Acta Ecologica Sinica 36 (2016) 108–112

Contents lists available at ScienceDirect

Acta Ecologica Sinica

journal homepage: www.elsevier.com/locate/chnaes

Efficiency of numerical and parametrical indices to determine biodiversity in mountain rangelands

Javad Motamedi *, Mahshid Souri

Department Range and Watershed Management, Natural Resources Faculty, Urmia University, Urmia 165 PB, Iran

ARTICLE INFO

Article history:
Received 11 November 2015
Received in revised form 10 January 2016
Accepted 15 February 2016

Keywords:
Species diversity
Grazing
Abundance distribution models
Khanghah Sorkh rangelands

ABSTRACT

Among various numeric and parametrical indices of plant species diversity, numerical ones may not provide a comprehensive description about abundance and richness of species, so application of parametric indices in addition to numerical ones would be a better approach to investigate on plant communities. For this purpose, indices of species richness, evenness and diversity were calculated for each of four plant communities of mountain rangelands in northwest of Iran. Then abundance–diversity and species ranking curves were plotted for each plant community and the best models for abundance distribution of diversity were fitted by chi-square goodness of fit test and the best representative one was selected. The results showed that there are significant differences in terms of numerical diversity among the communities and each of the indices showed higher value of diversity in every community so it was so difficult to decide on the community with the highest species diversity. Also the difficulty to explain the plotted curves species diversity and abundance ranking was obvious so the curves were not efficient to identify the distribution of species richness. So determination of species diversity by models of abundance distribution and adjustment of species distribution with expected values of distribution for plant species was implemented. The results showed the log-normal model as the best one for all locations with moderate intensity of grazing. Also the intermediate disturbance hypothesis (IDH) was supported by this model. As overall result species richness, evenness and diversity increases in intermediate levels of disturbance (moderate grazing).

1. Introduction

Rangelands are extended ecosystems all around the world that face to various management problems, so studying ecological aspects of this ecosystems have great importance. However, diversity is one of the most important concepts of rangeland ecology [1]. Indices of diversity are considered as the most important criteria in vegetation ecology to determine ecosystem condition as consequence of management programs. These indices are efficient to study the population dynamics and distribution of plant species to provide required recommendations for management planning [2].

Several methods have been developed to evaluate and study species diversity. Two major groups of these methods include numerical indices (richness, diversity and evenness) [3]; and parametric indices (abundance distribution models, abundance–ranking curves, dominance–diversity curves and diversity ranking curves) [4,5]. The effect of management practices on plant species diversity was investigated by numerical indices in many researches [6,7]. The effect of grazing management on species richness of grasslands in Kansas was studied, and it is reported that grazing systems caused no significant differences on species richness and diversity, but grazing intensities affected such indices significantly, and density of perennial grass species reduced by the increase of grazing rate [8]. Variation of species diversity and richness along grazing gradients in a rangeland of South Africa was investigated and the lowest values for diversity and richness was observed around the cattle's night resting sites where moderate grazing pressure was higher [9]. Species richness of Alborz mountain rangelands didn't changed by increase in grazing intensity in elevated sites but in sites with moderate and low elevation species richness decreased by increase in grazing intensity [10]. While in a previous study, various indices of diversity were calculated for three different grazing managements and it is concluded that the enclosure and heavy grazed sites had the highest and lowest richness respectively [5].

It can be concluded from the previous researches that various numeric indices of diversity try to show the diversity in sampling sites or definite vegetation community with only a number. Also for example the Shannon–Wiener index that can be represented on various logarithmic bases. These cause confusion in interpretation of the results to help managers in determination of species distribution and vegetation structure. Therefore, the question that always arises is that in different conditions which index would be more efficient to evaluate diversity? And

* Corresponding author.
E-mail addresses: j.motamedi@urmia.ac.ir (J. Motamedi), m.souri@urmia.ac.ir (M. Souri).

http://dx.doi.org/10.1016/j.chnaes.2016.02.001
1872-2032/

what is the optimal value of these indices for richness, evenness and biodiversity (heterogeneity) about animal and plant species in natural ecosystems?

Because of the represented difficulties and as is obvious that numerical indices of diversity, are quick markers to compare different vegetation communities, but the results cannot be explained ecologically, therefore parametric indices of diversify such as abundance distribution models were developed to compare vegetation communities and find appropriate answer for above questions.

Although these diversity indices were developed since three decades ago, few studies have focused on developing the models of abundance distribution for vegetation communities and the use of parametric indices in natural ecosystems of Iran was limited. Plant diversity was evaluated in different grazing intensities in protected area of Muteh plain and Kavir Meighan Arak, Iran. It was concluded that diversity is one of the most important indices of ecosystem changes. In this regard the communities with low biodiversity (fragile communities) described properly by geometric series model and communities with high biodiversity (stable communities) can be described by log-normal model [11]. Also a great number of studies had studied this issue [12,13].

The results achieved here show that grazing and other management programs in rangeland ecosystems have direct effect on vegetation biodiversity and all the results in this issue aren't same and experts' suggestions cannot be advised in all areas similarly [14]. Therefore, this paper aims to compare the numerical indices of rangeland vegetation species diversity and determine the appropriate model of distribution of species diversity in studied areas.

2. Materials and methods

2.1. Site description

This study was conducted in Khanghah Sorkh catchment as a representative site for bio-climatic area of Azerbaijan in northwest of Iran (Fig. 1). It covers an area of over 2000 ha and coordinates 44° 57′ 4″ and 45° 32′ 00″ E and 37° 46′ 18″ to 37° 50′ 42″ N located in the northeast of Urmia city. The altitude ranges from 1483 to 2379 m above sea level with a mean annual temperature of 9.87 °C and a mean annual precipitation of 393.9 mm. According to Emberger climate classification method the climate is cold and semi-arid in the study area [15,16].

2.2. Methods

In this study, primary boundary of plant communities was determined by land unit maps and aerial photographs, then with field surveys the exact borders of plant communities were selected. Then vegetation communities were named by species physiognomy of two domain species. After selection of sampling areas (representative key area) in each plant community, the size of sampling plots was determined based on the highest canopy size of dominant plants. So we located 1 m × 1 m plots in every 10 m along transects from 0 m up to 100 m. In each plot, we determined the cover and number of all plant species. In this regard, the instruction of national plane for rangeland assessment in different climatic regions of the country [17], previous studies [16] and statistical relationships recommended for rangelands were the references to use total number of 60 plots that established by systematic random method in each sampling area. Plant species identification was conducted using available studies in this site and adjacent regions [16,18], and also the national studies as flora of Iranica [19] and flora of Turkey [20]. Also vegetation condition and trend were determined according to the four-factor method the scoring of the soil and vegetation cover respectively [21]. Considering the required area for one unit of grazing livestock and comparing with the total number of animal units that were in the studied site, field observations, distance from settling and the watering places, and grazing intensity were determined in each of the vegetation communities.

This study aimed to study all aspects of diversity, in order to get more accurate results, in the first step numeric indices of diversity (heterogeneity) including: Shannon–Wiener and Simpson, J. Pielou index of evenness, richness indices of Margalef and Menhinick were calculated. Then in the second step for completion of numeric indices, the parametric indices including: diversity ranking curve, species abundance–ranking curve and species distribution models (broken stick, log normal, log series and geometric series) were applied to graphical investigation of the diversity. To test the fitness of each model, first the abundance classes were set for observed data, and then the expected values of species abundance in each class, based on frequency model were calculated. Chi-square test was applied to evaluate the correlation between observed abundance and expected abundance of species in each class. Calculation of numerical indices, drawing of diversity ranking curves and

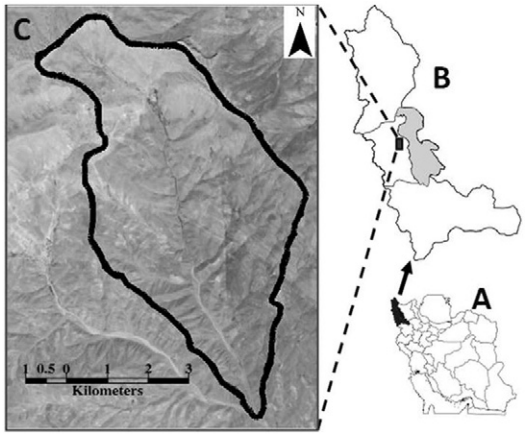

Fig. 1. Geographical position of Khanghah Sorkh rangelands of Urmia (C), in West Azerbaijan province (B) and Iran (A).

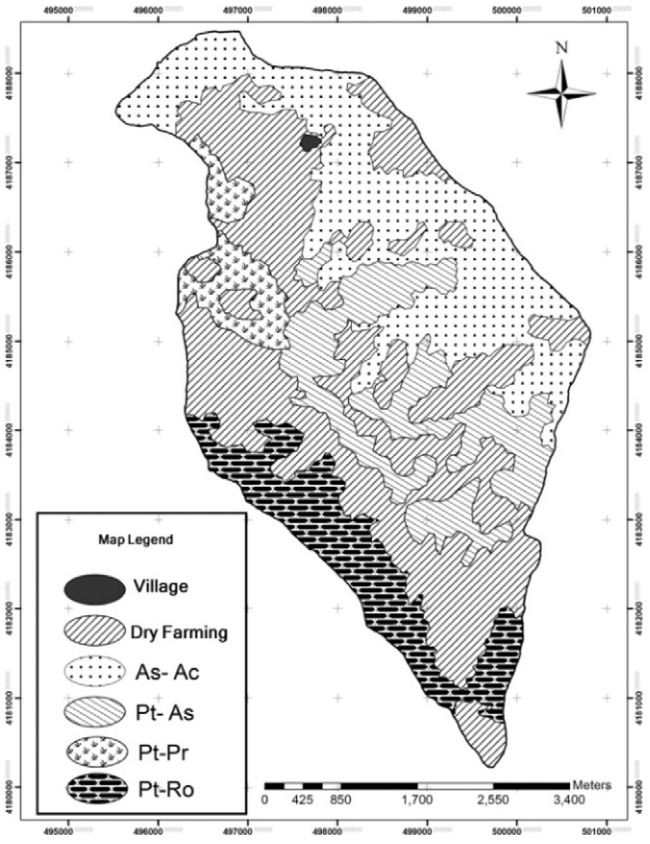

Fig. 2. Spatial distribution of plant communities.