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The comparison of increment (diameter and basal area) in utilized and natural stands in northern Zagros (case study: Nejo forests in Baneh, Kurdistan province, Iran)

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Abstract

Basal area and diameter increment in utilized and natural oak stands located in the Baneh (Northern Zagros - Iran) were measured and compared using increment borer. In each stand sampling plots of 40 × 40 meters were established then diameter at breast height (DBH) and height of trees were measured and recorded by 100% inventory method. To determine which trees were choosing to obtain growing samples Point-Quarter Method was used. Growing samples extract by Increment borer in tow aspect of sample trees. Average annual increment diameter with dark and without dark in natural stand was 2.84 and 2.46 millimeters corresponding and in the utilized stand was 2.26 and 2.04 millimeters corresponding. The average basal area in natural and utilized stands were 23.70 and 7.89 square meters per hectare corresponding and the average increment basal area in natural and utilized stands were 0.5818 and 0.1671 square meters per hectare corresponding, the dominant height in natural and utilized stands were 8.83 and 5.50 meters respectively were calculated. Comparisons showed that the mean annual increment diameter, mean annual increment basal area, average of basal area per plot and dominant height of natural and utilized stands meaningful difference exists so that all of those cases in natural stand with were greater than utilized stand. The above results indicate that the greatest effect of stand utilization on the diameter of less than 15 centimeters and more than 30 centimeters. Forest management planning should be tried to less pressure on the diameter classes.

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Introduction

With due attention to climate conditions of Iran that 65% area includes arid and semi-aired and degradation rapid of north and west, because of degradation of natural resources will cause to degradation agricultural lands and human environmental (Zabiholahii *et al*, 2012, Haidari *et al*, 2012a, Haidari *et al*, 2013b and Askari *et al*, 2013a). Forests cover about 12 million ha in Iran (Forest and Rangeland Organization, 2002), including 5 million ha in the mountainous Zagros region. The major element of Zagros forest destruction include: fire, grazing, farm operation in forest, fuel wood and timber, mining, semi-parasite plant and non-wood forest production (Jazirei and Ebrahimi Rastaghi, 2003, Bazyar *et al*, 2013a, Parma and Shataei, 2013). Increasing population, low level of development and high dependence of local communities on forests for their primary livelihood needs, are the main reasons of this destruction. The lack of regeneration in these forests is a major concern (Fattahi 1994, Jazirei and Ebrahimi Rastaghi, 2003, Bazyar *et al*, 2013b, Rezaei *et al*, 2013, Askari *et al*, 2013c).

To evaluate the forest management, Identify the process of degradation factors of natural regeneration in a particular Habitat, natural similar geographical specification habitats should be exist to comparing the structure and dynamics process with management results. It leads to guidance and management of the biological diversity of forests and preservation of natural habitats.

In the study area due to the economic structure of society, the forests are utilized and used, in fact, a traditional utilizing system rely on endemic knowledge of forestry is running there. These forests are a kind of managed forests that is considered as the native management of forestry and Silviculture. At the other hand several stands (almost equal number of villages in the region) with the random distribution that because of the specific reasons remains as natural and human interference in them were close to zero. In general, most of these forests are utilized forests. This type of forest management should evaluate and compared with the remaining natural stands to realize and estimates destructive or beneficial impacts of this management system. Various characters of forest stands such as growth, structure, species diversity etc. can be compared. One of the most basic and appropriate method for the evaluation of forest management, is comparison of natural and utilized stands growth (objective of this study). Given the lack of information in some parts of the Zagros forest, (especially in the northern Zagros), calculating the Basal area and diameter increment of the natural and utilized stands is another objective of this study.

Materials and methods

Study area

Study area belongs to the forests that located in the West of Nejo village (Baneh, Kurdistan, Iran) with an annual average rainfall 712.78 millimeters. The natural and utilized stands area were 2.68 and 3.16 hectare respectively, slope aspect was northern and eastern, dominant tree species was *Quercus infectoria*, average altitude was 1680 meters and a slope was 35% to 45%. In this study with 100% inventory method by using 0.16 hectare (40 × 40 mm) sampling plots, diameter and height of each tree in plots measured and were recorded. Stands inventory by using plots caused to calculations and comparisons will be possible.

Fig. 1. Location of research site.

Methods

The growth samples extract at DBH height of control trees, then in the laboratory experimentally radial increment during the past 10 years to accurately tenth millimeter measured, diameter increment and basal

area increment will be calculated based on the previous prepared tables. To determine the control trees in the stand, a baseline parallel to the sides of the stand will be located in the north _ south. Based on baseline transect lines vertical to each other at regular intervals of 50 meters along the slope of the line. The first point on each transects completely random and the rest are taken at regular intervals of 40 meters from each other. Area surrounding each point divided into four quarters and in each quarter the nearest tree to sample point select as the control tree and the DBH, height, and thickness of bark were measured.

Observations and Results

Basal area and number of trees hectare

The relationship between the diameter at the middle of the period and annual increment diameter with dark

This relationship in stands is as follows: (Ri is annual increment diameter with dark and dbh is diameter at breast height).

A: natural stand: $Ri = 0.000081(dbh)^2 + 0.006576(dbh) + 0.178$.

B: utilized stand: $Ri = 0.0007(dbh)^2 + 0.0301(dbh) + 0.064$.

Table 1. Statistics of the Basal of stand area.

stand / quantity	natural	utilized
Total basal area	63.51	20.19
Mean basal area in plot	23.70	7.89
Mean basal area in hectare	2.68	3.16
Area	1651	986
Total trees	616	312

the increment Basal area

The results of the comparisons between two stands

Comparison of diameter increment

(Mean annual diameter increment with dark in natural and utilized stand were 0.28 and 0.23 millimeters respectively).

Table 2. radial increment stand for ten years (millimeter).

Diameter classes		10	15	20	25	30	35	40	45	50	55	60	65	70	75
Radial Incremen	1*	10.28	11.42	12.04	12.08	11.85	13.3	14.45	14.32	13.78	--	--	11.50	9.85	9.60
in ten year millimeter	2**	6.10	10.46	11.09	12.19	9.97	7.24	--	--	--	--	--	--	--	--

* 1: natural stand ** 2: utilized stand.

Table 3. Data diameter increment stands for.

natural stand						Utilized stand				
Diameter classes	No. in diameter class	Diameter Without dark At middle period	Annual diameter increment Without dark	Diameter with dark At middle period	Annual diameter Increment with dark	No. in diameter class	Diameter Without dark At middle period	Annual diameter increment Without dark	Diameter with dark At middle period	Annual diameter Increment with dark
		centimeter	centimeter	centimeter	centimeter		centimeter	centimeter	centimeter	centimeter
10	6	8.552	0.206	9.698	0.233	7	8.933	0.122	10.228	0.140
15	5	10.058	0.228	11.406	0.259	12	10.238	0.209	11.722	0.239
20	10	15.366	0.240	17.425	0.279	17	16.068	0.222	18.397	0.254
25	9	19.470	0.241	22.079	0.273	14	20.338	0.244	23.287	0.2798
30	6	25.115	0.237	28.480	0.269	6	25.637	0.199	29.354	0.228
35	5	30.670	0.266	34.780	0.302	5	30.816	0.145	35.284	0.166
40	6	34.888	0.289	39.536	0.328	--	--	--	--	--
45	5	37.968	0.286	42.056	0.324	--	--	--	--	--
50	4	43.548	0.275	49.383	0.312	--	--	--	--	--
65	2	59.200	0.230	67.133	0.261	--	--	--	--	--
70	2	62.565	0.197	70.949	0.223	--	--	--	--	--
75	1	65.840	0.192	74.663	0.218	--	--	--	--	--

The results show that the increment in diameter under 15 centimeters and higher than 30 centimeters in utilized stand less than natural stand, therefore can be concluded that the utilization and exploitation made the most impact on the diameter of less than 15 centimeters and more than 30 centimeters and a diameter of between 15 to 30 centimeters are less vulnerable. Mean annual increment diameter without dark and wit dark in two stands were compared by t-test.

Comparison of the basal area increment 0.16 hectare per plots

Mean growth rates of plot in two stands compared by t test (Mean growth rates in natural and utilized stands were 930.99 and 267.43 square centimeters).

Table 4. Calculated of annual diameter increment from model.

Diameter 10 15 20 25 30 35 40 45 50 55 60 65 70 75 Quantity														
1	0.236	0.259	0.278	0.292	0.303	0.309	0.312	0.310	0.305	0.295	0.281	0.264	0.242	0.216
2	0.167	0.230	0.258	0.251	0.209	0.132	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00

1: annual increment diameter in natural stands, 2: annual increment in utilized stand.

Table 5. Annual basal area Statistics in tow stands.

Diameter classes	Natural stand					Utilized stand				
	Basal area Increment In result of 1 cm. diameter increment	Annual diameter increment of individual tree (model)	Annual basal area increment of Individual tree	No. of trees per hectare	Total Annual basal area increment per hectare	Basal area Increment In result of 1 cm. diameter increment	Annual diameter increment of individual tree (model)	Annual basal area increment of Individual tree	No. of trees per hectare	Total Annual basal area increment per hectare
cm	Cm^2	cm	Cm^2	No.	Cm^2	Cm^2	cm	Cm^2	No.	Cm^2
10	15.71	0.236	3.708	143.7	532.84	15.71	0.167	2.655	89.2	236.83
15	23.56	0.259	6.102	134.3	819350	23.56	0.230	5.489	118.4	649.90
20	31.42	0.278	8.735	158.6	1385.37	31.42	0.258	8.201	80.4	659.36
25	39.27	0.292	11.467	94.0	1077.90	39.27	0.251	10.014	19.3	193.27
30	47.12	0.303	14.277	37.7	538.24	47.12	0.209	10.037	2.8	28.10
35	54.98	0.309	16.989	25.4	431.52	54.98	0.132	7.532	1.3	9.79
40	62.83	0.312	19.603	4.5	88.21	62.830	--	--	--	--
45	70.69	0.310	21.914	4.5	98.61	--	--	--	--	--
50	78.54	0.305	23.955	3.7	88.63	--	--	--	--	--
55	86.39	0.295	25.485	3.7	94.29	--	--	--	--	--
60	94.25	0.281	26.484	1.9	50.32	--	--	--	--	--
65	102.10	0.264	26.954	1.5	40.43	--	--	--	--	--
70	109.96	0.242	26.610	1.9	50.56	--	--	--	--	--
75	117.81	0.216	25.447	0.7	17.81	--	--	--	--	--

Table 6. Results of t test for comparison with dark diameter increment.

Diameter increment with dark (millimeters)	Loon test for equality of variances		t test						
	F	The significance level	t	df	The significance level	The difference of means	Standard error of The difference of means	95% CI for the mean difference	
								lower limit	upper limit
Assuming equal variances	7.32	0.01	9.82	120	0.00	0.06	0.01	0.05	0.07
Assuming unequal variances			9.82	10.183	0.00	0.06	0.01	0.05	0.07

Comparison of Basal area per 0.16 hectare plots

The average basal area in the natural and utilized stands was compared by t-test (average for natural and utilized stand was 379157.27 and 10225.25 square centimeters).

Discussion

Mean annual diameter growth with dark and without dark in natural stand were 2.84 and 2.46 millimeters respectively, in utilized stand were 2.46 and 2.04 millimeters corresponding.

Facts and figures that are calculated diameter growth rate indicates that in natural stand at the early years of tree life until reach the 35, 40 and 45 centimeters, have a gradual increase with a gentle slope, and after reaching diameter of 45 centimeters, diameter growth rate to be decreased gradually in curve of growth increase and decrease a gradual process with low slope that imply the natural growth rate in natural stand. But in the curve obtained for utilized stand, in the initial years of tree, curve has a lot and have high slope and quickly reaches milestone then with the same high slope tilt as well as reduced. The diameter growth in natural stand were happen in more diameter classes and more level for diameter growth rate but in utilized stand In comparison with the natural stand diameter growth were happen in less diameter classes and less level for diameter growth rate. . The greatest diameter increment decrease was below 15 centimeters classes and higher than 30 centimeters diameter classes is observed, so that the annual diameter increment at 35 centimeters diameter class in utilized stand, less than annual diameter increment 75 centimeters diameter class in natural stand .To be the same annual diameter increment below 15 centimeters class in utilized stand was much less in comparison with natural stand. With regard to this results must be in protective and supportive programs to try that do highest protection in diameter of 15-35 centimeters and also try to less the intensity of the exploitation and utilization in mentioned diameter classes. The t-test was also concluded that the average annual diameter growth with dark and without dark quite significant differences in the two stands (P=0.00).

Table 7. Results of t-test to compare the growth rates of basal area per plot.

Basal area Increment in each plot	Loon test for equality of variances		t test						
	F	The significance level	t	df	The significance level	The difference of means	Standard error of The difference of means	95% CI for the mean difference	
								lower limit	upper limit
Assuming equal variances	0.46	0.49	10.28	34	0.00	663.57	64.54	532.4	794.7
Assuming unequal variances			9.76	24.3	0.00	663.57	67.97	523.4	803.7

Table 8. Results of t-test to comparison of Basal area per plots.

basal area in plot (square centimeters)	Loon test for equality of variances		t test						
	F	The significance level	t	df	The significance level	The difference of means	Standard error of The difference of means	95% CI for the mean difference	
								lower limit	upper limit
Assuming equal variances	3.28	0.08	8.66	34	0.00	27690.02	3199.11	21188.64	34191.39
Assuming unequal variances			7.90	20.11	0.00	27690.02	3506.46	20378.21	8235001.82

The comparison of basal area in two stands shows that the average rate of basal area per plot in the stand (in natural and utilized stand were 3.79 and 1.02 square meters per hectare respectively) differed significantly (P=0.00) Because of the lower number of trees and the lower mean DBH of trees in plot and lower growing stock in plots. The curves obtained for the rate of growth in annual basal area per tree revealed that basal area growth has been a gradual increase and after reach to diameter of 60 and 65 centimeters, growth rate was decrease. The considerable note about mentioned curve is that increase (growth) diameter in high diameter classes in comparison with low diameters classes lead to much more increase (growth) in basal, for example 0.5 centimeters in a tree with a diameter 10 centimeters lead to rise 8 square centimeters basal area but that 0.5 centimeters in a tree with diameter 75 centimeters lead to rise 59 square centimeters basal area (more than 7 times).

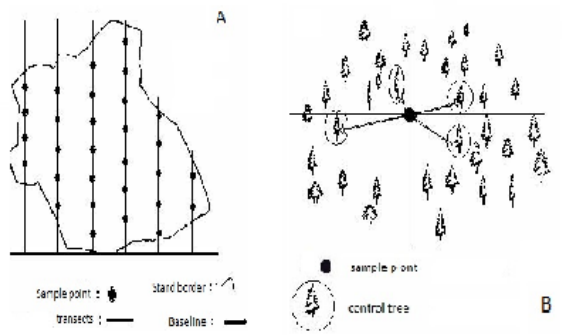

Fig. 2. Schematic drawing Point quarter method.

The results of this research shows that human interference effect is quite significant negative effect on diameter increment, basal area increment and basal area per hectare (they cause to extreme increase in increment), therefore the study of socio-economic indigenous people of these areas is important. After The survey of income and livelihood of the indigenous people it needs to plan that not only the people who destroy forests do not that, but to maintain and restore the forest to help in achieving the objectives of sustainable forestry in these areas, the implementation of such policy is necessary.

It is suggested that these results (including the destruction has most negative effects on the diameter classes lower than 15 centimeters and higher than 30 centimeters), applied in executive management of the forests and have support with the law to enforce. As is suggested in some of the utilized stands, utilization in diameter less than 15 centimeters and higher than 30 centimeters prohibit and after a few years, recovery rate of diameter increment, basal area increment and basal area, calculate and with similar stands statistics that normally utilized are to be compare.

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