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Evaluation of different sampling methods to study of shrub density in Zagros forest

Yousef Askari[*1], Elmira Kafash Saei[1] and Dorna Rezaei[2]

[1]*Department of Forestry, University of Shahrekord, Shahrekord, Iran*
[2]*Department of Forestry, University of Yazd, Yazd, Iran*

ABSTRACT

Collection of appropriate qualitative and quantitative data is necessary for proper management and planning. To determination of suitable sampling methods (distance methods) to study of shrub density 53 hectare of Chartaghe forest reserve in Ardal region, chaharmehal and Bakhtiari Province in southern Zagros forest was selected (southwest of Iran). Information includes the position of shrub and kind of species was recorded. Distance sampling methods was nearest individual, nearest neighbor, second nearest neighbor, T-Square and compound in the 150×100 meter net. To study of spatial pattern of shrub used Johnson and Zimmer, Heines and Eberhart. Data analyzing was done by SPSS16 and Ecological Methodological software's to compare of sampling methods to real quantity used the t-test, Leven and ANOVA test. T-test analysis showed that two nearest neighbor and compound sampling methods not different to perfect inventory (real quantity). The spatial distribution of shrub in the study sites showed two patterns of distribution which are clumped distribution. General results showed that shrub species in southern Zagros forest has clumped distribution and to study of shrub density (N/ha) nearest neighbor (Byth and Ripley) and compound (Byth) was suitable sampling method. Authors suggested to study of shrub density in the southern zagros forest used the two sampling methods.

Key words: distance methods, chaharmehal and Bakhtiari Province, southern zagros forest, spatial pattern, nearest neighbor, compound methods.

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 [23]. Forests cover about 12 million ha in Iran [25], including 5 million ha in the mountainous Zagros region [28]. This forest extends from Turkey and Iraq into Northeastern and Southeastern Iran (between Azerbaijan and Fars Province).The Zogros Mountains are divided into two parts: northern and southern [26]. 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.) species are found in this part. However, the southern Zagros is included *Q.persica* site which it extended to Fars province (i.e., 29º 5´ N). The northern Zagros is wetter and cooler than the southern one [27]. Collection of appropriate qualitative and quantitative data is necessary for proper management and planning [1]. For maintaining of Zagros forests role in wild life, water and soil conservation, the suitable solutions and methods for assessing the existing conditions and planning for management of this forests should be given [7].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 [18].To determination of

suitable sampling methods for study of forest characteristics several studied in the Iran and other country include: The researcher to compare the quadrant and distance methods and results showed that the nearest individual and nearest neighbor was suitable methods to study of plant density [11]. The researcher to study effect of grazing on the shrub density in the semi-arid area and suggested to use the nearest neighbor to this study [20]the researcher indicated the central quarter was suitable sampling methods to study of plant density in the non-monotonous area [13].The researcher studied and Comparison of Randomized-Systematic Sampling with Circle Shape Plot and Transect Method, Based on Precision and Cost. Parameters evaluated were number per hectare, crown cover and basal area (suitable parameters for these forest types). With respect to precision, random-systematic sampling with circle shape plots is of less error than transect method in all cases [2] The researcher studied application of T-square sampling method in Zagros forests, at first, 50 hectares of the forest area was selected and the inventory of the population was carried out. Then, 50 systematic random sampling points for T-square sampling method in this area were measured and recorded. The results show that none of the formulas could provide an acceptable estimate based on ± 10% accepted accuracy; even though, the Blyth formula has more accuracy level for density and crown coverage for this kind of forests [3]. The researcher studied applicability of point-center quarter method in Zagros Forests and firstly, 50 hectares of this forest area was selected and the inventory of the population was carried out. Then, 50 systematic random sampling points for Point-center Quarter method in this area were measured and recorded. The results show that none of the formulas could provide an acceptable estimate based on±10% accepted accuracy; even though, the our formula has more accuracy level for density and crown coverage for this kind of forests and it could provide an acceptable estimate for management works based on ±25% acceptable accuracy [4]. 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 [1]. 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 [5]. Study of spatial pattern Manna oak trees (*Quercusbrantii*Lindl.) in Bayangan forests of Kermanshah province, zagros forest. All of the applied indicators showed a clumped pattern for *Quercusbrantii*[26]. The researcher studied the accuracy of nearest individual sampling method in Zagross forests and results showed results show that Morisita ,1953 [19] and Batcheler and Bell ,1970 [9] formulas can provide an acceptable estimate of density based on ± 10% accepted accuracy, but none of the formulas could provide an acceptable estimate of crown coverage based on ± 10% accepted accuracy; even though, the Batcheler and Bell formula has more accuracy level for crown coverage for this kind of forests[6]. 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 [7]. The aim of our study was comparing the accuracy and precision of several of the inventory (distance methods) methods in zagros forest.

MATERIALS AND METHODS

Site description

This research was investigated in the chahartagh forest reserve, Ardal region, chaharmehal and Bakhtiari Province, southern Zagros forest, and southwest Iranian state (Figure 1).Chartagh 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 [12].

Analysis

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 compare the different sampling methods used the 150×100 meter. Sampling methods include: nearest individual (Byth and Ripley), nearest neighbor (Byth and Ripley), second nearest neighbor (Cottam and Curtis), T-Square (Digel) and compound (Byth) to study of shrub density (N/hectare).

Nearest individual (Byth and Ripley):

This method was simplest distance methods and name of shrub species and distance of random point to nearest shrub (Regardless of aspect).

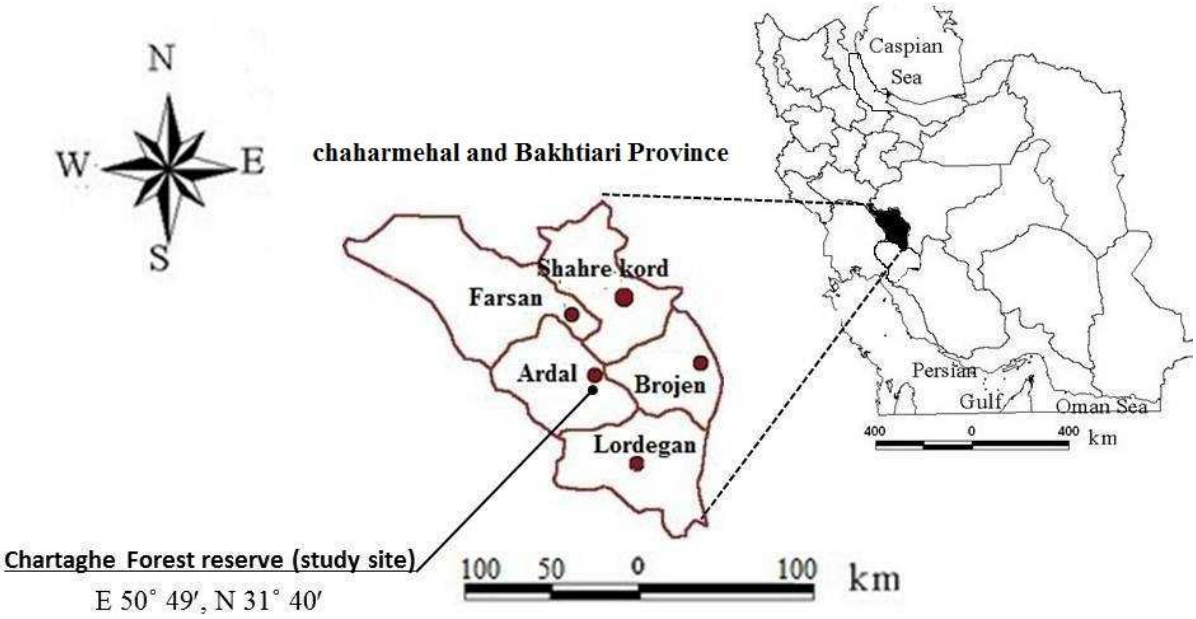

Figure 1. Study site location in the chaharmehal and Bakhtiari Province, Zagros region, and Western Iranian state of Iran.

Nearest neighbor (Byth and Ripley):
In this method after the detection of sample point two distances was recorded include 1: distance of sample point to first tree 2: distance of first tree to nearest shrub from first tree.

Second nearest neighbor (Cottam and Curtis):
In this method after the detection of sample point three distances was recorded include 1: distance of sample point to first tree 2: distance of first tree to nearest shrub from first tree, 3: distance of second tree to nearest shrub from second tree.

Compound methods (nearest individual and nearest neighbor):
This method compacted of two nearest individual and nearest neighbor methods and need the two distances include 1: distance of nearest shrub 2: distance of nearest neighbor

T-Square (Digel):
In this methods distance of nearest shrub from the sample point measured. In the second stage the imaginary line draws Perpendicular on the line that connected two sample points and nearest shrub, and distance of shrub to nearest shrub measured.

T-square sampling method is one of the distance sampling methods for estimating the plant density and canopy cover. For plant density measurements, three formulas, of Diggle and Byth have been used [3].

Tree spatial pattern
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 [36]. There are three basic spatial patterns as following: clumped, random and uniform [21].

Table 1: different sampling methods and formula in the study area

Sampling methods	formula	characteristic
Nearest individual (Byth and Ripley), [3].	$\hat{N} = \frac{n}{\pi \sum (r^2_{pi})}$	N=density (N/ha) n=number of sample r_{pi} =distance sample point to nearest shrub
nearest neighbor (Byth and Ripley), [3]	$\hat{N} = \frac{1}{2.778\left[\bar{r}_m\right]^2}$	N=density (N/ha) n=number of sample $\bar{r}_m$ =distance of first sample to nearest neighbor
second nearest neighbor (Cottam and Curtis): second nearest neighbor (Cottam and Curtis), [3].	$\hat{N} = \frac{1}{2.778\left[\bar{r}_m\right]^2}$ $\bar{r}_m = \frac{\sum_{i=1}^{n} r_{mi}}{n}$	N=density (N/ha) $\bar{r}_p$ = distance of sample point to first shrub $\bar{r}_n$ = Distance of first tree to nearest neighbor
Compound methods (nearest individual and nearest neighbor):	$\hat{N} = \frac{\hat{N}_1 + \hat{N}_2}{3}$ $N_1 = \frac{1}{4\left[\bar{r}_p\right]^2}$ $N_2 = \frac{1}{2.778\left[\bar{r}_n\right]^2}$	N=density (N/ha) $\bar{r}_p$ = distance of sample point to first shrub $\bar{r}_n$ = Distance of first tree to nearest neighbor
T-Square (Digel), [4].	$\hat{N}_T = \frac{n^2}{2\sum (r_{pi})\left[\sqrt{2}\sum (r_{ni})\right]}$	$\hat{N}_T$ = density (N/ha) n=number of sample $\bar{r}_p$ = distance of sample point to first shrub $\bar{r}_n$ = Distance of first tree to second shrub

Table 2: different dispersion indices and formula in the study area

Formula name	formula	characteristic
Johnson & Zimmer [17]	$I = \left[(n+1)\left(\sum_{i=1}^{n} (r_{pi}^2)^2\right)\right] \Big/ \left[\sum_{i=1}^{n} (r_{pi}^2)\right]^2$	I=Johnson &Zimmer index n=number of sample r_{pi} = distance of first shrub to nearest shrub
Heines [3 and 15]	$h_T = \frac{2n\left[2\sum (r_{pi}^2) + \sum (r_{ni}^2)\right]}{\left[\left(\sqrt{2}\sum r_{pi}\right) + \sum r_{ni}\right]^2}$	h_T = Heines index r_{pi} = distance of first shrub to nearest shrub $\bar{r}_m$ =distance of first sample to nearest individual
second nearest neighbor (Cottam and Curtis): Eberhart [3 and 15]	$I_E = \left(\frac{S}{\bar{x}}\right)^2 + 1$	I_E = Eberhart index S = standard division $\bar{x}$ =mean distance of random sample point and nearest individual

Table 3: spatial pattern index and quantity of this index

index			Tree spatial pattern
Eberhart	Heines	Johnson and Zimmer	
<1.27	<1.27	<2	uniform
1.27	1.27	2	random
>1.27	>1.27	>2	clumped

Data analyzing was done by SPSS16 and Ecological Methodological software's. to study of accuracy used Leven and Games-Howell and to compare the every sampling methods to real quality used the one sample t-test

RESULTS AND DISCUSSION

Results of perfect inventory showed that 4266 shrub observed in the study area. To study of shrub in this researches used the density parameters (N/ha)

Table 4. List of Shrub species in the studied areas

no	Scientific name	Family
1	*Cerasus mahaleb Miller*	Rosaceae
2	*Daphne mucroanta* Royle	Thymelaceae
3	*Lonicera nummularifolia* Jaub& spach.	Caprifoliaceae
4	*Cotoneaster morulus* pojark	Rosaceae
5	*Amygdalus orientalis.*	Rosaceae
6	*Cerasus microcarpa* Boiss	Rosaceae

The shrub species belonged to three families were identified in the study area (Table 2) thus for the classes of rosacea, Caprifoliaceae and Thymelaceae, four, one and one species were existed, respectively.

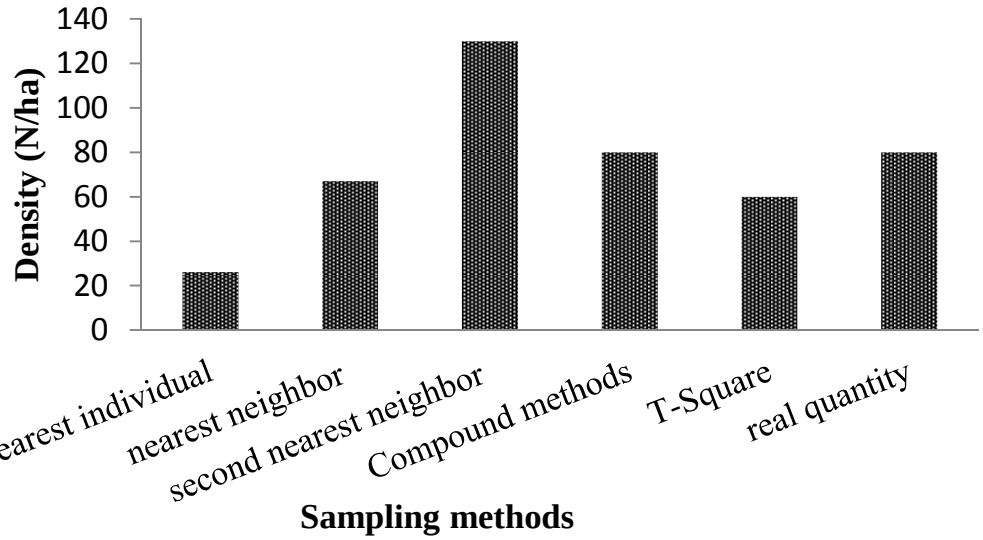

Figure 2: estimation of shrub density in the different sampling methods and real quality

Result showed that the density estimated in the nearest neighbor and Compound methods nearest the real quality (perfect inventory).

Table 5.The results of ANOVA test to estimate the density in different sampling methods.

	df	Mean of square	sum of square	F	Sig.
Sampling methods	4	57027	14256	22.89	0.000
error	45	28020	622		
total	50				

Results showed that between different sampling methods to study of density was significant different because this results researcher used the Leven test.

Table 6.The results of t-test to compare estimate quality and zero quality in the different sampling methods

	df	Mean of different	Sig.
nearest individual	9	-53	0.000
nearest neighbor	9	-12	0.254
second nearest neighbor	9	50	0.000
Compound methods	9	-1	0.919
T-Square	9	-19	0.005

Result of table showed that between estimate quality and zero in the nearest neighbor and Compound methods not significant different.

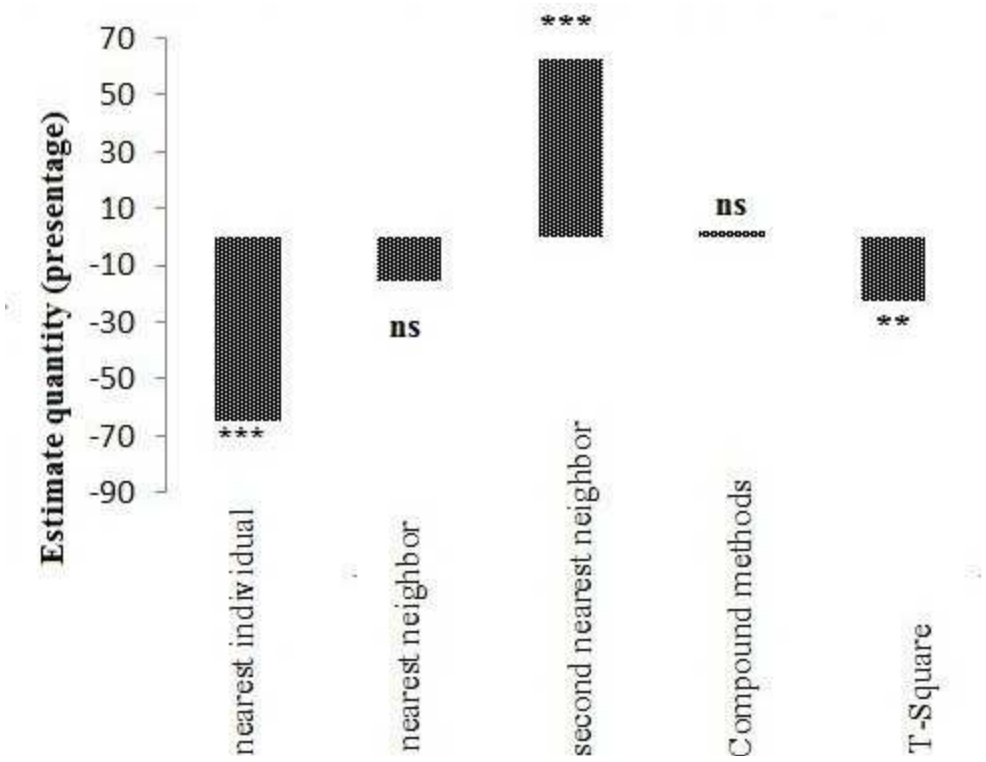

Figure 3: skew of density (N/ha) in the different inventory methods

Results showed that the in the two nearest neighbor and Compound methods not significant different, and not skew of density in compare of real quantity, but other of sampling methods have skew of real density (N/ha).

Table 7: spatial pattern of shrub in study area

index			
Eberhart	Heines	Johnson and Zimmer	
2.21	2.177	6.77	Quantity of index
clumped	clumped	clumped	spatial pattern

All of applied indicators showed a clumped pattern for shrub species in this forest.

The zagros forest where enough rain falls to support habitation, humans have degraded the landscape because the zagros forest where enough rain falls to support habitation. Agriculture, pastoralism, and woodcutting have caused the loss of natural vegetation. For maintaining of Zagros forests role in wild life, water and soil conservation, the suitable solutions and methods for assessing the existing conditions and planning for management of this forests should be given [7]. To determine a suitable method, based on precision and cost, of inventory in Western oak forests [2]. In our study to determination suitable sampling methods used the accuracy and skew of real density index. Perfect inventory showed the shrub density in the study area was 80 shrubs in ha, and *Rosacea* family has high number of shrub species (table 4). To determination of suitable sampling methods compared the perfect inventory (real quantity) and sampling methods. Results showed that the density estimated in the nearest neighbor and Compound methods nearest the real quality (perfect inventory). Two sampling methods (nearest neighbor and Compound methods) was suitable to study of shrub density in the southern zagros forest. Results showed the five sampling methods showed the different estimate of shrub density and authors used the Leven test to study of shrub density. ANOVA test showed the different between five sampling methods (distance methods) in the estimate of density was significant (table 5). Sampling methods (distance methods) compared the real density and results showed that between estimate qualities and zero in the nearest neighbor and Compound methods not significant different (table 6). Study of skew of density (N/ha) in the different inventory methods showed that the two nearest neighbor and Compound methods not significant different, and not skew of density in compare of real quantity, but other of sampling methods have skew of real density (N/ha).the overall results showed that the nearest neighbor (Byth and Ripley) and compound (Byth) sampling methods were the suitable sampling methods to study of shrub density. Spatial patterns of trees in forest stands are of particular interest to ecologists and foresters because they can reveal information about stand history, population dynamics and competition. The spatial distribution pattern of plants is an important characteristic of ecological communities. The spatial distribution of shrub in the study sites showed two patterns of distribution which are clumped distribution (table 7). This study (safari et al, 2011 [26],

Catana, 1963[10], Laycock and Batcheler, 1975 [16] and Morisita, 1957[19]) showed that clumped patterns are typical of natural forests. Safari et al, 2011[26] showed that clumped distribution for zagros forest. In other hand general results showed that this forest has clumped distribution and to study of shrub density (N/ha) nearest neighbor (Byth and Ripley) and compound (Byth) was suitable sampling method. Authors suggested to study of shrub density in the southern zagros forest.

CONCLUSION

Overall results showed that shrub species in southern zagros forest has clumped distribution and to study of shrub density (N/ha) nearest neighbor (Byth and Ripley) and compound (Byth) was suitable sampling method.

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