Journal of Agricultural Technology 2012 Vol. 8(5): 1769-1777
Available online http://www.ijat-aatsea.com
ISSN 1686-9141

Floristic study and estimating species diversity indices in a rangeland of middle Iran

Farzaneh khojasteh[1*], Ameneh Sobhani[2] and Mohammad Ali Zare Chahouki[1]

[1]Department of Reclamation of Arid and Mountain Regions, Faculty of Natural Resources, University of Tehran, Iran, [2]Department of Arid and Mountainous Reclamation Regions, Faculty of Natural Resources, University of Gorgan, Iran

Farzaneh khojasteh, Ameneh Sobhani and Mohammad Ali Zare Chahouki (2012) Floristic study and estimating species diversity indices in a rangeland of middle Iran. Journal of Agricultural Technology 8(5): 1769-1777.

Land use and land transformation are mainly threated to biodiversity. Grazing as a land use is not incompatible with biodiversity conservation if proper management are applied. The conservation of plant diversity is a major objective in rangeland management. The current research was performed to determine the species diversity in Artoon rangeland of Taleghan in meddle Iran. There were random investigated in 240 plots, each one with an area of 1 m^2 was established which based on randomized-systematic method and density of the species was recorded. Species properties including the related genus and family in addition to life forms and growth forms were determined. Species diversity was studied by using of Shannon and Simpson indices showed that diversity of Artoon rangelands could be considered as moderate. The highest distribution frequency was related to the species of *Stipa barbata*, *Agropyron trichophorum* and *Astragalus effusus* in perennial species and *Bromus tectorum*, *Agilops kotschyi* and *B. danthonia* in annual species.

Keywords: biodiversity, density, management programs, grass species, Taleghan

Introduction

Destruction of plants' vegetation and transition from multi-cropping to monoculture system has led to decrease in biotic diversity in ecosystems. As a consequence, many valuable species of animals and plants have been exposed to extinction. Our general understanding from biotic diversity in term of plant species is relatively poor and continued studies are needed to evaluate the diversities of plants' communities and to provide a comprehensive knowledge on the health of the ecosystems. Many researchers consider species richness in an ecosystem as a confident index for its health and sustainability. Maintaining

* Corresponding author: Farzaneh Khojasteh, e-mail: fkhojasteh@ut.ac.ir

plant diversity is an important factor in the management of biodiversity in ecosystems. Issues related to diversity (e.g. influence of diversity on community dynamics, diversity–stability relationships and relationship between productivity and species diversity) across space are one of the best studied subjects in ecology. Among the scales of regional species group and local communities, diversity exhibits patterning that is the focus of a large amount of management activities (Rogers *et al*., 2001). A large body of studies on rangeland ecosystems, including natural grasslands, suggests that the function of ecosystem is largely dependent on biodiversity (Balvanera *et al*., 2006; Diaz *et al*., 2007; de Bello *et al*., 2009). Also, it can thus be used to indicate the ecophysiological response of plants and communities to environmental factors, providing more understanding on the functional benefit of biodiversity for ecosystem functioning in diverse ecosystems (de Bello *et al*., 2009). In a simple definition, biodiversity is the total sum of all biotic variation from genes to ecosystems (Purvis and Hector, 2000). In popular usage, the word biodiversity is often used to describe all the species living in a particular area. However, this concept is more complex; it is used to indicate the diversity of species, the diversity within species, and the diversity of ecosystems.

In this study, we evaluated the species diversity of plants in a semi-arid rangeland of Taleghan region located in central parts of Iran. Restoration and reclamation of the rangelands in this area is of more much importance because they have been exposed to degradation due to high pressure of grazing by sheep and some edaphic limitations. High slope in this rangelands cause the leaching and faster erosion of soil, leaving a low depth and often young soil for establishment and growth of native plant species. Awareness of species diversity in these rangelands may provide key insights that are useful for land managers' programs.

Materials and methods

Study area

In July 2010, we selected four field sites at different elevations (1900-2400 m a.s.l) on the south foothills of the Taleghan ranges, Alborz Province, central Iran (50º19′30″ E, 36º5′20″ N). The experimental sites were selected facing west north somewhat similar slopes (15-40º). The climate in these sites varies from semi-arid to semi-humid. Average annual precipitation of the study area ranges between 460 and 600 mm. Minimum temperature is recorded in December (-25 ºC) while the highest temperature touches +35 ºC in June. The plant species in sites 1 and 2 are exposed to overgrazing, while in site 3, in

addition to grazing pressure, low soil depth and light soil texture are the main stressful factors.

Data collection and analysis

Four transects of 150 meters were considered in each sampling unit (two transects perpendicular to the slope and two others deployed to the slope). With respect to the short distance along the studied valley, using randomly-systematic method, 15 plots (1m × 1m) were placed along each transect with a distance of 10 m. Based on this method, along each transect, the first point was selected randomly and other points were determined systematically with an interval of 10 meter from the previous point. Therefore, in each sampling 60 plots were stationed. List of species cover and the number of plant stalks were determined in each plot. Density of the species within each plot was recorded. Species properties including the related genus and family in addition to life form, growth form and biological type were determined. Based on the maximum canopy cover, the dominant species plants (typically *Stipa barbata*, *Astragallus effusus*, *Agropyron trichophorum*, *Psathyrostachys fragilis*) were determined. Shannon and Simpson diversity indexes were used. Data were analyzed using Ecological Methodology software (Krebs, 1988). These parameters were calculated using the following equations:

Shannon diversity index (1) $H' = -\sum_{i=1}^{s}(p_i \ln p_i)$

Simpson diversity index $1 - D = 1 - \sum_{i=1}^{s} P_i$ (2)

PC-ORD 4 was used for cluster analysis (MjM Software, www.pcord.com).

Results

Our results showed that 36 plants species of 8 families were present in the studying area (Table 1) and the most density was related to the two families: Geramineae and Compositae, while two families Umbellifera and Boraginaceae were rarely observed in the studied area. Among these plants, grass species were more abundant (Table 2, see also Fig. 1). Based on palatability, most of the studied species were unpalatable and only 16.22% of them were palatable (Fig. 1). The perennial species constituted 75.68% of the observed species, while the relative abundance of biennials and annuals was 8.11% and 16.22%, respectively. Altogether, forb species that are observed in all studies families except for gramineae (Table 1) constitute the most abundance of these rangelands (51.35%), while grass life form (seen only in Gramineae) and shrub

life form (seen in three families: Leguminosae, Compositae, and Labiate) constitute only 37.83% and 10.81% of plant species in this area (Fig. 1). The density of each family is shown in Table 2.

Diversity indices and species richness data were used to assess community variations across four different sites (Table 3). The maximum amount of Shannon index is 3.6 in site 1and minimum its 2.04 in site 4. The range of this index is between 0-4.5.

Table 1. The list of plant species in Taleghan rangelands LF = Life form (F – forb, G – graminoid, S – shrub); GF = Growth form (A –annual, B – biennial, P – perennial); Palatability: I – highly palatable, II – less palatable and III – unpalatable

Speceis	Family	LF	GF	Palatability
Achillea millefolium	Compositae	S	P	III
Aegilops kotschyi	Graminae	G	A	III
Agropyron intermedium	Graminae	G	P	I
Agropyron tauri	Graminae	G	P	I
Agropyron trichophorum	Graminae	G	P	II
Astragalus effusus	Leguminosae	F	P	I
Astragalus gossypinus	Leguminosae	S	P	III
Boissiera squarrosa	Graminae	G	A	III
Bromus danthonia	Graminae	G	A	III
Bromus tectorum	Graminae	G	A	II
Bromus tomentellus	Graminae	G	P	I
Centaurea virgata	Compositae	F	P	III
Cichorium intybus	Compositae	F	P	III
Echinops robustus	Compositae	S	P	III
Eryngium bungei	Umbelliferae	F	P	III
Euphorbia aelleni	Ephedraceae	F	P	III
Goebellia alopecuroides	Leguminosae	F	P	III
Gundelia tournefortii	Compositae	F	P	III
Hordeum bolbosum	Graminae	G	P	II
Hordeum marinum	Graminae	G	A	II
Lactuca orientalis	Compositae	F	A	III
Onopordon leptolepis	Compositae	F	B	III
Onosma heterophylla	Boraginaceae	F	P	III
Phlomis olivieri	Labiatae	F	P	III
Poa bulbosa	Graminae	G	B	II
Psathyrostachys fragilis	Graminae	G	P	II
Salvia limbata	Labiatae	F	P	III
Stachys infelata	Labiatae	S	P	III
Stipa barbata	Graminae	G	P	III
Taeniatherum crinitum	Graminae	G	A	III
Taraxacum syriacum	Compositae	F	P	III
Teucrium polium	Labiatae	F	P	III
Thymus kotschyanus	Labiatae	S	P	III
Tragopogon pterocarpus	Compositae	F	P	II
Verbascum speciosum	Scrophulariaceae	F	P	III
Ziziphora tenuior	Labiatae	F	A	III

Table 2. Density (number of individuals in 240 sampling unit (plots with 1 × 1 m^2 dimensions)) of rangeland plant species arranged based on family

Family	Density
Gramineae	7699
Leguminosae	292
Labiatae	198
Compositae	209
Boraginaceae	4
Umbelliferae	2
Scrophulariaceae	7
Euphorbiaceae	25

Table 3. Canopy cover and density dominant species and diversity index of plant communities in Taleghan rangelands. Values are mean ± SE, n=60

Sites	Site 1	Site 2		Site3	Site 4
	S. barbata	*A. effusus*	*S. barbata*	*P. fragilis*	*A. trichophorum*
Cover (%)	6.06	12.23	7.13	12.52	19.58
Shannon' index	3.6	2.91		3.11	2.04
Simpson' index	0.9	0.8		0.8	0.51
Richness	19	17		18	17

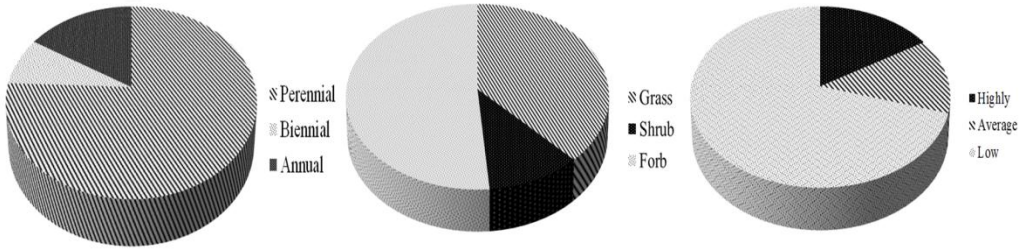

Fig. 1. Growth form, life form and palatability of plant species in studied area (abundance percentage)

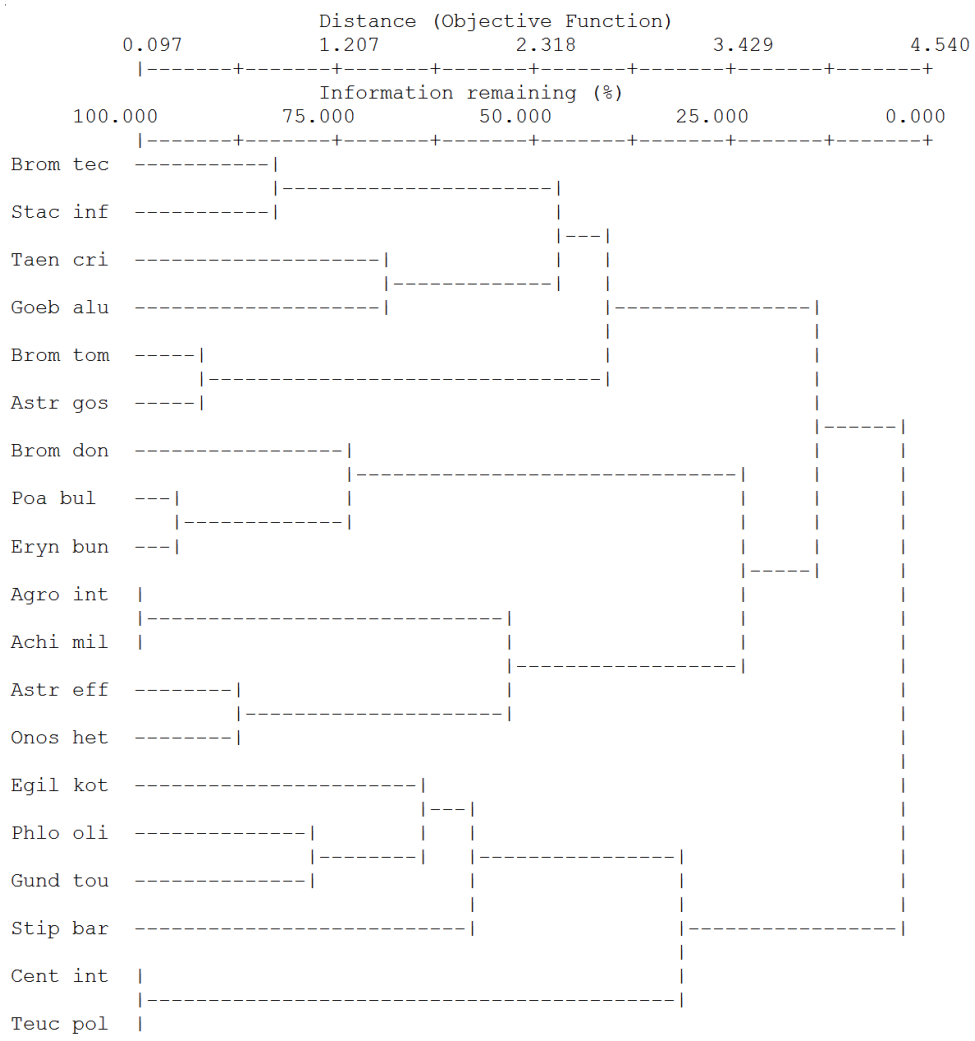

Fig. 2. Cluster analysis of species spatial distribution at Site 1 based on correlation of species' abundances across 60 plots

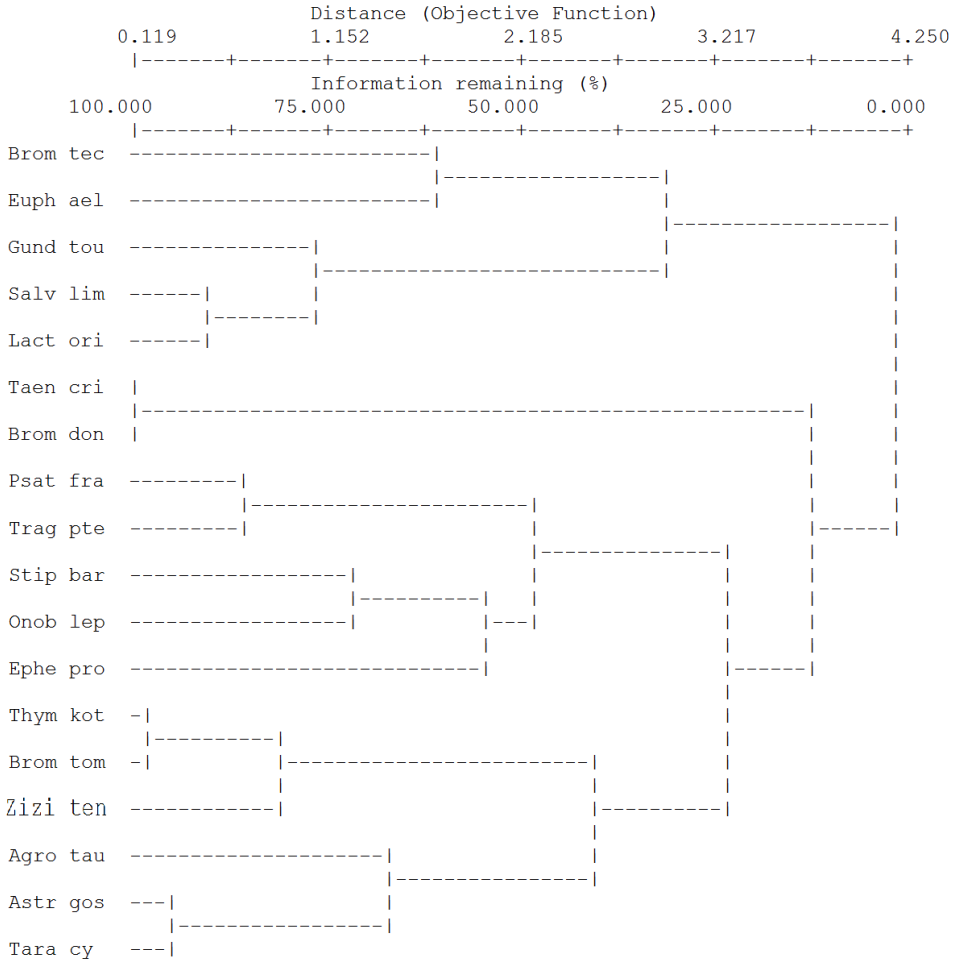

Fig. 3. Cluster analysis of species spatial distribution at Site 3 based on correlation of species' abundances across 60 plots

Discussion

Increasingly researches have shown that the function of ecosystems are directly associated with its biodiversity. However, it should be held in mind that any type of biodiversity does not essentially lead to elevated performance of the ecosystems. For example, although the presence of invasive species in the rangeland increases its biodiversity and species richness, it can decrease the health of the ecosystem. In this study, species diversity of a semi-arid rangeland was analyzed with respect to some influencing factors such as facilitative species, grazing and environmental conditions. Low amount of Shannon index is related to the hard situation of society (biotic and abiotic), and the high

amount of evenness and richness indexes indicates the high species diversity in the society (Krebs, 1998). Our study area showed high diversity in site 1, medium diversity in sites 2 and 3, and low diversity in site 4. The characteristics of *S. barbata* such as growth in all territories except for the salt and sandy lands, high resistance to drought (so that some of its ecotypes grow in areas with 100 mm of precipitation) and low palatability (III) make it the dominant species in many types of Taleghan (in site 1 and 2 study area). *A. gossypinus* and *T. kotschyanus* have a wide canopy and create a suitable microclimate in understory so that it protects grasses' species against overgrazing through a mechanical facilitation (Sthultz *et al*., 2007). In addition, these species are among the most important shrubs that protect soil against erosion. *A. effusus* increases soil fertility with having a symbiotic relationship with the bacteria *Rhizobium*, so facilitate the establishment of other herbaceous plants under its understory (Padilla and Pugnaire, 2006). The high biodiversity of plant species in sites 1 and 3 can be attributed to the presence of this facilitative species. In a previous study, we had shown that grass species such as *Bromus tomentellus*, *A. intermediom* and *A. tauri* are significantly more abundant in understory of some facilitative species such as *A. gossypinus* and *A. effusus* (unpublished data) (see Fig 2 and 3).

Dominant species may decrease the overall biodiversity of rangeland when they contribute to the most cover of the community in comparison to other species (Hild *et al*., 2006). For instance, dominant species such as *A. trichophorum* (19.58% canopy cover in site 4) and the pair species, *A. effusus*-*S. barbata* (19.35 canopy cover in site 2) (Table 3) reduce the establishment and growth of the other grass species in a simple competitive interaction. Also, *A. trichophorum* is a dens grass species with a perennial rhizome and allelopathic effects. So, in type of this species, only some invader species such as *Achilea millefolium*, *Goebellia alupecuroides*, *Onobordon leptolepis* and also annual species, especially *Boissiera squarroza* are seen.

As previously stated, the most important use of these rangelands is grazing pastures for sheep. So, the restoration and reclamation programs should be planned for protection of palatable species. At the current time, palatable species constitute a small percentage of plant species in these rangelands. We showed that some shrubs and forb species can facilitate the establishment and maintenance of perennial palatable grasses and increase biodiversity in favor of them. So, managers can benefit from these positive interactions for preservation of useful species in these rangelands.

Acknowledgements

The authors appreciate Seyed Mohammad Tabadkani for his great helps in preparation of manuscript. This work was funded by University of Tehran.

Reference

Balvanera, P., Pfisterer, A.B., Buchmann, N., He, J.S., Nakashizuka, T., Raffaelli, D. and Schmid, B. (2006). Quantifying the evidence for biodiversity effects on ecosystem functioning and services. Ecology Letters 9: 1146–1156.

de Bello, F., Buchmann, N., Casals, P., Leps, J. and Sebastia, M.T. (2009). Relating plant species and functional diversity to community d13C in NE Spain pastures. Agriculture, Ecosystems and Environment 131: 303–307.

Diaz, S., Lavorel, S., de Bello, F., Quetier, F., Grigulis, K. and Robson, T.M. (2007). Incorporating plant functional diversity effects in ecosystem service assessments. Proceedings of the National Academy of Sciences of the United States of America 104: 20684–20689.

Hild, A.L., Schuman, G.E., Vicklund, L.E. and Williams, M.I. (2006). Canopy growth and density of wyoming big sagebrush sown with cool-season perennial grasses. Arid Land Research and Management 20:183–194.

Krebs, J.C. (1998). Ecological methodology, Addison Wesley Longman Inc., pp. 620.

Padilla, F.M. and Pugnaire, F.I. (2006). The role of nurse plants in the restoration of degraded environments. Frontiers in Ecology and Environment 4: 196–202.

Purvis, A. and Hector, A. (2000). Getting the measure of biodiversity. Nature 405: 212–219.

Rogers, P., Atkins, D., Frank, M. and Parker, D. (2001). Forest Health Monitoring in the Interior West: a baseline summary of forest issues, 1996–1999. USDA, Forest Service, Rocky Mountain Research Station, Fort Collins, CO: Gen. Tech. Rep. RMRS-GTR-75. URL: http://www.fs.fed.us/rm/pubs/rmrs_gtr75.html.

Sthultz, C.M., Gehring, C.A. and Whitham, T.G. (2007). Shifts from competition to facilitation between a foundation tree and a pioneer shrub across spatial and temporal scales in semiarid woodland. New Phytologist 173: 135–145.

(Published in September 2012)