>Tilia platyphyllos</i> Stev.	85	59.48 ± 43.4	26.6 ± 9.4	36.1
<i>Fagus orientalis</i> Lipsky.	578	36.65 ± 22.5	24.1 ± 8.2	80.6
<i>Carpinus betulus</i> L.	562	34.16 ± 18.8	22.7 ± 7.3	67
<i>Quercus castanaeifolia</i> C.A.Mey.	4	104 ± 74.0	34.8 ± 7.0	4.7
<i>Acer cappadocicum</i> Gled.	69	37.15 ± 21.2	24.4 ± 8.0	9.9
<i>Acer velutinum</i> Boiss.	56	36.2 ± 12.1	23.6 ± 7.0	6.4
<i>Parotia persica</i> (DC.)C.A.Meyer.	300	27.5 ± 13.7	18.6 ± 4.8	22.2
<i>Diospyrus lotus</i> L.	86	18.72 ± 6.2	14.9 ± 4.3	2.6
<i>Alnus subcordata</i> C.A.Mey.	30	44.73 ± 30.2	44.7 ± 30.2	6.8
<i>Ulmus glabra</i> Huds.	7	20.12 ± 6.62	20.1 ± 6.6	0.24
<i>Cerasus avium</i> L.	3	27.3 ± 5.8	27.3 ± 5.8	0.18
<i>Buxus hyrcanus</i> Pojark	18	16.17 ± 4.4	16.2 ± 4.4	0.4

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The Duncan test results showed that the mean differences between the different sampling plot areas were significant in all diversity indices at the 0.05 level, except Simpson Index. In the study areas, the species-area relationship described the tendency for species richness to increase with sampling area. When the sampling area increased to 0.25 ha, there were about 6 species, approximately 75% of the total number of species (Table 3 and Figure 3). The relations between abundance and sampling area are showed when the sampling

area increased to 0.5 ha, there were about 92 species (Table 3 and Figure 4).

The relationship between Shannon diversity and area also shows that Shannon diversity varies greatly within small sample areas in the Study area. The Shannon diversity-area relationship are showed when the sampling area increased to 0.5 ha, there were about 1.22 (Table 3 and Figure 5).

There were no significant differences in the Simpson index between sampling plot areas (Table 3 and Figure 6).

**Table 2.** Population parameters of stems >7.5 cm DBH for elevation in the 1 ha plot of the study area

Altitude	Stem density	DBH (cm)	Height	Basal area (m <sup>2</sup> ha-1)
		(cm) Mean±S.D.	(m) Mean±S.D.	
< 500 m	642	34.7 ± 24.8	21.5 ± 7.7	91.7
500-1000 m	450	36.1 ± 24.2	22.2 ± 8.4	66.6
> 1000 m	706	32.7 ± 18.8	23.0 ± 7.7	78.8

**Table 3.** Duncan test for diversity indices in the plot areas

Plot Area	N	Richness				Abundance				Shannon			Simpson	
		1	2	3	4	1	2	3	4	1	2	3	1	2
313	7	2.71				6.71				0.84				
625	9	3.33				12.00	12.00			0.92	0.92		0.51	
1250	9		4.44			22.89	22.89			1.06	1.06	1.06	0.52	
2500	9			5.89			46.78				1.22	1.22	0.56	0.56
5000	9			6.67	6.67			92.22				1.29	0.61	0.61
10000	9				7.22				182.60			1.37	0.62	0.62
Sig.		0.22	1.00	0.12	0.27	0.38	0.06	1.00	1.00	0.14	0.05	0.05		0.67

Subset for alpha = 0.05

## Conclusion

In the study stand, the density of beech and horn beam was much higher than others, although lime-large leaved tree occupied appropriate density and basal area. All species were distributed independently of other species in almost all sizes of quadrat. Study of the variation in species diversity helps us to understand the community structure in forest, and the processes that may have contributed to its formation. In this study there are several plot areas of variation in the richness, abundance, Shannon and Simpson diversity data. There were no significant differences in the diversity indices between altitudes in the study area, but the different sampling plot area

significantly affected the diversity indices. Diversity is also of vital importance for conservation of natural communities. In the temperate vegetation zone, natural and old growth forests still exist and can be regarded as highly valuable habitats in terms of biodiversity (Eshaghi Rad et al. 2009). The results illustrated that sampling plot areas to 0.5 ha were significantly more diverse than others. Study of Eshaghi Rad et al. (2009) showed the number of species per unit area decreases constantly, reaching eventually the value comparable to that recorded for hornbeam forest. Generally, species diversity is inversely correlated with the dominance of shade tolerant climax species (Eshaghi Rad et al. 2009).

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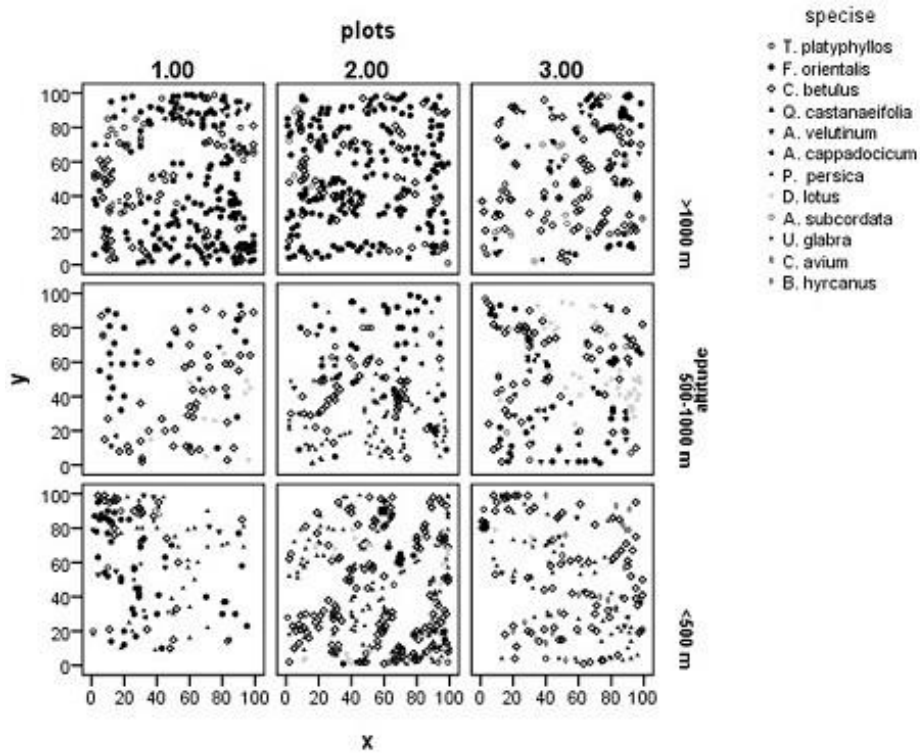


Figure 2. Distribution pattern of tree species in the study plots.

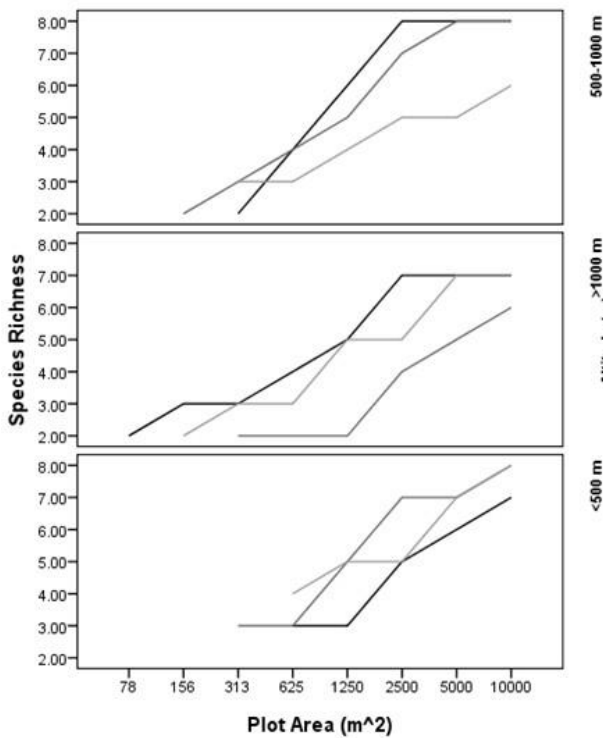


Figure 3. Species richness-area curves in different altitude in the study area.

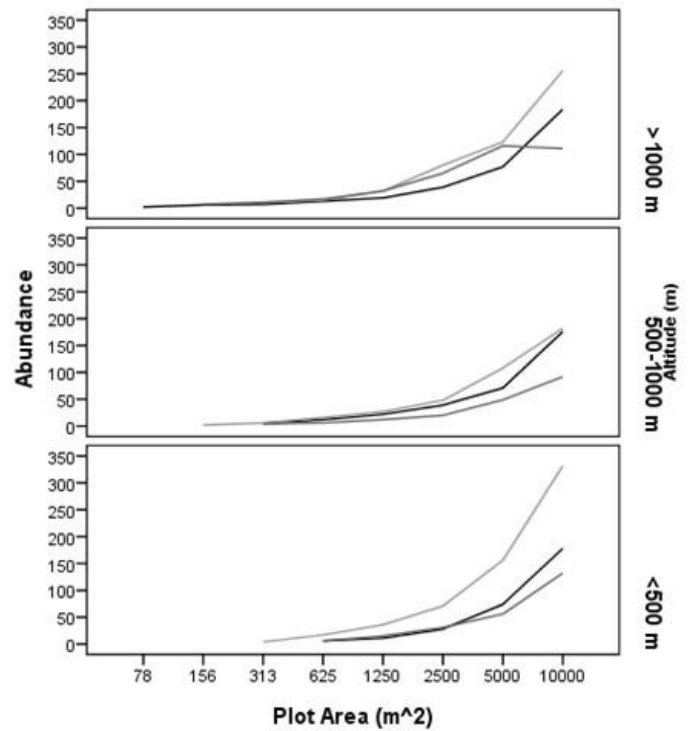
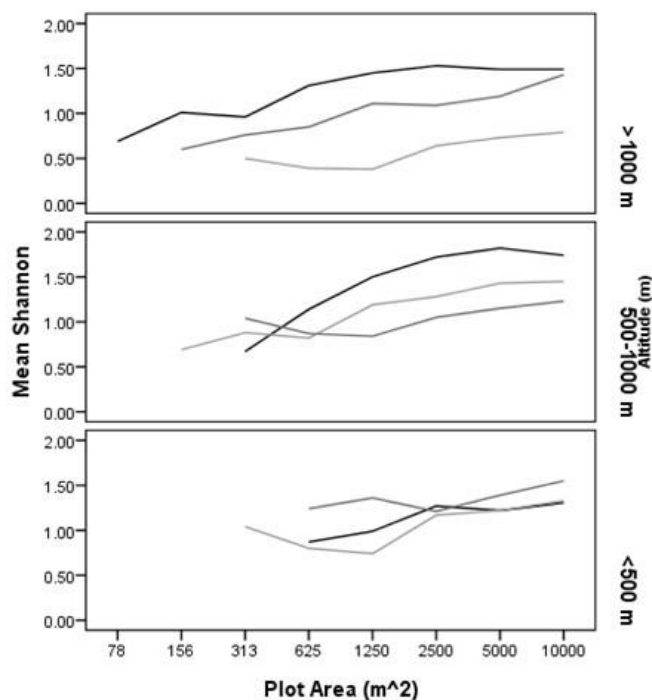
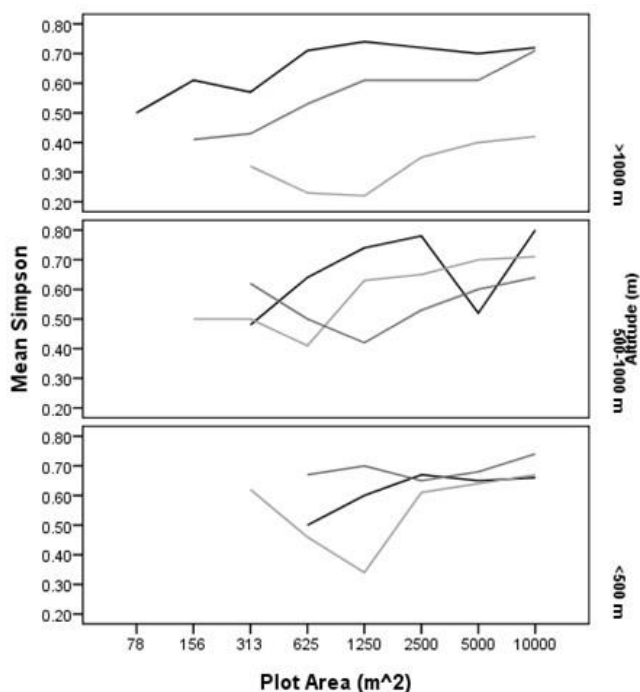


Figure 4. Abundance-area curves in different altitude in the study area.

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**Figure 5.** Shannon index-area curves in different altitude in the study area.



**Figure 6.** Simpson index-area curves in different altitude in the study area.

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