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Evaluation accuracy of nearest neighbor sampling method in Zagross forests

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ABSTRACT

Collection of appropriate qualitative and quantitative data is necessary for proper management and planning. Used the suitable inventory methods is necessary and accuracy of sampling methods dependent the inventory net and number of sample point. Nearest neighbor sampling method is a one of distance methods and calculated by three equations (Byth and Riple, 1980; Cotam and Curtis, 1956 and Cotam and Curtis, 1956). The 53 hectare of the study area was selected and perfect inventory. To study of nearest neighbor sampling method used the systematic-random methods in the 100*150 meter net and recorded the location (X, Y) of all trees and by nearest neighbor sampling method in the 30 to 40 samples evaluated the accuracy of this method. Results showed that the three formulas in this study not have accuracy for study of density (N/ha), but suitable to study of spatial pattern. The quantity of Johnson & Zimmer index is a 5.522 and showed that a clumped pattern for trees in forest reserve. Overall results showed that the nearest neighbor sampling method and Byth and Riple (1980) equation are a suitable method to study of tree spatial pattern in Zagros forest.

Key words: nearest neighbor sampling method, Zagross forests, chahartagh forest reserve, Johnson & Zimmer, Johnson & Zimmer.

INTRODUCTION

I.R. of Iran is located in the North Temperate Zone from 25 to 40 latitude and 44 to 63 longitude degrees, with a total area approximately 1,650,000 Km2 (Haidari *et al*, 2013 a; Haidari *et al*, 2012b). Forests cover about 12 million ha in Iran (Haidari *et al*, 2012c, Haidari *et al*, 2012d), including 5 million ha in the mountainous Zagros region ((Askari *et al*, 2013b; Moslemi Seyed Mahalleh *et al*, 2013; Pourmoghadam *et al*, 2013). The Zogros Mountains are divided into two parts: northern and Southern (Askari *et al*, 2013 a; Askari *et al*, 2013 b). The northern Zagros is consisted of the growing site of *Quercus infectoria* Oliv. And also *Q.libani* Oliv. And *Q.persica* J. & Sp. (*Q.brantii* Lindl.) (Haidari *et al*, 2012e; Bazyar *et al*, 2013a; Bazyar *et al*, 2013a). Species are found in this part. However, the southern Zagros is included *Q.persica* site which it extended to Fars province (Bazyar *et al*, 2013b; Parma and Shataee, 2013). Collection of appropriate qualitative and quantitative data is necessary for proper management and planning (Naghavi *et al*, 2009). For maintaining of Zagros forests role in wild life, water and soil

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conservation, the suitable solutions and methods for assessing the existing conditions and planning for management of this forests should be given (Karamshahi *et al,* 2011). In ecological research, the basic objective of sampling is to obtain a descriptive estimate of some attribute of plant population. This estimate should be a relatively accurate representation of allow detection of real differences among plant populations. From an ecological viewpoint, choice long as it is meaningful and can be adequately described. One of the most commonly sampled parameters is density the number of individuals per unit area (Lyon, 1967).Nearest neighbor sampling method is one of the distances sampling methods for estimating the plant density and canopy cover. This methods suggested by Cottam *et al,* (1953) and Rangeland managers Society of America emphasis to use this method for sampling in the plant community (Heidari *et al,* 2011). Spatial pattern information for individual trees is increasingly sought by forest managers and modelers as means to improve the spatial resolution and accuracy of forest models and management scenarios (Wulder *et al,* 2004). To determination of suitable sampling methods for study of forest characteristics several studied in the Iran and other country include: The researcher to compere the quadrat and distance methods and results showed that the nearest individual and nearest neighbor was suitable methods to study of plant density (Cottam and Courtis, 1956). The researcher indicated the central quarter was suitable sampling methods to study of plant density in the non-monotonous area (Joset, 2004). The researcher studied and Comparison of Randomized-Systematic Sampling with Circle Shape Plot and Transect Method, Based on Precision and Cost, With respect to precision, random-systematic sampling with circle shape plots is of less error than transect method in all cases (Nimvari *et al,* 2002).The researcher studied application of T-square sampling method in Zagros forests and results show that none of the formulas could provide an acceptable estimate based on ± 10% accepted accuracy; even though, the Byth formula has more accuracy level for density and crown coverage for this kind of forests (Heidari *et al,* 2007). The researcher studied applicability of point-center quarter method in Zagros Forests and results show that none of the formulas could provide an acceptable estimate based on±10% accepted accuracy (Heidari *et al,* 2008). The researcher comparison of five distance methods for estimating density on Shrub Communities in Tang-Laybid Yazd and results showed that the point center quarter method can give reliable results in shrub communities with cover around 10% and a clumped pattern while the nearest neighbor method can give a reliable estimate in communities with cover between 16-20% and a uniform pattern (Mirjalili *et al,* 2008). The researcher determination of the most appropriate transect length for estimation of quantitative characteristics in Zagros forests and results showed that transects with 140m length had the most precision for estimating the above-mentioned parameters. Also, comparison of results for different lengths of transects with (E %) ^2×T criterion showed that transects with 75 and 140m lengths are more appropriate for estimating the crown cover and species number per hectare (Naghavi *et al,* 2009). The researcher Comparison of circular plot and transect sampling methods in the Zagros Oak Forests, for this purpose and based on cost and precision (E%2 × T) criterion. Results showed that the more suitable method for these forests in west of Iran is the circular sample plot with 1000m2 area (Heidari *et al,* 2009). The researcher studied the accuracy of nearest individual sampling method in Zagross forests and results showed results show that Morisita ,1953 and Batcheler and Bell ,1970 formulas can provide an acceptable estimate of density based on ± 10% accepted accuracy (Heidari *et al,* 2009). The researcher studied the suitable than distance method for density measuring and distribution pattern of Artemisia in the north Khorasan province and result indicated that third nearest and random pairs methods are suitable. The results showed that the precise distance method whether density or estimation of production in shrub lands is nearest neighbor. The most accurate method was third nearest. Distribution pattern of the plant in the study area was random (Asaadi and Ghorbanzadeh, 2010) The researcher Investigation of spatial pattern of wild pistachio (*Pistacia atlantica* Desf.) in Bayangan forests (Zagros forest) abd results showed that all indices related to plot samples indicated the clumped pattern for *Pistacia atlantica* (Safari *et al,* 2010). The researcher Investigated pattern of Manna oak trees (*Quercus brantii* Lindl.) in Bayangan forests of Kermanshah province, zagros forest. All of the applied indicators showed a clumped pattern for *Quercus brantii* (Safari *et al,* 2010). The researcher Investigation on application of k-nn (k- nearest neighbor) sampling method in Zagros forests, the mean value of trees density per hectare for all three networks were

calculated and compared. Results showed that there is no significant difference between mean values in three inventory networks and the real mean value (Karamshahi *et al*, 2012). The researcher studied the effect of traditional forest management practices in Havare khol pattern (Kurdistan province, Northern Zagros forest) on forest structure and results showed that uneven-aged young aged stand and spatial pattern of this forest was uniform to clumped pattern (Zabiholahii *et al*, 2012). The researcher studied of Study of vertical and horizontal forest structure in Northern Zagros Forest and results showed uneven aged stand and spatial pattern of this forest was uniform to random pattern (Haidari *et al*, 2013b). The aim of our study was Evaluation accuracy of nearest neighbor sampling method in Zagross forests.

MATERIALS AND METHODS

Site description

This research was investigated in the chahartagh forest reserve, Ardal region, chaharmehal and Bakhtiari Province, Central Zagros forest, and southwest Iranian state (Figure 1). Chahartagh Forest reserve located 100 kilometer of southeast Shahrekord city and 40 kilometer of south Ardal region. The forests are located between 2100 and 3100 m a.s.l. Mean annual precipitation is 530.15 mm, Mean annual temperature is 18.3º C, Type of climate is sub humid in the basis of Domarton formula (Jahanbazi gojani *et al*, 1998).

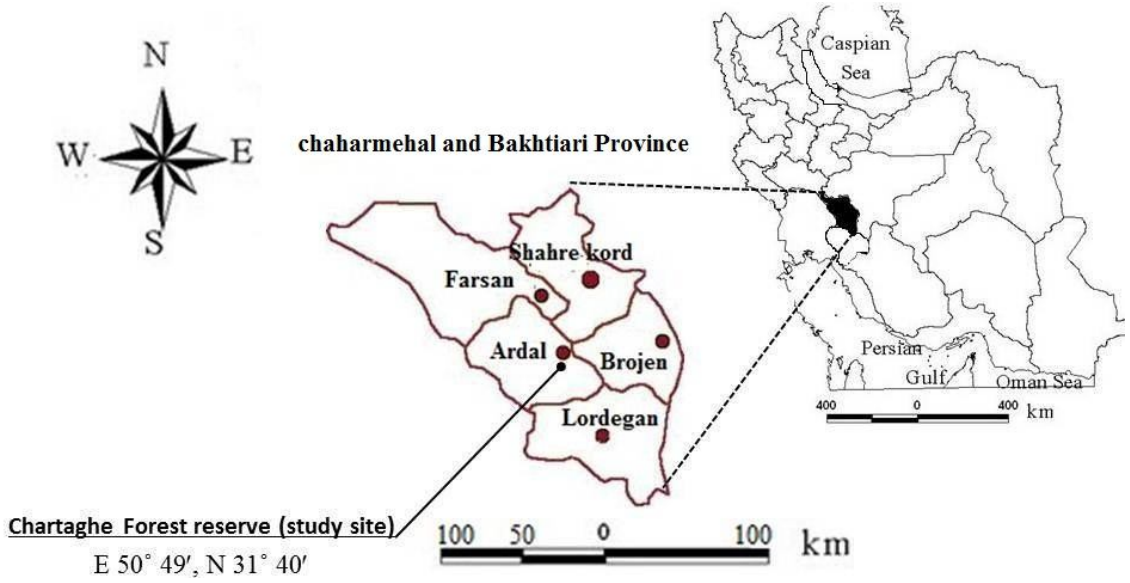

Figure 1. Study site location in the chaharmehal and Bakhtiari Province, Zagros region, and Western Iranian state of Iran.

The chahartagh forest reserve have a suitable diversity and density, and density (N/ha) of shrub are more the trees (54% shrub and 46% trees) and this area a determinate for reserve area in a 1983.

Methods

In this study 53 hectare of the study area was selected and perfect inventory. Information includes the position of shrub and kind of species was recorded. This information transfer in the GIS environment. To study of nearest neighbor sampling method used the systematic-random methods in the 100*150 meter net.

Nearest neighbor sampling method

In this methods detected the sample point, and detected the nearest tree (tree a) to sample point. In the tree a detected the nearest tree to tree a (tree b) and measured the distance of tree a to tree b (figure 2).

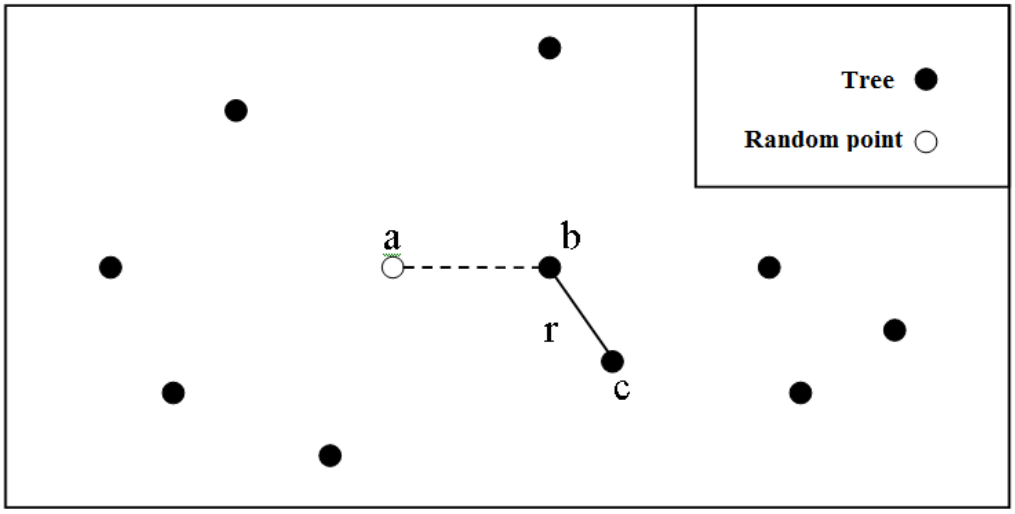

Figure 2: nearest neighbor sampling method

To measurement of nearest neighbor sampling method used the three formulas (Table 1). In this study recorded the location (X, Y) of all trees and by nearest neighbor sampling method in the 30 to 40 samples evaluated the accuracy of these methods.

formula	Characteristic	Equation
$\hat{N} = \frac{n}{\pi\sum(r^2_{ni})}$	$\hat{N}$ =Density (N/ha) n =number in the samples r_{ni} =distance between first tree and second tree	(Byth and Ripley)
$\hat{N}_{cc1} = \frac{1}{4[\sum r_{ni}/n]^2}$ $c2 = \frac{1}{2.778[\sum r_{ni}/n]^2}$	$\hat{N}_{cc1}$ $\hat{N}_{cc2}$ = Density (N/ha) n =number in the samples r_{ni} =distance between first tree and second tree	Cotam and Curtis (1) Cotam and Curtis (2)

Spatial pattern

Also methods for quantifying spatial pattern of trees based on indices or on statistical techniques have been compared but we focus on distance sampling techniques because of better results comparing to quadrat sampling. Distance methods were developed by plant ecologists to study vegetation communities (Ludwig and Reynolds, 1988). The use of sampling methods to estimate indices related to spatial pattern at reasonable accuracy levels often requires very large sample size and is not always feasible but neighbor sampling is generally more efficient than plot sampling (Kint *et al*, 2004). To detected the tree spatial

pattern used the Johnson & Zimmer index (table 1), this index used the distance between sample point to nearest trees) Ludwing & Reynolds, 1988).

Table 1: spatial pattern Indix used in this paper

	Johnson & Zimmer (Ludwing & Reynolds, 1988)
Formula	$I = \left[(n+1)(\sum_{i=1}^{n} (r_{pi}{}^2)^2) \right] \Big/ \left[\sum_{i=1}^{n} (r_{pi}{}^2) \right]^2$
characters	n=number of sample $= r_{pi}$ distance from nearest neighbor from sample point
Clumped	۲>
Uniform	I=2
Random	2>

RESULTS

Results showed that in the 53 hectare of inventory area *Crataegus* sp. are maximum and Populus sp. are minimum of density (N/ha), and about canopy cover the Juniperus sp. are maximum and Populus sp. are minimum.

Table 2: results of perfect inventory in the study area

species	Number of tree and shrub	Density (N/ha)	Canopy cover (%)
Crataegus sp.	1453	27.4	0.75
Fraxinus rotumdifolia	893	16.8	1.4
Quercus persica	494	9.3	1.1
Pistacia atlantica	42	0.8	0.13
Populus sp.	18	0.33	0.025
Salix sp.	35	0.66	0.1
Juniperus sp.	671	12.66	2.06
Acer mnspessulanum	97	1.83	0.12
Cerasus microcarpa	1378	26	0.2
Amygdalus communis	740	13.96	0.19
Lonicera nummularifolia	630	11.88	0.2
Cotoneaster frigidus	496	9.35	0.17
Daphne mucronata	593	11.18	0.11
Cerasus mahaleb	429	8.1	0.25
Total	7969	150.3	6.8

To study of accuracy of nearest neighbor sampling method used the one sample t-test and SPSS16 software. Results showed that the three formulas in this study have accuracy (significant differences in 1% level).

Table 3: results of one sample t-test to study accuracy of nearest neighbor sampling method

Equation	df	Mean of different	Sig.
(1980) Byth and Riple	19	44.5	0.000
(1956) Cotam and Curtis	19	23.5	0.006
(1956) Cotam and Curtis	19	-33	0.008

** significant differences in 1% level.

Figure 3 showed that the accuracy of Byth and Riple are higher in the three equation, accuracy of Cotam and Curtis (1956) and Byth and Riple (1980) are positive and have a under estimate, but Cotam and Curtis (1956) are invers relation and over estimate.

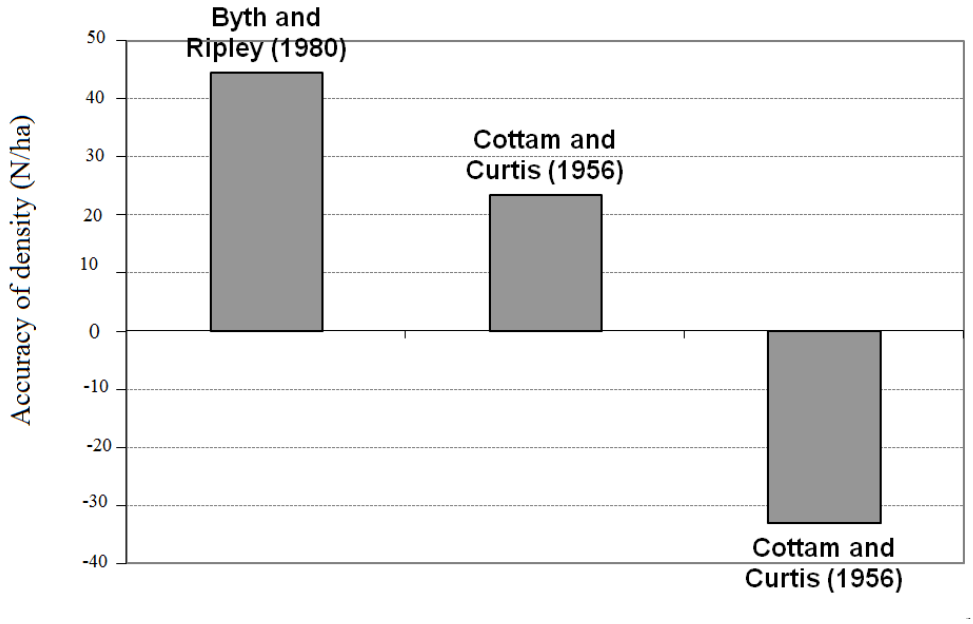

Figure 3: the accuracy of three Equations in the nearest neighbor sampling method

Spatial pattern

The quantity of Johnson & Zimmer index is a 5.522 and showed that a clumped pattern for trees in forest reserve. The randomize test showed that the 15.81 quantity and this number indicate the clumped pattern for this forest.

Discussion

Forest stand structure is a key element in understanding forest ecosystems (Kint *et al*, 2004; Wolf, 2005). Studying the pattern of trees, can be used to better understand processes of forest structure (Nelson *et al*,

2002). Also quantitative assessment of the distribution of trees in a forest stand is an initial step towards understanding the forest community dynamics (Shimatani and Kubota, 2004). The accuracy of inventory methods dependent the inventory net, number of sample point and others elements. Results showed that the distance methods are different estimates of tree density (N/ha), and this subject are a major problem in the Zagros disturbed forest. This result is due to the spatial pattern of trees and life forms (Borhani et al, 2001). Results showed that the three formulas in this study not have accuracy (table 3). The quantity of Johnson & Zimmer index is a 5.522 and showed that a clumped pattern for trees in forest reserve. Overall results showed that the nearest neighbor sampling method is a suitable method to study the spatial pattern in the Zagros forest and Byth and Riple equation has a more application in this study area. About spatial pattern of tree results indicate the clumped pattern to this forest and Heidari *et al*, 2007, Mirjalili *et al*, 2008, Heidari *et al*, 2009, Asaadi and Ghorbanzadeh, 2010, Safari *et al*, 2010, Safari *et al*, 2010, Zabiholahii *et al*, 2012, Karamshahi *et al*, 2012 indelicate the clumped pattern to Zagros region and application of distance methods to study of density and canopy cover.

Conclusion

Overall results showed that the clumped pattern of tree in this forest, nearest neighbor sampling method and Byth and Riple equation are a suitable method to study of spatial pattern in the Zagros forest.

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