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Efficiencies of Two Distance Methods in Estimating Plant Density in Shrublands (Case Study: Tange-Sarheh, Nikshahr)

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Abstract **– Careful, precise, and accurate estimation of vegetation density has always been one of the concerns of researchers in quantitative analysis of vegetation, and different experts have introduced various suitable methods for this purpose. Plant density is estimated in different ways with distance methods as some of the fastest and least costly of them. Therefore, the present research studied and compared efficiencies of the two distance methods of random pairs and nearest neighbor with respect to their accuracy and precision and the required time for density measurement in the plant species Periploca aphylla of the Tang-e Sarheh rangelands in Nikshahr employing the random distribution pattern. Results indicated that the random-pairs method was the more efficient one in the study area with respect to the three criteria of accuracy, precision and required measurement time, and the nearest neighbor method lacked suitable efficiency.**

Keywords **– Plant density, without plots, random pairs, nearest neighbor, Nikshahr.**

I. Introduction

Quantitative plant analysis methods are considered the basis for describing and analyzing plant communities, and density plays a significant role as one of the important features in evaluating rangelands to describe characteristics of and changes in plant communities during various periods of change and plant reaction to various management measures, make measurements of vegetation, determine species composition, and to estimate production and biomass (Musaei Sanjarei and Basiri, 2008). Density is defined as the number of individuals of the plant species per unit area in the rangeland, usually expressed as the number of plants per hectare (Moghaddam, 2005). At present, measuring and estimating plant density and production in rangelands are considered necessary steps because plant density measurement is one ways of estimating and measuring production, especially of bush plants and shrubs in rangelands (Sheidai Karkaj et al., 2013). This is why researchers in range management try to find suitable ways for estimating density and production of bush plants. One of the basic principles in sampling is to select a method that yields the highest accuracy and precision at the lowest cost and in the shortest time, and does not disturb vegetation of the study area and collects information in the shortest possible time (Pearson & Sternitzke, 1974). The direct methods of measuring density are time-consuming and costly, therefore, various indirect methods (without frames) have been developed (Mesdaghi, 2003). Distance methods are among those used in measuring density (Laycock, 1961). They were developed after 1950 and are often known as variable-plot or plot-less techniques. Distance methods are without borders and do not measure density in a specific surface area. They are based on measuring the distance between two plants and/or between a point and a plant per unit area (Arzani and Abedi, 2015). In plot-less distance sampling methods, usually one plant species is studied because this increases time productivity and also estimation accuracy (Bonham, 1989). However, studies have demonstrated that various distance methods enjoy different precision and accuracy in estimating density in various types of plant growth (Sandgol, 1995).

Arefian et al. (2014) used seven distance methods (random pairs, nearest neighbor, regular angle, point-centered quarter, wandering quarter, Batcheler integrated, and the quadrat methods) in the Rudshure and Saveh regions to determine densities of Artemisia sieberi and Stipa hohenackeriana, and concluded that the random pairs and nearest neighbor methods had the highest efficiencies in estimating population densities of these two species. Taheri et al. (2014) studied accuracy of the random-pairs method in the rangelands of Manzel Ab in Zahedan and reached the conclusion that lacked acceptable accuracy.

II. Materials and Methods

The Study Area

The Tang-e Sarheh (Hichan) Basin has an area of 9092.9 hectares, latitude of from 26°31′ 13″ to 26°37′ 18″N and longitude of from 59°52 ′ 34″ to 59°59′ 58″ E (Figure 1)

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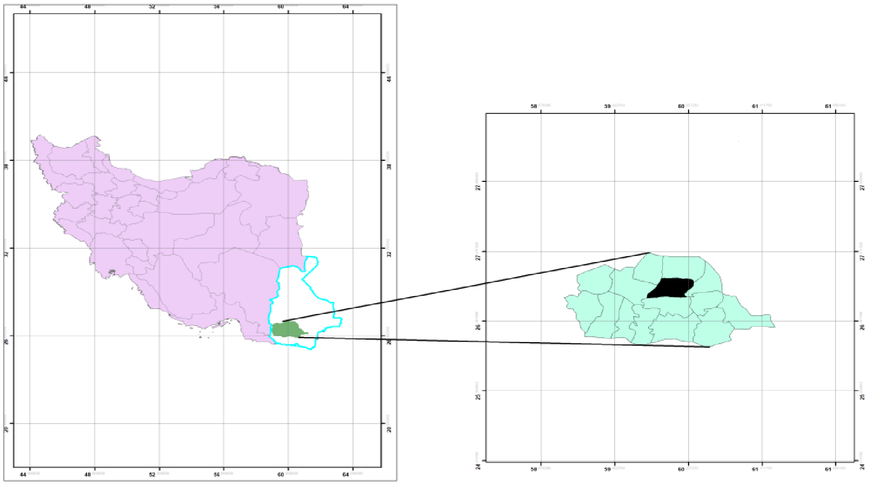

Fig. 1. Location of the study area

Characteristics of the Studied Plant Species

Periploca aphylla Dence is a leafless shrub with average height (three meters) and rope- or whip-like shoots that have some what a fleshy appearance. The branches are often opposite and exactly like those of Leptadenia pyrotechnica (these two shrubs cannot be differentiated by their appearance). The green branches serve as leaves in fixing CO_2 (Javanshir, 2000).

III. Sampling Method

The study area was first identified on the topographic map (scale 1:50,000 or 1:25,000) and then determined by field visits, the area where the plant type under study grew was specified, and three areas (replicates) of 5000 square meters (50 by 100 meters) were selected in the region in a way that the key areas in the monitored region included the species of interest. In each of these studied areas, all the plants of interest were counted using 50 by 100 meter strip-transects, and plant density was calculated by calculating the ratio of the number of plants to the area in square meters. This was considered the control method and the other two methods were compared with it. To estimate density using these other two methods, three areas were selected as the three replicates in the study area and five sampling lines 100 meters apart were created (Imani, 2013). Parallel transects were established using 100-meter long ropes with the two ends of each rope fixed in the ground with two iron nails. The height of the ropes was selected for them to be on plant crowns. Ten points 10 meters apart were selected along the length of each transect. The first point for each transect was randomly selected and the samples were taken at this point in both methods (Sandgol, 1995; Mirjalili, 2005). The random pairs and nearest neighbor were the two methods used in this study. In the random-pairs method, a line was drawn from the random point to the nearest plant base, another line was then drawn perpendicular to that at the random point, and the distance from this line to the nearest plant base that lay in the half-plane outside the random point was measured (Imani, 2013; Musaei, 2008; Mesdaghi, 2005; Sandgol, 1995). In the nearest neighbor method, the individual closest to each random (sampling) point was determined, and the distance from this plant to its nearest neighbor was measured and considered the distance between neighboring plants (Imani, 2013; Musaei, 2008; Mesdaghi, 2005; Sandgol, 1995).

The relative difference between the estimated densities in each of the studied methods from the actual density was calculated. The standard deviations of the methods in each region were calculated to determine the precision, and the method with the least standard deviation was considered to have the highest precision among the employed methods (Asadi, 2008, Eidy, 2012). The time required for using each method was considered a cost index, and the total time needed to employ each method consisted of the time spent in field operations and one-third of the time required for making the calculations (Mirjalili, 2005; Saadatfar et al., 2007). The Protected LSD method (HSD) and the Bonferroni test at the 5% level were employed for data analysis and comparison of the means. Moreover, the t-test was employed to compare the densities estimated by the distance methods with the actual density, and the relative density determined in each method was compared with that of the control to obtain the estimation error in each method. Statistical calculations were performed by SPSS 19 and diagrams were drawn by EXCEL.

IV. Results

Results related to control area 1 indicate that the mean estimated densities in the two methods were less than the actual one, the random-pairs method was more accurate and precise than the nearest neighbor method, but the nearest neighbor method required less time (Table 1).

Table 1: Mean density and accuracy and the time required to estimate density in the studied methods in control area 1

Method	Control	Random pairs	Nearest neighbor
Mean density	0.081	0.020	0.044
Mean accuracy of the density		0.84	0.88
Mean precision of the density		0.022	0.141
Mean time required for determining the density		0.60	0.41

In control area 2 also, the estimated densities were less than the actual one, the random-pairs method was more accurate, but the nearest neighbor method was more precise. Furthermore, the nearest neighbor method required less time (Table 2).

Table 2: Mean density and accuracy, and the time required to estimate density in the studied methods in control area 2

Method	Control	Random pairs	Nearest neighbor
Mean density	0.056	0.016	0.013
Mean accuracy of the density		0.77	0.83
Mean precision of the density		0.0105	0.0103
Mean time required for determining the density		0.24	0.44

In control area 3 also, the estimated densities were less than the actual one, the random-pairs method was more accurate and more precise than the nearest neighbor method and required less time for determining the density (Table 3).

Table 3: Mean density and accuracy, and the time required to estimate density in the studied methods in control area 3

Method	Control	Random pairs	Nearest neighbor
Mean density	0.041	0.013	0.007
Mean accuracy of the density		0.76	0.90
Mean precision of the density		0.006	0.011
Mean time required for determining the density		0.21	0.30

Considering the results obtained from the measurements and the statistical calculations and analyses, we can conclude that the random-pairs method was more efficient than the nearest neighbor method with respect to the three criteria of accuracy, precision, and time required for using the method.

V. Conclusion and Summation

The present research compared efficiencies of the random-pairs and nearest neighbor methods with respect to accuracy, precision, and the time required to determine plant density. Results indicated that the random-pairs method was the more efficient of the two methods. These results agree with those found by Saadatfar et al. (2007) who studied eight distance methods to determine densities in Zygophyllum atriplicoides shrublands of Bardsir. Their results showed that the regular angle method was the most precise among the eight methods. Musaei Sanjarei (2004) conducted a study in lands with Artemisia cover in Yazd Province, and found that the nearest neighbor and the nearest individual methods were the most accurate methods, respectively. Moreover, Eidy et al. (2012) compared eight distance methods and concluded that the transect method and the nearest neighbor methods were more efficient than the other methods with respect to the time required for determining the density and the precision of density estimation, respectively. Imani et al. (2013) carried out research on five distance methods and reached the conclusion that the point-centered quarter and the nearest neighbor methods were the most accurate. Taheri (2014) also compared seven distance methods for density determination in rangelands of Manzel Ab in Zahedan and reported that the random-pairs method was suitable with respect to accuracy, whereas the nearest neighbor method was appropriate with respect to precision and the time required for density determination, and the nearest neighbor method was the most efficient one if all three criteria were considered.

Various factors cause the differences in density estimations. The first one is the time spent in measuring plant density because less time is required with increasing density and with shorter distance between the shrubs. Plant distribution pattern is another important factor. Increased uniformity reduces the size of the required sample and influences the time needed for sampling. The third important factor is the method itself. Some methods such as the point-centered quarter method measure several distances instead of one. Another factor is finding and identifying individuals located close to and far from the random point. The person who makes the measurement is another factor because the mental images of this person concerning plant density can influence the results. It is recommended that consequent comparative studies be carried out for various types of vegetation in different parts of the country where they are found because this will help researchers select the more suitable methods for the specific conditions related to their research. Moreover, application of various methods in different regions of the country can help improve the available methods as

Ghorbani (2008), Borhani (2001), Sandgol (1995), and Anderson (2006) also observed in their research.

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References

[1] Anderson, R.C., Jones, S.L. and Swigart, R. 2006. Modifying distance methods to improve estimates of historical tree density from General Land office survey records. *Journal of the Torrey Botanical Soci*ety, 133(3): 449-459.

[2] Bonham, C.D. 1989. *Measurements for Terrestrial Vegetation*, , New York: John Wiley & Sons interscience, 338pp.

[3] Laycock, W.A. and Batcheler, C. L. 1975. Comparison of distance measurement techniques for sampeling Tussock grassland species in New Zealand. *Journal of Range Management*, 28(1): 235-239.

[4] Pearson, H.A., Sternitzke, H.S., 1974. Forest-range invertory: A Multiple-Use survey. *Journal of Range management*, 27: -404 .407.

[5] Sanjarahie,M. and Basiri,m.2005.Comparison and Evaluation of Different Methods of Density Measurement in Artemisia of Yazd Province.journal of natural environment.61(1).235-241.

[6] Moghadam, M. 2003. The ecology of eastern plants. First edition, Tehran: Tehran University Press, 701 .

[7] Shida Karkaj, A,. Useful, m,. Jahantab 1392. Evaluation and comparison of different distance methods for measuring density in bushes in Inche Bron. Journal of Rangeland Sciences.97. 46-50.

[8] Mesdaghi, M. 2006. Rangeland in Iran. Fifth Edition, Mashhad: Imam Reza University Press, 333 p.

[9] Arazani, H., Abedi, M. 2013. Evaluation of Rangeland Measurement of Vegetation, First Edition, Tehran: Tehran University Press, 305 p.

[10] Sandel, AS 1995 Comparison of the Efficiency of Different Methods of Density Measurement in Different Vegetative Types of Iran Turanian Region, Master's Degree, Faculty of Natural Resources, University of Tehran, 96 p.

[11] Arefian, M., Aries, Younes,. Rabiee M. 2012. Comparison of the Efficiency of Different Methods of Measuring Almond Density in Babak City, Kerman Province. Journal of Plant Research. Volume 27. Number one.

[12] Taheri m. 2012. Comparison of the Efficiency of Seven Methods of Plot Density Measurement in Zahedan Homestails Rangelands. Master's Degree, Faculty of Water and Soil, Zabol University, 63 p.

[13] Janshir, K Birds of the Bashaghrd district. First edition, Tehran University Press, 364 p.

[14] Imani, J., cheap, h. And Zare Chahuki, M. AS.2011. Comparison of the Efficiency of Methods for Estimating the Concentration of Three Rangeland Species of Bromus tomentelluse, Prangos Ferulacea, Festuca ovina (Case Study: Saral Kurdistan Rangelands). Pasture and Watershed Journal. 2 º: 179-190.

[15] Mirjalili, AS 2005. Comparison of Five Methods for Determination of Density Distribution in Yazd Tang Labid Plants, Master's Degree, Faculty of Natural Resources and Marine Sciences, Tarbiat Modares University, 89 p.

[16] Asadi, AS And Ghorbanzadeh, M. 2010. Determining the most suitable method for measuring the density and distribution pattern of Artemisia in North Khorasan Province, Abstract articles of the second National Student Conference on Pasture, Watershed and Desert, 5-4 March 2010, Tehran, Iran, 1: 252-243.

[17] Eidy, M., Ebrahimi, A.A., Asadi, A., Sohrabi. E. And Shirmardi, h. AS 2008. Efficiency of distance measurement methods for density in four rangeland species of Khorasan rangelands of Chaharmahal va Bakhtiari province. Scientific Journal of Rangeland. 3: 246-257.

[18] Sa'adatfar, A., Rainy, H. And mosqati, m. 2007 Comparison and comparison of eight density measurement methods in Bardsir - Sirjan Scatters. Journal of Agricultural Sciences and Natural Resources of Gorgan, 14 (1): 18-27.

[19] Borhani.F. 2001 Comparison of the Efficiency of Coating and Density Estimation Methods in Isfahan Steppe Artificial Plants, Master's Degree in Commodity Management, Faculty of Natural Resources, Isfahan University of Technology, 158 p.