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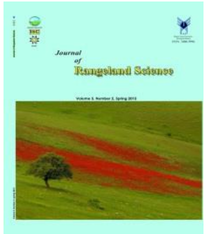

Research and Full Length Article:

The Surveying of Range Condition and Biodiversity in Four Sites of Northern Alborz Rangelands, Iran

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Abstract. Evaluation of range conditions and plant diversity circumstances can help to rangeland managers who establish their managerial approaches on the basis of ecological capabilities of rangeland ecosystems. Hence, surveying of rangelands was done in four sites of northern Alborz Mt. including western Alborz (Masooleh site), west to middle Alborz (Javaherdeh site), central area (Polour site), and eastern region (Ramian site). A 64 grid (1 m^2) was laid down in stand area of each site and range condition was assessed by Daubenmire Method. Alpha, Beta, and Gama diversities, and plant richness and evenness were calculated in each grid using PAST v.2.03 software. Relationships between range condition and biotic and abiotic factors were done using stepwise regression method. Results showed that Ramian site had the most Beta and Gama diversities and the Javaherdeh and Masooleh sites had the most Alpha diversity as well. The Polour site had the least diversities indices because of overgrazing and poor rangeland condition. It however had high level of the plant evenness. Range conditions, soil conservation, and litter rate were the highest grades in the Ramian site than the others. Regarding the results, therefore, the rangers can be capable to balance the rangeland ecological conditions using desirable grazing capacity and pressure.

Key words: Range condition, Biodiversity, Masooleh, Javaherdeh, Polour, Ramian, Northern Alborz

Introduction

Direct and indirect anthropogenic activities on rangeland ecosystems are caused to disturb the ecologica l equilibrium of ranges (Nabte *et al*., 2013), so that these disturbances can recline the ecological services of range ecosystems (Alkemade *et al*., 2013). Decreasing of forage production, deforming of indigenous plants, changing of birds, reptilia, wildlife habitats, and increasing of sediments are some of ecological services in rangeland ecosystems (Bhattarai, 2012). Grazing and overgrazing, as indirect activities, can be caused to change the plant communities, declining of plant vigour, frequency, and composition, invading of invaders species, decreases the litter, descend the soil fertility, depression of soil humidity, and soil degradations (Kauffman & Krueger, 1984; Kgosikoma *et al*., 2013; Davies *et al*., 2014). As a result, human activities and livestock grazing can change the biodiversity stability and descend the range succession to simple ecosystem where is vulnerable system (Ricciardi *et al*., 2013; Deng *et al*., 2014). Consequently, retaining of biodiversity, as of key objectives in ecology and vegetation management (Tilman *et al*., 2006), ecosystem (Magurran, 2004), ecosystem health (Henderson & Davis, 2014), and ecosystem productivity (Noor Alhamad, 2006) are reasonable. Biodiversity management in the rangeland ecosystem means considering all ecosystemic services and species-rich ecosystems are more stable (De Keersmaecker *et al*., 2014). Traditional utilisation approaches of rangeland ecosystems have increasingly lessened the biodiversity scale (Mulk Khan *et al.*, 2014) while trend of sustainable management must increase plant diversity and richness as well as wise utilisation of rangeland ecosystems (Gough & Marrs, 1990). Although upland livestock farming is an integral part of the culture and history of many pastoral areas worldwide (Pollock *et al.*, 2013), mountain ecosystems are hot spots for plant conservation efforts because they hold a high overall plant diversity as communities replace each other along altitudinal and climatic gradients, including a high proportion of endemic species (Mulk Khan *et al.*, 2014). The highly accelerated rate of anthropogenic modification of natural systems (Dong *et al.*, 2012) built up very important the ecosystem ecology in the 21st century (Kideghesho *et al.*, 2013).

According to the condition of the rangelands which Trollope *et al.* (1990) defined; the state of health of the rangeland in terms of its ecological status, resistance to soil erosion and potential for producing forage for sustained optimum livestock production must be investigated (Ash *et al*., 2011). Furthermore, rangeland condition is a function of all plant forms (trees, grasses and shrubs) that occur in it (Addison *et al*., 2013). Since animal production is directly related to rangeland condition, rangeland degradation will result in a lower income (Danckwerts & Tainton, 1996). Grazing intensity can have varying influences on plant diversity, diversity peaks under moderate grazing (Trollope *et al*., 2014). Plant diversity can be defined based on the number of species (i.e., richness; Brocque & Buckney, 2003), relative abundance of species (i.e., evenness; Gosselin, 2006), and/or an index that considers both of these measures, which is called SHE index (Buzas & Hayek, 1998) and is established based upon Information

Theory (Mana, 2005) so that it can provide the spatial and time changes of species (Horton and Murray, 2006). Plant diversity is important in promoting community productivity and stability (Tilman *et al.*, 2006), and also has intrinsic conservation value (Symstad and Jonas, 2011). The α, β and γ diversity (Wang & Loreau, 2014) are the elements to evaluate the given diversity, as well. Alborz mountain is a place where has gathered many domestic stocks and wildlife which effect the place and change its vegetation condition and trend. Study the grazing areas and comparing of range condition in separate areas of this land can draw feature of upland rangelands of northern Alborz so that it makes judgement around the managerial approaches in the rangeland ecosystem regarding in each area. The aim of this research was to survey of range condition and biodiversity in four sites of northern Alborz rangelands, Iran.

Materials and Methods

Sites

Studied area are located on Alborz Mountain (AM) where is stretched out on west to east aspect. Four case study sites were chosen such as Masooleh (west of AM), Javaherdeh (west to middle of AM), Polour (central of AM), and Ramian (east of AM) (Fig. 1). Climatologically, this zone is influenced by Mediterranean humid climate so that its effects reduce from west to east (Table 1 is also given some other features of the sits). The most herds of the area are goats and sheep which yearly graze summer periods. Vegetation features of the area are grassland which is mixed to cushion shrubs such as *Thymus kotschyanus* Boiss. & Hohen, *Astragalus* spp., *Onobrychis cornuta* (L.) Desv. *Acantholimon* sp. The grasses are also *Festuca ovina* L., *Agropyron* sp., *Dactylis glomerata* L., *Bromus tomentellus* Boiss. In debris area, *Juniperus excelsa* M.B. flaunts oneself.

Table 1. Some features of four sites of study areas

Site name	Altitude (m)	Latitude	Rain (m)	Soil Texture	
Masooleh	2516	37°06′57″ N 48°57′53″ E	601 (Ebadifar, 2011)	Clay-sandy-loam	Shemshak (Jouri *et al.*, 2013)
Javaherdeh	2450	36°50′447 N 36°27′063 E	650 (Jouri, 2010)	Loamy-clay-sandy	Elika (Hosseini, 1994)
Polour	2542	35°51′26″ N 52°03′36″ E	535 (Akbarzadeh and Mirhadji, 2006)	Clay-sandy	Shemshak, Delichay, Lar, and Tizkooh (Saeidi, 1980)
Ramian	2368	36°49′34″ N 55°14′46″ E	450 (Savadkoohi, 2013)	Sandy-clay-marn	Shemshak (Hafezi Moghaddas *et al.*, 2010)

Fig. 1. Positions of studied area in the Alborz Mt. such as (1) Masooleh, (2) Javaherdeh, (3) Polour, and (4) Ramian sites

Research methods

In order to judge the quality of rangelands in the Alborz Mountains, four case study sites were picked out and in each site, stand area was specified. In the stand area, a 64 grid framework, which is proposed by Adler *et al.* (2011), was laid down (Fig. 2). This framework is suitable to come by the Alpha, Beta, and Gama diversities. Moreover, it is contained 64 one square meter quadrate to investigate the range condition. In each cell (1 m^2), the number of species, and number of individual species were measured to achieve the diversities indices and then they calculated by formula (Table 2) (Edjtehadi *et al.*, 2009). The range condition in each cell was also determined using Daubenmire method (1959) as is known as six factors method which is modified by Mesdaghi (2003). The rangeland trend was also determined by Trend Balance Method (Mesdaghi, 2003).

SHE analysis examines the relationships between S (species richness), H (information–the Shannon diversity index) and E (evenness as measured using the Shannon evenness index) in the samples (Magurran, 1988).

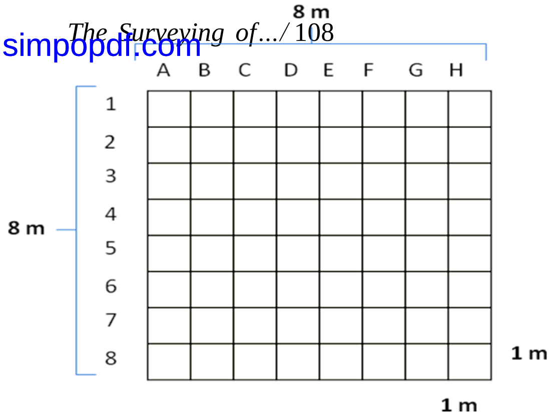


Fig. 2. Grid framework to obtain the diversity indices

Table 2. Formula of different biodiversity indices

Index	Formula	Source
Alpha diversity	$H' = -\sum_{i=1}^{s} P_i \, Ln \, P_i$ *	Shannon (1948)
Beta diversity	$\beta_w = \frac{S}{\alpha} - 1$	Whittaker (1972)
Gama diversity	$\lambda = \alpha + \beta$	Whittaker (1972)
Margalef index	$R_1 = \frac{S-1}{Ln(N)}$	Krebs (1989)

s= the number of species, β_w= the symbol of Beta diversity, α= the average species in each sample and Alpha diversity
P_i= the proportion of abundances from each species, Ln= natural logarithm, λ = the symbol of Gama diversity
N= the total species in the area, R_1= the Margalef index

Statistical analysis

Collected data was prepared in Excel 2010. Comparing of recorded data for four sites was done by ANOVA method and means comparisons were made using Duncan analysis (P<0.01). In order to calculate the biodiversity indices; PAST v.2.03 software (Hammer *et al.*, 2001) was employed. In each area, the relationships between range condition and biotic and abiotic factors was analysed by step wise regression method using Systat v.13 software (Systat Software Inc., 2013) except Polour site, which was used Enter method because the elements of site were not robustly correlated to the range condition scores.

Results

Range condition analysis

On the basis of data analysis, the best range condition refers to Ramian site with 88.87 score and the worst condition also refers to Polour site (Fig. 3). The range trend in Ramian and Javaherdeh were constant and the other sites were regressive. The range condition of the sites showed that all of them separately produced different groups so that the Ramian and Polour had the highest and the lowest range condition, respectively. The Javaherdeh site ranked second after the Ramian site, as well.

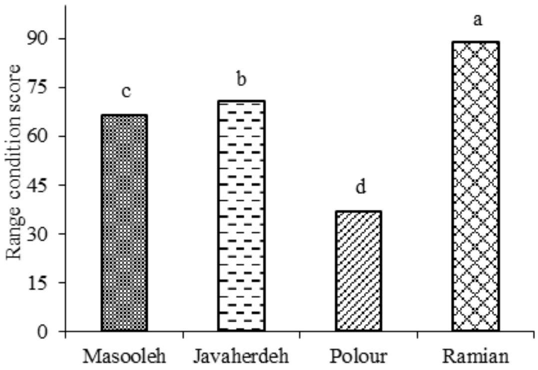


Fig. 3. Comparing of range condition in four sites

Regression analysis of variance (ANOVA) results showed that the relationships between the range condition and independent variables in each site were significant (Table 3). The stepwise regression was performed separately in four sites so that it was one step in Masooleh site, 2, 5, and 4 steps in the Javaherdeh, Polour, and Ramian sites, respectively. On the basis of the stepwise regression analysis in each site, soil conservation (38.5%) in the Masooleh, and perennial forb, annual grass, perennial grass, and annual forb (60.6%) in the Ramian site were the most attractive elements which have correlated to the range condition (Table 4). Soil conservation and basal area factors (82.3%) in the Javaherdeh site and shrub, perennial grasses and forbs, soil conservation, and annual forbs (99.2%) in the Polour site were correlated to the rangeland condition. According regression equations, all sites were reliable except Polour site where the range condition has the least position so that all factors, including shrub, perennial forbs and grasses, annual forbs, and soil conservation (litter + stone + basal area percentages) factors should stay in the equation and still the condition score is less than real position (Table 4). On the other hand, all mentioned factors could help the area to keep the poor condition and increase of them is caused to increase the range condition.

Table 3. ANOVA analysis in four sites of the study area

Site	V.R.*	S.S**	df***	MS****	F	Sig.
Masooleh	Regression	116.803	1	116.803	10.772	0.0002
	Residual	672.305	62	10.844		
	Total	789.108	63			
Javaherdeh	Regression	1219.372	2	609.686	62.943	0.000
	Residual	581.182	61	9.686		
	Total	1800.554	63			
Polour	Regression	1181.135	5	2376.227	737.506	0.000
	Residual	186.875	58	3.222		
	Total	12068.01	63			
Ramian	Regression	1588.509	4	463.127	8.462	0.000
	Residual	2768.992	59	46.932		
	Total	4357.501	63			

*Variation Reference, ** Sum of Square, *** degree of freedom, **** Mean of Square

Table 4. Step wise regression analysis between range condition as dependent variable and biotic and abiotic factors as independent variables for each site

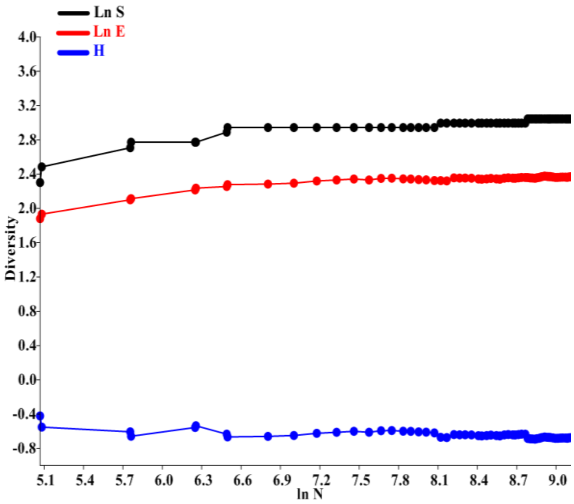
Site	R	R^2	Final Regression Equation
Masooleh	0.385	0.15	Y= 49.87 + 0.17 Soil conservation
Javaherdeh	0.823	0.68	Y= 48.05 + 0.36 Soil conservation + 2.22 Basal area
Polour	0.992	0.98	Y=-5.40 + 0.48 Shrub + 0.37Perennial grass + 0.34 Perennial forb + 0.13 Soil conservation + 0.28 Annual forb
Ramian	0.606	0.36	Y=71.21 + 0.082 Perennial forbs + 0.128Annual Grass + 0.074Perennial Grass + 0.089Annual Forbs

SHE analysis

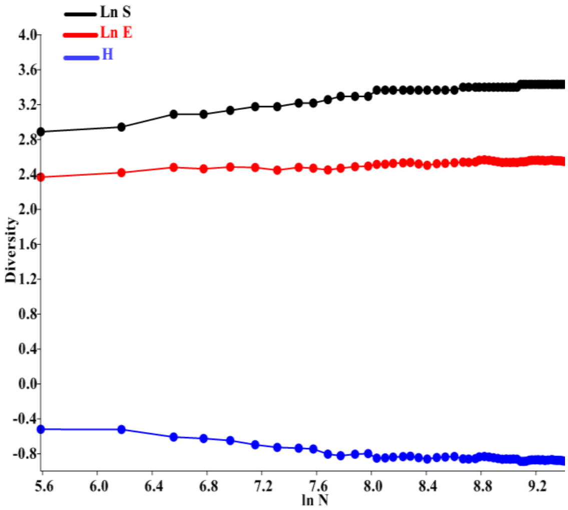
The SHE analysis of four sites showed that the diversity indices including the richness (S) and Shannon index (H) have same increasingly line gradient while the evenness index (E) line reversely has downward line gradient (Fig. 4). This figures precisely showed that with increasing of the sample number, the richness and diversity will rise to maximum rate (Table 5) and if it happen, the evenness of species will descend into less, as well. More focus on Table 6 showed that maximum richness and diversity in short distance will happen in the Ramian site and then the Javaherdeh site where already had the most richness and diversity and will arrive the highest level in 2 distance difference. On the other hand, this site had quite stable situation of range condition than the others. The worst place is for the Polour site where the less diversity and richness has yet and after long distance (3), it will reach to a semi-desirable state. On the other hand, this site to turn up to desirable position needs a blue moon period. Its pose will alternatively change along the time to reach well condition (Fig. 4) and the evenness line also proves this matter as it is the least amount (-0.9) and it showed that individual species are more in the Polour site than the others.

Table 5. Detail of the SHE analysis figures to four sites

Site	Start Point in Vertical Line			Max of Indices		Distance between Min to Max in Horizontal Line		Distance Difference
	H	Ln S	Ln E	H	Ln S	Min	Max	Max-Min
Masooleh	2.0	2.5	-0.5	2.3	3.0	4.0	6.5	2.5
Javaherdeh	2.3	2.9	-0.5	2.5	3.4	5.6	7.6	2.0
Polour	1.1	1.9	-0.9	2.2	2.7	4.0	7.0	3.0
Ramian	2.2	2.6	-0.5	2.5	3.0	4.5	6.0	1.5



Masooleh



Javaherdeh

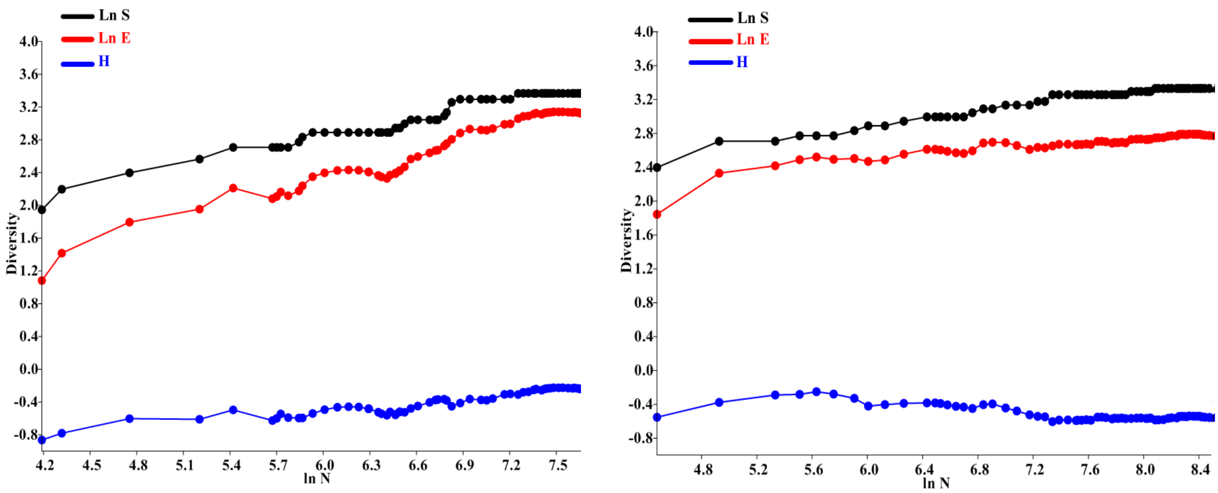


Fig. 4. The SHE analysis of four sites in the Alborz Mountains

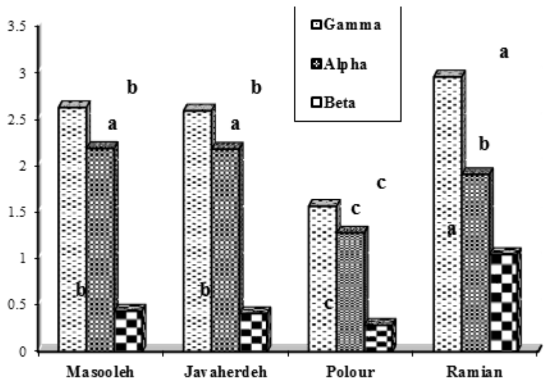
Comparison of sites

For the sake of comparing the sites, homogeneity test determines to select the comparative test model and levene statistic is the way to judge the homogeneity of variance. Based upon Table 6, all parameters have homogenous variance because of their sigs are less than 0.01 and hence, Duncan test is employed to compare the means of variations. All comparable variables in the four sites were significantly differed each other (Table 6). The data analysis of grouping by Duncan model showed that alpha diversity in the Javaherdeh and Masooleh sites were the highest level than the others (Fig. 5). Beta diversity index were also the great level in the Ramian site and the least one was for Polour site. The Ramian site had the superior level of Gama diversity index and the Polour site was the least one as well. For the soil conservation, the Ramian site had the exalted rate and the Masooleh site was the least one from this point. The Ramian and Javaherdeh sites had respectively the most litter than the other sites so that the Masooleh site has the least amount of litter.

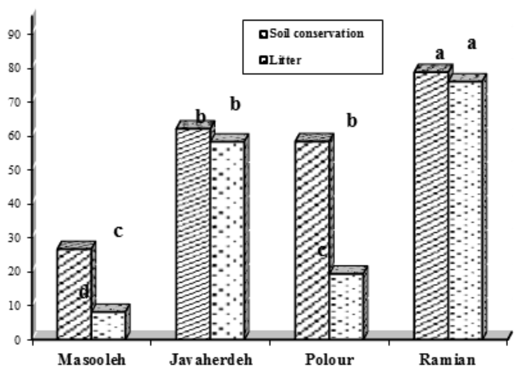
Table 6. One way ANOVA results in comparison of four sites data

SOV	DF	MS				
		Alpha Diversity	Beta Diversity	Gama Diversity	Soil Conservation	Litter Amount
Within Groups	3	11.66**	7.418**	23.207**	30201.6**	65218.9**
Between Groups	252	0.108	0.209	0.153	171.2	91.36
Levene Statistic		15.79**	28.75**	12.06**	12.93**	22.51**

** = significant at 1% probability level



a) Biodiversity indices



b) Rangeland condition factors

Fig. 5. Grouping of different parameters in the four sites on the basis of Duncan model; a) Biodiversity indices, and b) Rangeland condition factors
The means of parameters within each sits followed by the same letters were not significantly different as per Duncan's multi-range test at P<0.05

Discussion and Conclusion

As former is mentioned, the direct and indirect anthropogenic activities on rangeland ecosystems are caused to disturb the ecological equilibrium of ranges (Nabte *et al.*, 2013). In the area, the Polour site had the worst range condition in which it has the less score of rangeland condition, minimum number of species and maximum evenness. Despite, this site had same weather and climate condition to other sites, overgrazing of livestock was the cause of disarray and disturbance, which same result is reported be other researchers such as Alkemade *et al.* (2013), and consequently it has made unique the species presences on the area. Reversely, the range condition, beta and gamma diversity indices were the best poses in the Ramian site in spite of that has less precipitation in the area. The condition range of this site gets back to enough springs which imbrue the land surface and all species can permanently use it spring and summer periods. Hence, it has the highest rate of condition and diversity indices than the other sites. Even correlation of biological factors, e.g. grasses and forbs, to the range condition was the minimum situation and increasing of them will enhance the range condition and accordingly biodiversity indices that reversely bear out the other researcher's achievement (Davies *et al.*, 2014). In fact, this area brings out desirable position of ecosystem.

In the Masooleh site, the least litter, soil conservation, and the range condition have been seen after the Polour site. The soil texture of this area geologically refers to Shemshak formation which has sensitive elements such as marn and sand (Jouri *et al.*, 2013). The area has also overgrazing and overstocking conditions which have straitened the vegetation covers and plant species. Hence, this area has less biodiversity elements after the Polour site. In addition, many landslides have been taken place because the lack of endemic perennial plants and shrubs which is necessary to keep the range condition (Addison *et al.*, 2013). The Javaherdeh site was semi-desirable range condition which possesses the less livestock capacity than the others. Because of touristy situation of the Javaherdeh site, the most grazing area is going to give off by ranchers and new generation of ranchers tend to spend their time to other jobs, as well. Then light and moderate grazing of the area are caused to increase the rate of biodiversity indices, as SHE analysis has showed it too, and the range condition. Regarding this, many researchers directly or indirectly report same results such as Danckwerts & Tainton (1996); Ricciardi *et al.* (2013).

The range condition and biodiversity indices, therefore, influence by biotic, e.g. livestock grazing, and abiotic, e.g. rain and springs' wet, factors which vouch for ecosystem services and rangeland ecosystems' biodiversity (Mulk Khan *et al.*, 2014). To reaching the sustainable management in the study area, reducing of livestock capacity in the Polour and Masooleh sites are recommended and training of ranchers can help to balance the ecological capability of rangeland ecosystems, as well.

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بررسی وضعیت مرتع و تنوع زیستی در چهار منطقه از مراتع البرز شمالی

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چکیده. ارزیابی وضعیت مرتع و تنوع گیاهی به مدیران مرتع کمک می‌کند که در شیوه‌های مدیریتی براساس توانمندی‌های اکولوژیک اکوسیستم‌های مرتعی تصمیم‌گیری نمایند. بدین منظور، بررسی مراتع در چهار منطقه از البرز شمالی واقع در البرز غربی (ماسوله)، غرب به میانه البرز (جواهرده)، البرز میانی (پلور) و شرقی (رامیان) صورت گرفت. در هر مرتع یک شبکه ۶۴ خانه‌ای (یک متر مربعی) در توده معرف به عنوان واحد اندازه‌گیری در نظر گرفته شد و وضعیت مراتع طبق روش دابن مایر محاسبه شد. تنوع آلفا، بتا، گاما و غنای گونه‌ای برای هر شبکه در هر منطقه بوسیله نرم افزار PASTv.2.17c محاسبه شد. درجات وضعیت مرتع با عوامل زنده و غیرزنده به کمک مدل رگرسیونی استاندارد و معادلات آن در محیط نرم‌افزاری Systat v.13 ارزیابی شد. نتایج نشان داد که منطقه رامیان دارای بیشترین مقدار تنوع گاما و مناطق

جواهرده و ماسوله نیز دارای بیشترین مقدار تنوع آلفا هستند. به علت وضعیت بسیار نامطلوب مراتع پلور، انواع تنوع در این منطقه نسبت به مناطق دیگر پایین بوده است، در عوض یکنواختی گونه‌های آن در بیشترین حد بوده است. همچنین درجات وضعیت مرتع در منطقه رامیان در بالاترین حد و فاکتورهای حفاظت خاک و لاشبرگ نیز در آن نسبت به سایر مناطق در بیشترین مقدار قرار داشته است. بنابراین با توجه به نتایج، مرتعداران با رعایت ظرفیت و شدت چرا در مراتع به خوبی می‌توانند در تعادل اکولوژیک این مناطق همت گمارند.

کلمات کلیدی: وضعیت مرتع، تنوع زیستی، ماسوله، جواهرده، پلور، رامیان، البرز شمالی