The study of relation between biodiversity indices of woody species and growing stock in natural forest stands

Seyed Armin Hashemi [1]

[1.] Department of Forestry, Lahijan Branch, Islamic Azad University, Lahijan, Iran.
hashemi@iau-lahijan.ac.ir

Abstract: In order to determine the relationship between diversity indices of woody species and growing stock per hectare in natural beech (*Fugus orientalis Lipsky*) Forests, Twenty sites specially at middle elevations were studied including three plots per each site . The dimension of each plot was 50 ×100 meters. The method of surveying was selective sampling. Results indicated there are positive linear regression between the biodiversity indices and growing stock per hectare. The best equation were obtained from the relationship between Brillouin index and growing stock per hectare(r =0.95).

[Seyed Armin Hashemi, Department of Forestry, Lahijan Branch ,Islamic Azad University, Lahijan, Iran. Journal of American Science 2011;7(5):437-441]. (ISSN: 1545-1003). http://www.americanscience.org.

Key words: Biodiversity indices of woody species , Growing stock , Beech , Natural forest stands .

1. Introduction

Biodiversity has so wide meaning and consists of genetic diversity up to ecosystems diversity. Species diversity is known equal to biodiversity that is limited to diversity in local or regional surface (Krebs, 1998). Diversity of organisms, measurement of diversity and examination of some hypothesis about reasons of diversity are some cases that have been favored by ecologists for a long time (Barnes *et al*., 1998). Researchers have applied different indices in order to measurement of diversity (Krebs, 1998).Understanding of necessity of species diversity that has happened recently has caused to concentrate on the quality of measurement of biodiversity in plants and animals a lot (Ehrlich and Wilson, 1991).

The some research used quantitative models (nonlinear matrix) with ecological criterion of diversity index of Shannon – Winer , minimum number of trees in each age class and section level of trees and some other criteria in order to manage combined forests of oak , pine and spruce(Bazzaz ,1987). In most studies about biodiversity, Alpha and Beta diversities have been considered (Pitkanen, 1998). Alpha diversity has been species diversity in a region (Whittaker, 1972) and Beta diversity mentions to the amount of changes of species in environmental gradient length (Whittaker, 1972; Wilson and Shmida, 1984). The first index of heterogeneity has been applied by Simpson in the year 1949 for the first time (Whittaker, 1972) and many copies of this index have been developed up to now. Another index that has wide application in studies is shannon index (Vujnovic *et al*., 2002).in order to estimate the diversity of vegetative covering of forestry projects of Boreal used the diversity index and by using different variables such as the number of needle – leaf and wide – leaf species , determining fires , the fertility of growing places , topography , average diameter of trees , the number of floors of canopy , the type of soil , drainage and artificial life renewal , presented a classification including 14 classes of biodiversity in forestry projects(Itkanen ,1997).Studied the impact of beneath woody floor and the age of stand on relative diversity and frequency bryophytes , lichens and fungi in trampling pine stands (*Popolus tremuloides*) in combined forests of Boreal in Alberta and showed that the availability of combined stands of aged pine and fallen woods in different steps of demolition are important for preserving the total of bryophytes , lichens , and fungi(Crites,2000) .Some studied the relations of biodiversity and surface in been forests of Denmark in a case study . The diversity of forest species showed negative relation with surface (Harris ,1984). The purpose of this research is that the relation between diversity indices with growing stock in hectare in natural stands would be studied, So that we can estimate ideal growing stock in other areas by studying these indices in each step of stand. In order to this, forests in Guilan province that have considerable natural stands were selected for study. In this research, the aim of biodiversity is the diversity of species and the diversity of species is dependent on the number of species (as richness) and also the ratio of the number of individuals within each species (as frequency or monotonousness) in a specified level or a group of creatures. In each community with two way , the quantity of biodiversities determined that in first method , the calculation of the quantity of diversity , the rare species in a community is very important which is calculate able by dependent methods of Shannon– Winer and Brillouin index. In this study, the relation

between these indices with growing stock of trees in hectare between these indices with growing stock of trees in hectare was studied.

2. Materials and Methods

This study has been done in twenty growing places of basin 21 from dividing the auriferous basins of north forests of country in natural beech stands.
In the studied region most rainfall is in autumn. The mean annual rainfall in plainly region in the station of the climatology of Rasht (100 meters ASL) is 1258 mm and mean annual temperature in the station is 15.6º C.

The most soils of study area have been placed on maternal igneous rocks (Alkaline and acidic) and be seen on the maternal Andesitic and Basalt rocks with more spreading. The type of the soils of this region is acidic brown. The acidity of these soils is 4.5 to 5.5.

For studying of the relation between the diversity indices with growing stock in forest stands of beech, first natural stands which not to be interfered as for as possible , were identified and reflected on the map. Then, with primary studies in each identified region, three pieces of 0.5 hectare which were intact and with least interference were measured as selective sampling. Twenty sites especially at middle elevations were studied including 3 plots per each site. The dimension of each plot was 50 ×100 meter. Statistics within each piece as hundred percent was done for measuring the characteristics of the type of species, the diameter equivalent to tree slope. The situation of studied regions was also identified from the slop and altitude from sea level. After obtaining desired characteristics, first diversity indices using related formula were calculated and growing stock using local volume table was estimated. Then the relation between diversity indices with growing stock in hectare by regression calculation, were analyzed.
The amounts of diversity indices are calculated with following formula.
Equal (1) – The index of Simpson:

$$1-D=1-\sum_{i=1}^{s} Pi^2 \qquad (1)$$

In this equal, 1-D is the diversity index of Simpson and P is the proportion of the individuals in each species in the piece of sample.

Equal (2) – the function of Shannon – Wiener

$$H^{/}=-\sum_{i=1}^{s} p_i \ln (p_i) \qquad (2)$$

In this formulation, H is Shannon – Wiener's function and its unit is Bits / individual and S is the number of species.

Equal (3) – Brillouin index H = 1/N log

$$Ni/n_1.n_2.n_3 \qquad (3)$$

In this formulation, H is Brillouin index, N is total number of stands (individuals) in sample, N_1 is the number of related stand and N_2 is the number of stands related to second species.

3. Results

In this research , the amounts of biodiversity (using Simpson's index , Shannon – Wiener's function and Brillouin index) and the estimation of growing stock in hectare in studied growing places were calculated and the relationship between the indices of diversity and growing stock was studied (Table 1)
Amounts of indices of diversity and the amounts of growing stock in hectare to estimate growing stock in hectare, local volume table have been used. The amounts of diversity and growing stock indices in hectare in studied regions have been presented in table 1.In table 1 is seen that in regions where growing stock of trees is high , diversity indices is also higher and in regions with low growing stock , the amounts of diversity indices is less than other regions. Since this subject should be studied from statistical point of view, the relationship between diversity and growing stock indices of trees by regression calculation were studied.

Regression relationship between diversity indices and growing stock in hectare

The relationship between different indices of biodiversities of trees in studied regions (including Simpsons' index, N2 Hill, Shannon – Wiener's function , and Brillouin index) and growing stock in hectare have been presented in figures 1-4.
The figures 1-4 show that:
- There is the relation of Y=495.1X + 298.3 with correlation coefficient of 0.83 (r = 0.83) between Simpson's index and growing stack. In this relation , X is the amount of Simpson's index and Y is growing stock in hectare (Figure1.)
- There is a relationship between N2 Hill and growing stock in hectare with the relation of Y = 176 X +240.2 with correlation coefficient of 0.83 (r = 0.80) . In this relation X is the amount of N2 Hill's index (Figure2.).
- Shannon – Wiener's function and growing stock in hectare have the relation of Y = 540.5X + 270.7 and (r = 0.85) in that X is the amount of Shannon – Wiener's function(Figure 3.).

- It was observed a relation of Y = 560 X + 290.1 and r = 0.95 between Brillouin index with growing stock in hectare (Figure4).
Therefore the hypothesis of Zero is rejected and there is meaningful relationship between diversity and growing stock indices in hectare in the level of 0.05.

Table 1. The amount of biodiversity indices and amount and rate of growing stock in hectare in studied region.

Site	ASL	Growing volume	Simpson	N_2hill	Shanon-Winer	Brillouin
1	1320	521	0.44	1.804	0.451	0.433
2	1340	425	0.31	1.168	0.296	0.283
3	1370	350	0.14	1.211	0.152	0.144
4	1260	419	0.17	1.211	0.187	0.180
5	1260	419	0.17	1.604	0.187	0.180
6	1080	516	0.37	1.954	0.499	0.303
7	840	574	0.48	1.685	0.437	0.419
8	780	478	0.40	1.823	0.400	0.382
9	730	550	0.45	1.527	0.445	0.414
10	1640	401	0.34	1.751	0.280	0.272
11	1610	441	0.42	1.670	0.327	0.322
12	980	440	0.40	1.053	0.405	0.392
13	1400	324	0.50	1.653	0.059	0.056
14	1110	449	0.39	1.418	0.344	0.332
15	1080	430	0.29	1.891	0.260	0.250
16	840	565	0.46	2.812	0.433	0.415
17	840	623	0.64	2.812	0.606	0.582
18	1040	571	0.46	1.878	0.407	0.384
19	1040	564	0.54	2.194	0.502	0.476
20	960	556	0.65	2.858	0.599	0.568

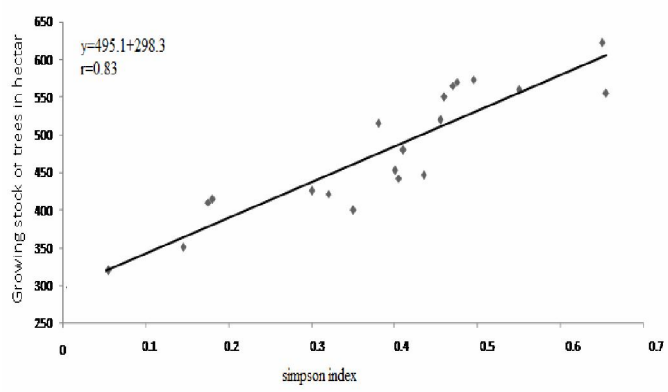

Figure 1. Relation of Simpson's index with growing stock in hectare

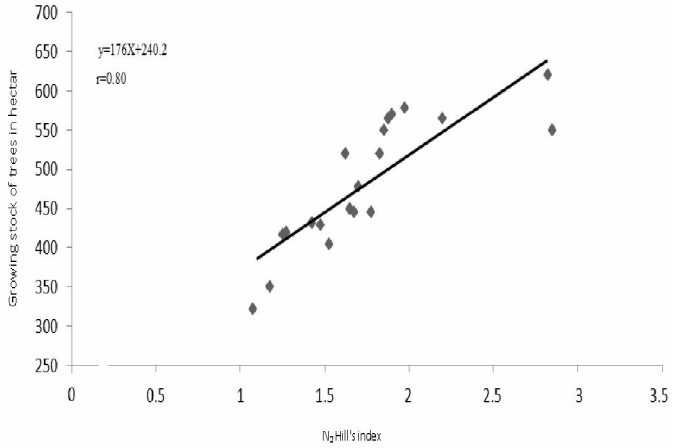

Figure 2 Relation of N_2 Hill's index with growing stock in hectare

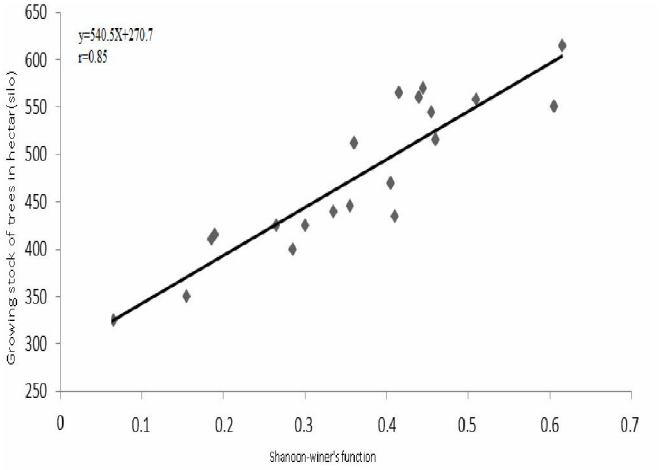

Figure 3 Relation of Shannon-winer's function with growing stock in hectare.

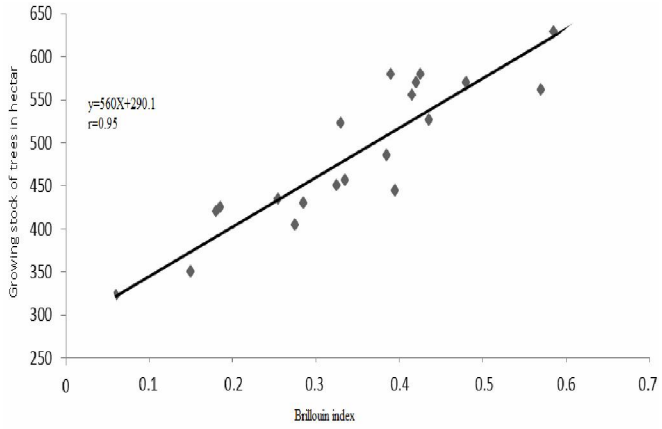

Figure 4 .Relation of Brillouin index with growing stock in hectare

Discussion

The study of obtained results from the relation between biodiversity indices and growing stock in hectare in the studied growing places show that there is meaningful relationship between these biodiversities indices of trees and the factor of growing stock in hectare at the level of 0.05. Beech have more than 70% of the number of trees in this region .According to this study, maximum correlation coefficient is related to the relation of growing stock of trees with Brillouin index (r = 0.95) and minimum of that has been obtained in the relation between obtained in the relation between N2 Hill and the factor of growing stock in hectare (r = 0.80) . As a result Brillouin index function is more suitable for study of the relation of biodiversity with growing stock in forests of studied regions. Obtained relationship shows positive and linear correlation, it means that in regions that biodiversity shows high rates; growing stocks in hectare are also higher. This subject shows that growing places which have higher biodiversity generally have high stability and fertility and from growing stock of trees in hectare perspective also have better condition. According to the result of this study, we can obtain the amount of growing stock of trees in hectare with high accuracy by determining biodiversity criterion (the amount of Shannon – Winer's function) in studied regions.

It seems that we can obtain a relationship in a wider area which according to biodiversity criterion , can estimate growing stock of trees in hectare with acceptable of growing stock in each region or obtaining models that are considered biodiversity factor as one of basic variables of that model.

Also, according to obtained results from this study, it seems that we can obtain a relationship between biodiversity indices with other factors of forest stands in this region with other studies. Also , It seem that we can understand relatively ecological ability and potential of growing places by comparing the factor of biodiversity in different regions , or obtain relations which be a base for ideal planning in forest units. In this study, other factors like slope orientation, altitude, and some characteristic of soil also have been studied.

From the result of the study of these factors can understand that generally by increasing the altitude in studied region , mean growing stock in hectare will be decreased and mean biodiversity indices in hectare also become low(Whittaker. R.H., 1972).

In this study, growing stock in hectare in different growing places with changing slope , depth and the moisture of soil show that growing stock in growing places.

North Slope and deep soil and high moisture compared with other growing places. In these conditions, ideal growth of trees has caused that trees reach stock of trees in hectare. On the other hand , the diversity of trees with high percent combination in these growing places have caused the increase of biodiversity indices.

Sub – diversity of species in a growing place with percentage of low number has little impact on the increase of biodiversity indices.

It's necessary to state that this research has been done in beech community and done researches have shown that in natural beech stands , in addition to altitude and aspect , factors like low depth of soil , being high the sand of the soil and being rocky and stony of growing sites also have negative impact on volume (Hashemi,2010). The result of research in studied regions showed that biodiversity indices of tree species have direct relationship with growing stock.

Of course in studied pure stands, some negative factors in growing beech like low depth of soil, being high in the sand of soil and being stony were observed. Since some growing place factors may intensify or neutralize or weaken the impact of other factors, so if we can compare the similar stand of natural and intact forest from the perspective of growing place conditions but by different biodiversity to each other, therefore judgment about optimum point of diversity will be possible.

Acknowledgements:

Author is grateful to the Forests, Range and Watershed Management Organization (FRWO) of Iran for financial support to carry out this work.

Corresponding Author:
Seyed Armin Hashemi
Assistance professor, Department of Forestry
LahijanBranch
Islamic Azad University
Kashef Street, Postal Code:1616, Iran
E-mail: hashemi@iau-lahijan.ac.ir

References

1. Krebs CJ .Ecology: The experimental analysis of distribution and abundance.2nd ed. Harper and Row , New York 1989 :678.
2. Barens BV, Zak DR, Denton SR ,Spurr SH. Forest Ecology. 4th Edn., John Wiley and Sons Inc., 1998: 773.
3. Ehrlich PR , Wilson EO. Biodiversity studies: Science and policy. Science, 1991:253:758-762.
4. Bazzaz FA .Plant species diversity in old-field succession ecosystem in southern Illinois ecology 1987:56: 485-488.
5. Pitkanen S. The use of diversity indices to assess the diversity of vegetation in

managed boreal forests. For. Ecol. Manage 1998: 112: 121-137.
6. Whittaker RH . Evolution and measurement of species diversity. Taxon1972: (21) 213-251.
7. Wilson MV , Shmida A. Measuring beta diversity with presence- absence data. J. Ecol.1984:(72) 1055-1064.
8. Vujnovic K , Wein RW , Dale MRT.Predicting plant species diversity in response to disturbance magnitude in grassland remnants of central Alberta. Can. J. Botany2002: (80) 504-511.
9. Itkanen.The future of the forested landscape of Canada for Chron, 1977:(67),14-18.
10. Crites S,Dale M.Diversity and abundance of bryophytes , Lichens and fungi , Canadian journal of Botany , 1998:76(4),641-651.
11. Harris LD .The fragment forest: island biogeography theory and the preservation of biotic diversity, Chicago,1984: 211.
12. Hashemi SA. Evaluating Plant Species Diversity and Physiographical Factors in Natural Broad Leaf Forest . American Journal of Environmental Sciences 2010:6 (1): 20-25.

4/23/2011