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# Woody species diversity in natural *juniperus excelsa* M. Bieb. stands in Northwest of Iran

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**Key words:** *Juniperus excelsa*, Biodiversity, Shannon – Wiener index, Regeneration, Stand structure.

**Abstract**

In this research woody species diversity, species importance value (SIV) and stand structure of natural *J. excelsa* M. Bieb. stands were studied in Ardebil province in the North West of Iran. The elevation of the study area ranges from 2,000 to 2,100 m above sea level. Data were collected in summer 2014, by systematic sample plots with an area of 400 m² (20 m × 20 m). A total of 30 woody species belonging to 14 families were recorded from the study area. The family of Rosaceae with 9 species had the most number of woody species. The *J. excelsa* had a highest density (63.6 stem ha$^{-1}$) and species importance value (SIV=58.3) in the study area. After Juniper, the trees of *Acer monspessulanum, Amygdalus lyciodes, Pistacia atlantica, Quercus macranthera* and *Berberis integerrima* had the highest density and SIV. The *Carpinus orientalis* had a high seedling density (9.7 stem ha$^{-1}$). The seedling density of *J. excelsa* was 8.6 stem ha$^{-1}$. The results showed that the studied stands had an uneven aged structure. The mean of Shannon – Wiener diversity index was calculated 1.62. The values of diversity and richness indices were decreases by increasing diameter classes ($P<0.01$). Regeneration in these forests is strongly inhibited by grazing pressure and human disturbance.

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## Introduction

Biodiversity refers to the natural variety and the physical organization or pattern of the variability among living organisms (Putz, 2000). Species diversity is an important index in community ecology (Mayer and Harms, 2009). It is now widely accepted that forests should be managed in an ecologically sustainable fashion (Kohm and Franklin, 1997; Lindenmayer *et al.,* 2000). Forests are among the most diverse and complex ecosystems in the world, providing a habitat for a multitude of flora and fauna. Species diversity at the property, compartment and stand level contributes to the habitat value and biodiversity of a forest. Forest ecosystems provide habitat for a disproportionate share of the world's biological diversity. The Juniper populations have a high ecological value, mainly in relation to their soil retaining ability, as well as their associated flora and fauna. Junipers containing 60 species and spreading among many different temperature environments from the northern hemisphere to Southern Africa, are ever green trees and shrubs (Deligoz, 2012). *J. excelsa* usually appears in mountainous areas (Korouri and Khosnevis, 2000; Stampoulidis and Milios, 2010).

Iran is a country with relatively poor forest resources. The total forest area of Iran is estimated 12.4 million hectares, which make only 7.3 percent of the total land area (Mossadegh, 1996; Marvie-Mohadjer, 2006). The *J. excelsa* is one of the most important trees of Iran which is found on south slopes in high mountains of Elburz, Arassbaran, and Northern parts of Khorassan (Marvie-Mohadjer, 2006). An investigation on the distribution and ecology of Juniper genus was conducted as a national plan in the Iran (Korouri and Khosnevis, 2000). *J. excelsa* is cold resistant and requires a high degree of humidity (Aussenac, 2002). Their vital needs are limited. *J. excelsa* exhibits growth plasticity and can adapt and grow in diverse growth regimes (shade – light), while, in favorable conditions, it is able to increase its growth rates even at old ages (Milios *et al.*, 2009). Moreover *J. excelsa* is capable of growing in harsh abiotic environments (shallow and stony soils, cold, hot and dry climates) as well as in severe biotic conditions like grazed sites (Ahmed *et al.*, 1989; Fisher and Gardner, 1995; Korouri and Khosnevis, 2000). They are important food sources for wildlife, several bird species feed on juniper cones (Decker *et al.*, 1991). This specie is notable in soil conservation, also is a frost resistant plant and grows in areas where the minimum of temperature reaches to –35 °C.

The knowledge of the floristic composition of an area is a perquisite for any ecological and phyto-geographical studies and conservation management activities (Jafari and Akhani 2008, Tavankar, 2013). It has been well documented that species composition and diversity can be used as indicators of past management practices in forested areas (Hunter, 1999; Kneeshaw *et al.*, 2000). Degraded plant communities are generally quite difficult or sometimes impossible to restore (Van Diggelen and Marrs, 2003), moreover the continuous severe disturbances reduce the number of species and alter the species composition (Heydari *et al.*, 2013).

Juniper forests cover an area of 1.3 million ha in Iran (Marvie-Mohajer, 2006). Little research has been done so far in Iran on biodiversity of Juniper stands. The objective of this study was estimating of woody species diversity, species importance value (SIV) and structure of Juniper stands in the North West of Iran.

## Material and methods

*Study area*

The study area is located in the Ardebil province in the North West of Iran (latitude 37° 38' 43" to 37° 40' 8" N, longitude 48° 34' 28" to 48° 36' 18" E). The elevation of the study area ranges from 2,000 to 2,100 m above sea level. The mean annual temperature is 8.1°C and the mean annual precipitation is 376 mm for along with the 1990 to 2008 years. The slope gradient of study area is 28 to 60 percent with south-west aspect. Soil is generally shallow, with clay loam texture and regarding to the FAO classification, is called lithic lithosol. The original vegetation of this area is natural uneven-aged

mixed stands of *Jniperus excelsa* with the companion species.

*Data collection*

Data were collected in summer 2014, by systematic sample plots with an area of 400 m² (20 m × 20 m). The sample plots were located on the study area through systematic grid (100 m × 100 m) with a random start point. Diameter at breast height (DBH) and heights of all trees (height ≥ 1.5 m) were measured. Individuals of trees with height < 1.5 m were counted by species as seedling (Milios *et al*., 2009).

*Data analysis*

Species importance value (SIV) for each specious was calculated by: SIV= Relative density (RD) + relative frequency (RF) + relative dominance (RD). Basal area was considered for dominancy and relative dominance (RD) calculated by: RD = (basal area of a species × 100) / total basal area of all species (Tavankar and Bonyad, 2015). The species diversity index was computed using the Shannon – Wiener information function as: $H'=-\Sigma n_i/n \log_2 n_i/n$, where: $n_i$ = denote to the SIV of a species and n= denote to the sum of total SIV of all species. The species evenness index was computed using the Pielou's evenness index (J) as: J = H' / ln S, where ln is Natural logarithm, S is the total species number in each plot. Also species richness (S) was number of species per plot (Ganesh *et al*., 1996; Krebs, 1999; Sharma *et al*., 2009; Pourbabaei *et al*., 2013; Rezaei Taleshi, 2014). After checking for normality (Kolmogorov–Smirnov test) and homogeneity of variance (Levene's test), the means of biodiversity indices in DBH classes compared using a one-way ANOVA. Multiple comparisons were made by Tukey's test (significance at $\alpha < 0.05$).

**Results and discussion**

A total of 30 woody species belonging to 14 families were recorded from the study area (Table 1). The family of Rosaceae with 9 species had the most number of woody species in the study area that includes *Amygdalus lyciodes, Crataegus songarica, Prunus divaricata, Sorbus torminalis, Malus orientalis, Amygdalus scoparia, Cerasus microcarpa, Cotoneaster nummularia* and *Rosa canina*.

The family of Caprifoliaceae had 4 woody species (*Lonicera nummulariafolia, Viburnum opulus, Viburnum lantana* and *Cornus sanguinea*). The family of Aceraceae had 3 woody species (*Acer monspessulanum, Acer campestr* and *Acer hyrcanum*) and Rhamnaceae had also 3 woody species (*Rhamnus spathulaefolia, Paliurus spina Christi* and *Rhamnus pallasii*). The family of Oleaceae had 2 woody species (*Fraxinus excelsior* and *Jasminum fruticans*). Each family of Cupressaceae, Anacardiaceae, Berberidaceae, Fagaceae, Corylaceae, Celastraceae, Papilionaceae, Cornaceae and Ulmaceae had one woody species (Table 1). From all of the species, only one tree was from coniferous that it was Juniper tree (*Juniperus excelsa*). The *J. excelsa* had a highest density (63.6 stem ha$^{-1}$) and species importance value (SIV=58.3) in the study area. After Juniper, the trees of *Acer monspessulanum, Amygdalus lyciodes, Pistacia atlantica, Quercus macranthera* and *Berberis integerrima* had the highest density and SIV. The stand density was measured 253.7 trees ha$^{-1}$.

The results showed that the seedling density in the study area was 82.8 stem ha$^{-1}$. Seedling of different tree species is shown in Fig. 1. The seedling of *Quercus macranthera* had the highest density (11.4 stem ha$^{-1}$). The *Carpinus orientalis* had a high seedling density (9.7 stem ha$^{-1}$). The seedling density of *J. excelsa* was 8.6 stem ha$^{-1}$. After these species, the trees of *Paliurus spinachristi, Amygdalus lyciodes, Acer monspessulanum* and *Pistacia atlantica* had 7.8, 7.2, 5.3 and 5.1 stem ha$^{-1}$, respectively (Fig. 1).

The density of trees in DBH classes is shown in Fig. 2. According to Fig. 2 the tree densities were decreased by increasing DBH. The maximum DBH of Juniper trees was 24 cm, but other tree species had the

maximum DBH of 40 cm. This results shows that these stands had an uneven aged structure. The density of trees in height classes is shown in Fig. 3. Density of other trees decreased by increasing tree height class, but density of Juniper trees increased from 1 to 2 m of height class, and then decreased. The height class of 2 m had the highest Juniper density (23.6 stem $ha^{-1}$). The study of forest structure especially in virgin forests is very important and gives us comprehensive information about the condition in forest for programming.

**Table 1.** Density and species importance value (SIV) of woody species in the study area.

| Tree species | Family | Density (stem $ha^{-1}$) | SIV |
|---|---|---|---|
| *Juniperus excelsa* M. Bieb. | Cupressaceae | 63.6 | 58.3 |
| *Acer monspessulanum* | Aceraceae | 32.6 | 28.1 |
| *Amygdalus lyciodes* L. | Rosaceae | 28.3 | 30.4 |
| *Pistacia atlantica* F&M. | Anacardiaceae | 12.7 | 17.9 |
| *Lonicera nummulariafolia* J. | Caprifoliaceae | 9.7 | 13.4 |
| *Rhamnus spathulaefolia* F&M. | Rhamnaceae | 5.3 | 15.2 |
| *Paliurus spina christi* Mill. | Rhamnaceae | 6.2 | 11.1 |
| *Berberis integerrima* L. | Berberidaceae | 7.5 | 9.3 |
| *Quercus macranthera* | Fagaceae | 11.3 | 19.1 |
| *Carpinus orientalis* | Corylaceae | 9.3 | 17.2 |
| *Acer campestr* | Aceraceae | 6.8 | 9.0 |
| *Acer hyrcanum* | Aceraceae | 5.0 | 7.1 |
| *Crataegus songarica C. Koch* | Rosaceae | 8.1 | 8.1 |
| *Prunus divaricata* | Rosaceae | 5.7 | 4.5 |
| *Sorbus torminalis* | Rosaceae | 4.6 | 6.0 |
| *Viburnum opulus* | Caprifoliaceae | 5.2 | 4.2 |
| *Viburnum lantana* | Caprifoliaceae | 4.5 | 3.0 |
| *Fraxinus excelsior* | Oleaceae | 3.3 | 5.3 |
| *Malus orientalis* | Rosaceae | 3.6 | 4.5 |
| *Eunymus latifolia* | Celastraceae | 3.1 | 3.7 |
| *Amygdalus scoparia* Spach. | Rosaceae | 3.0 | 4.6 |
| *Colutea persica* Boiss. | Papilionaceae | 2.4 | 4.4 |
| *Cerasus microcarpa* (C.A.Mey) | Rosaceae | 2.2 | 3.3 |
| *Cotoneaster nummularia* Pojark. | Rosaceae | 2.0 | 2.0 |
| *Cornus sanguinea* L . | Cornaceae | 2.1 | 2.8 |
| *Lonicera iberica* M.B. | Caprifoliaceae | 1.0 | 1.8 |
| *Rhamnus pallasii* F. M. | Rhamnaceae | 1.2 | 1.5 |
| *Rosa canina* L. | Rosaceae | 1.1 | 1.7 |
| *Celtis caucasica* wild. | Ulmaceae | 1.0 | 1.5 |
| *Jasminum fruticans* L. | Oleaceae | 1.0 | 1.0 |
| All species | - | 253.7 | 300 |

Biodiversity indices in the study area are shown in table 2. The mean of Shannon – Wiener diversity index was calculated 1.62. Species diversity is an important index in community ecology (Myers and Harms, 2009). The Pielou's evenness index was calculated 0.52 and the species richness was calculated 2.35 (Table 2). It is widely demonstrated that more species contribute to greater ecosystem stability. The values of biodiversity indices in different DBH classes are shown in table 3. According to the table 3, the values of diversity index was increased by increasing of DBH classes. The highest diversity value (2.24) was observed in DBH of < 10 cm and the lowest diversity value was observed in DBH of 30-40 cm. Tukey's test showed that the mean of diversity value in the DBH of < 10 cm is significantly higher ($P < 0.05$) than other DBH classes. But there was not significantly difference

between diversity index of 10-20 and 20-30 cm of DBH. The highest evenness value was observed in the DBH class of 10-20 cm. The results showed richness values were decreased by increasing of DBH. The highest richness value (3.18) was observed in the first DBH class (< 10 cm), and the lowest richness value (1.71) was observed in the DBH of 30-40 cm. ANOVA tests showed the DBH classes had significantly affect ($P < 0.01$) on the means of biodiversity indices in the study area (Table 4).

**Table 2.** Biodiversity indices in the study area (n=67).

| Indices | Mean | SD | E (%) |
|---|---|---|---|
| Diversity (H') | 1.62 | 0.52 | 7.8 |
| Evenness (J) | 0.52 | 0.23 | 10.5 |
| Richness (S) | 2.35 | 0.68 | 7.0 |

**Table 3.** Biodiversity indices (mean ± standard deviation) in DBH classes.

| DBH (cm) | Diversity* | Evenness | Richness |
|---|---|---|---|
| < 10 | $2.24 \pm 0.77^{a}$ | $0.40 \pm 0.19^{c}$ | $3.18 \pm 0.89^{a}$ |
| 10 – 20 | $1.81 \pm 0.95^{b}$ | $0.62 \pm 0.15^{a}$ | $2.88 \pm 0.91^{a}$ |
| 20 – 30 | $1.51 \pm 0.89^{b}$ | $0.55 \pm 0.11^{ab}$ | $2.10 \pm 0.96^{b}$ |
| 30 - 40 | $1.01 \pm 0.71^{c}$ | $0.51 \pm 0.20^{b}$ | $1.71 \pm 0.36^{c}$ |

*: Different letters in each column indicated significant difference at $\alpha = 0.05$.

High species diversity in ecosystems led to high food chain and more complex network environment (Ardakani, 2007). Forests are among the most diverse and complex ecosystems in the world, providing a habitat for a multitude of flora and fauna. The conservation of biodiversity has become a major concern for resource managers and conservationists worldwide and it is one of the foundation principles of ecologically sustainable forestry (Carey and Curtis, 1996; Hunter, 1999). Biodiversity is an essential case for life continuance, economical affairs and ecosystems function and resistance (Singh, 2002). Species composition and density of natural tree regeneration are important factors that determine future quality of forest stands. The results of this study showed the seedling density is low, specially, Juniper seedlings, in the study area. Regeneration in these forests is strongly inhibited by grazing pressure and human disturbance.

**Table 4.** ANOVA results for means of biodiversity indices in DBH class.

| Indices | SS | df | MS | F | P-Value |
|---|---|---|---|---|---|
| Diversity | 53.41 | 3 | 17.80 | 25.41 | 0.000 |
| Evenness | 1.69 | 3 | 0.56 | 19.76 | 0.000 |
| Richness | 93.56 | 3 | 31.19 | 46.82 | 0.000 |

Shahi *et al.* (2007) studied Juniper stands in the North West of Iran and reported production of good quality seeds by individuals is the most important basis for maintenance of natural regeneration. Species with high conservation importance should be reintroduced in order to maintain a viable population. Forest protection should aim at ensuring that forests continue to perform all their productive, socio-economic and environmental functions in the future. A planned program of silvicultural treatments ensures the conservation and maintenance of biological diversity and richness for sustainable forestry (Torras and Saura, 2008; Schumann *et al.*, 2003; Battles and Fahey, 2000; Simila *et al.*, 2006). The protection of *J.*

*excelsa* stands is essential for their long-term persistence and biodiversity. *J. Excelsa* is a major forest element in the mountain areas of North West of Iran. Forest managers have been seeking a feasible way to integrate biodiversity issues into management plans. Degraded plant communities are generally quite difficult or sometimes impossible to restore (Van Diggelen and Marrs, 2003).

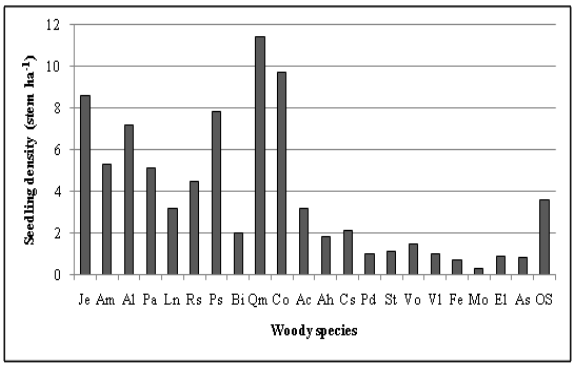


**Fig. 1.** Seedling density of woody species in the Juniper stands of the study area.

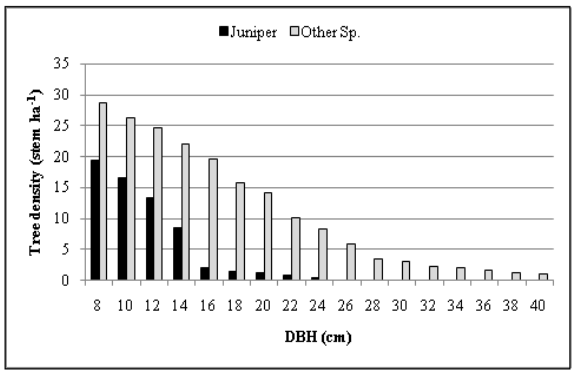


**Fig. 2.** Distribution of tree density in DBH classes.

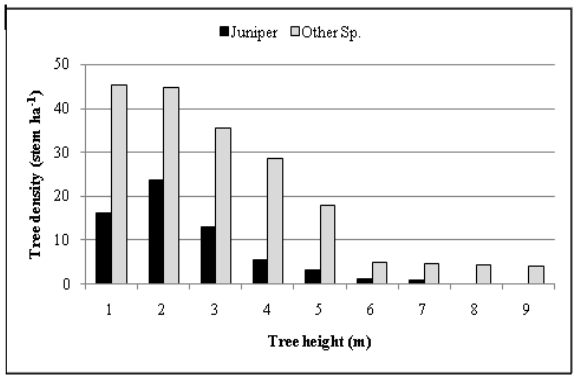


**Fig. 3.** Distribution of tree density in height classes.

The forest biodiversity guidelines focus on how best to conserve and enhance biodiversity in forests, through appropriate planning, conservation and management. Conservation of forests biodiversity is one of important objective in sustainable forest management (Burton *et al*., 1992; Brockerhoff *et a*l., 2008).

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