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A Study on Various Grazing Intensities on Plant Species Richness and Diversity Indices: Case study on Taftan Rangelands in Sistan & Baluchestan, Iran

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ABSTRACT

Since comprehensive conservation of rangeland ecosystems required management based on protection and maintenance of species diversity, it would not happen unless by studying and measuring species diversity. Therefore, knowledge about destructive environmental pressures on the ecosystem that was resulted in destruction of habitats and biomes and consequently reduced species diversity is necessary. One of destructive physical pressures on rangeland that leaded to decreased diversity and destruction of vegetation elements was livestock overgrazing. This research was conducted aimed at investigating the effect of various grazing intensities on vegetation diversity in Taftan rangelands. For this purpose, three sample sites including heavy grazing, light grazing and 8 years ungrazed areas were selected. In each site, by using statistical method, sample size was determined and 7 transects were established in the entire 42 plots (8m2) by using systematic-random method established. Then for any frame, list of the species and number of each species were recorded. Then richness indices of Margalef &Menhinick, Shannon-Wiener, and Hill 1 &Hill 2 were calculated and the statistical comparison was done by SPSS 19 software. Unilateral variance analysis indicated significant differences of species richness and diversity at %1 level for various grazing intensities. Also Tukey test showed that difference of species richness between ungrazed area and light grazing area at 1%, between ungrazed area and heavy grazing area at 5%, and also between light grazing and heavy grazing areas at 1% were significant. Hill 2 index indicated significant difference between the heavy grazing and ungrazed areas and also between light and ungrazed areas at 1%. The highest species richness and diversity have been obtained under light grazing condition.
KEYWORDS: Rangeland, Ungrazed area, heavy grazing, Overgrazing, Light grazing.

I.INTRODUCTION

Natural renewable resources have considerable roles in providing needs of human life (Azarnivand and Zare Chahuky, 2008). Rangelands are part of renewable resources and the most natural valuable capitals. They also play valuable role in conservation of soil, providing forage, byproducts, pharmaceutical and industrial products. Rangelands are grounds of life and sustainable development. Population growth, resources limitation, and additional pressure on these resources have leaded to destruction and extinction of plant species so that biodiversity has been endangered (Ejtihadi et al. 2009). Today, in Iranian rangeland ecosystems, particularly in semi-steppe zones, most of the important species are going extinct or have gone extinct without being registered anywhere due to incorrect use (overgrazing and heavy grazing and land conversion) and genetic erosion. Removal of key and important species from the natural areas will cause increased bioenvironmental crisis and difficulty for posterity (Sharify and Shahmoradi, 2009). According to experts and scholars in the field of natural resources, ecosystems in arid, and semi-arid regions, and especially in hyper-arid regions in south are too sensitive and fragile, and any unconscious manipulation regardless of this fact could damage those ecosystems, particularly vegetation and soil irreparably (Paryab et al. 2004).

Achieving sustainability in natural ecosystem is considered one of the objectives of scientific management, and it depends on conservation of species diversity. Iranian natural ecosystems are one of the important origins for speciation all over the world and conservation of this diversity is considerably important (Ejtehadi et al. 2009).

One of the effective factors on parameters such as richness and diversity is utilization of vegetation as animal rangeland which will cause irreversible effects on the vegetation and ultimately on the soil and pasture ecosystem if it exceeds conventional and tolerable level of ecosystem (Azarnivand and Zare Chhuky, 2008). Livestock and/or wild animals' grazing is one of the effective factors on the quantitative and qualitative changes in vegetation (Smit & Schmutz, 1975). And overgrazing, inappropriate distribution of grazing, and the undesirable transmittal of livestock are problems face range managers and those involved in it. Any change in vegetation due to the grazing beyond capacity appears as a change in the plants composition (Mesdaqi, 2000). Changes in composition due to the grazing could cause reduction in species richness and diversity (Jahantab et

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al. 2009). Gillen et al. 1998 studied the effect of various intensities of grazing on species richness and diversity of herbaceous plants and they found why efforts were made towards development or reduction of richness and diversity indices. In a study on numerical indicators of species diversity in two habitats with different grazing managements, Ejtehadi et al. 2002 concluded that the ungrazed rangeland with 93 species not only had higher species richness but also it had more conformity and high species diversity indices compared to the grazed rangeland with 70 species, therefore, ecological sustainability of the ungrazed rangeland was higher. Pyke et al. (2002) studied plant species diversity and health of rangeland. Hendricks et al. (2005) investigated species richness and diversity along different grazing gradients in South African rangelands and they concluded that species richness and diversity had the least values at regions near night location of animals with high grazing pressure. In a study on the effects of grazing on composition and diversity of species in semi-arid rangelands of Tanzania, Milgo (2006) stated that there were significant differences among diversities of species in regions with high grazing intensities so that the highest species diversity occurred in the lowest grazing pressure. Considering the effect of grazing intensity, Zamora et al. (2007) found that the plant diversity had a direct relationship with the grazing intensity. Also, Salami et al. (2007) studied and compared plant species diversity in the grazed and the ungrazed areas in rangelands of Noshahr, and they concluded that all numerical indices for species diversity in the ungrazed areas were more than that in the grazed areas. Comparing indices of diversity and species richness in rangelands of Safaroud in Ramsar, Jouri et al. (2008) demonstrated that diversity in rangeland ecosystems in the average status and light grazing increased and the highest diversity and species richness occurredin regions with the long-term ungrazing. According to Stodart et al. (1975), grazing regions could be used as reference regions in the study on the effect of different grazing intensities.

Taftan is located at southeast Iran and in proximity of arid belt of desert regions as a relatively tall mountain (height of 4042m). The average precipitation in Sistan & Baluchestan is about 100mm and it is 160mm in Khash. The height gradient of Taftan and its presence in the pathway of wet streams have made not only the quantity and continuity of atmospheric precipitation become higher and to be originated from rising masses, but also, it made precipitation to change from rain to snow due to the relative cold weather so that we could see snowing at least once a year (Rigi, 2005). According to this climate, a habitat relatively different from the other surrounding regions has been created at Taftan skirts that has been differentiated from species such as Pistacia atlamtica, Amigdalus lyciodes, Artemisia lehmania, Amygdalus orientalis, Rheum ribes, and so on (Table 1) (Aplan on management of Forest Resource in West Taftan, 2001). The presence of these resources has resulted in the population units to be created that rely on livestock farming, and rangelands of the region are known as sources of forage. Expansion of settlements and livestock in the region along with droughts and topographical conditions have put rangelands under pressure in terms of heavy grazing and non-uniform distribution of grazing within the rangelands (Rigi et al. 2012).

This research aimed at studying the effect of different intensities of grazing and utilization of rangelands in these regions on the richness and diversity indices and as a result of their influence on sustainability of the rangeland ecosystem, so it studied the ungrazed, light grazing, and heavy grazing sites and it was attempted that a scientific useful strategy in management of the rangeland of the region is presented by comparing them accurately.

Table 1. The existing plants in the study area:

Scientific names of plants (gender & species)	Family	Scientific names of plants (gender & species)	Family	Scientific names of plants (gender & species)	Family
Acanthophyllum sordidum	Caryophyllaceae	Carex physodes	Cyperaceae	Melica persica	Gramineae
Acanthophyllum spinosum	Caryophyllacae	Ceratophylus falcatus	Rannunculaceae	Nepeta bracteata	Labiatae
Allium staminium	Liliaceae	Cicer spiroceras	Papilionaceae	Nepeta saccarata	Labiatae
Alyssum marginatum	Cruciferae	Circium . sp	Compositae	Nepeta ispahanica	Labiatae
Amberboa turanica	Compositae	Cousinia gedrosica	Compositae	Paracayum rugulosum	Boraginaceae
Amygdalus lyciodes	Rosaceae	Cousinia stocksii	Compositae	Peroveskia abrotanoides	Labiatae
Amygdalus scoparia	Rosaceae	Descurainia Sophia	Cruciferae	Peroveskia artemisoides	Labiatae
Amygdalus wendelboii	Rosaceae	Ephedra intermedia	Ephedraceae	Peroveskia atriplicifolia	Labiatae
Anthemis rhodocentra	Compositae	Eragrostis banclieri	Gramineae	Pistacia atlantica	Anacardiaceae
Artemisia lehmania	Compositae	Erodium cicutarium	Geraniaceae	Pistacia khinjuk	Anacardiaceae
Astragalus mucronifolius	Papilionaceae	Eurotia ceratoides	Chenopodiaceae	Rheum ribes	Polygonaceae
Astragalus squarosus	Leguminosae	Ferula ovina	Umberlliferae	Rosa begerriana	Rosaceae
Astragalus triboloides	Papilionaceae	Ficus carica	Moraceae	Saccharum bengalensis	Gramineae
Berberis integerrima	Berberidaceae	Heterocaryum szowitsianum	Boraginaceae	Scariola orientalis	Compositae
Bromus gracilinmus	Gramineae	Hypecum pendulum	Papaveraceae	Setaria verticilatus	Gramineae
Bromus tectorum	Gramineae	Isatis minima	Cruciferae	Stipa hohenkeriana	Gramineae
Buchingera axillaris	Cruciferae	Kilirion tataricum	Amarylidaceae	Tribohus terrestris	Zygophyllaceae
Bunium persicum	Umbelliferae	Koelpinia temussima	Compositae	Tulipa biflora	Liliaceae
Cakile arabiea	Cruciferae	Matthiola chenopodifolia	Cruciferae	Ziziphora clinopodioides	Labiatae
Cardaria draba	Cruciferae	Mentha longripetala	Labiatae		

2. MATERIALS AND METHODS

2.1. The area under study

The study rangelands are located in proximity of Khash and Taftan heights with an area of 23,000 hectares. The average height of the region is 2,300m, and it has been morphologically located at mountain unit. The average annual precipitation ranges from 160 to 295mm depending on height conditions, and snowing at winter as well as occurrence of freezing are common (Rigi & Narui, 2007). According to climate conditions, particularly temperature and precipitation, the conventional grazing season of the region has been between 21 Mar to 23 Sep when the presence of livestock in the region has resulted in the continuous grazing in some regions and especially in livestock passages. According to the existing documents and audit evidences and coordination of afore-mentioned rangelands, grazing season in rangelands of the region extends for 6 months from Apr 9 to Oct 12. Exploitation system for rangelands of the region is shared and the range management projects have been designed based on this system (Range Management Plan of Naroon, 1994).

In order to study the effects of different intensities of grazing, sampling area was selected in the middle altitudinal range of the region and at the average height of 2470m, and annual precipitation of 210mm. Sites were selected after making sure that the average height, slope, domain direction, soil, water resources are the same for all sites. The study sites have shrub vegetation and its dominant type is often Artemisia lehmania. The first site has been grazed heavily due to proximity of population centers and passages of livestock. The second site has been grazed lightly in terms of capacity and observation of the operation allowed, and ungrazed site (the third one) has been ungrazed for 8 years in an experimental plan.

2.2. Method of sampling and data analysis

In order to study the effects of different intensities of grazing, three sites have been considered in the region: heavy grazed, light grazed, and 8 years ungrazed sites. For the purpose of eliminating the effect of the other environmental factors, sites were selected in the homogeneous areas in terms of work unit, soil, the average slope, direction of slope, and the altitudinal class(Figure 1). Plot size and number were determined based on the habitat by using the minimum level and statistically by using Kochler relationship, respectively (Mesdaqi, 2010). Establishing 7 transects (600m) in each site, and 2 plots ($8m^2$) on any transect randomly, totally 14 plots in every site, and 42 plots in 3 sites were studied. Once plots established, list of the existing species in any plot was prepared, and number of the individuals belonging to any species was registered (Mogaddam, 2000). Margalef and Menhinick indices were used to determine species richness, and Shannon-Weiner, Hill 1, Hill 2 indices were used to study diversity. Once the quantitative size for each index was determined, the effect of grazing intensities was investigated by using unilateral variance analysis in the environment of software SPSS19, and different grazing intensities were compared by using Tucky test.

3. RESULTS

Review of species richness indicated that Margalef indices for the heavy grazed, light grazed and ungrazed sites were 1.09, 1.64, and 0.76 respectively, and Menhinick indices were 0.92, 1.147, and 0.65, respectively, and the highest species richness was found under light grazing condition (Table 2).

Table 2. Calculated values for richness indices:

Type of management	Magalef	Minhinick
Heavy grazing	1.09	0.92
Light grazing	1.64	1.147
Ungrazed	0.76	0.65

3.1 The effect of different grazing intensities on richness indices

Unilateral variance data analysis for dual indices of richness suggested that both indices were affected by different grazing intensities, and it was quite evident that response to the grazing ratewas significant ($P<0.01$).

Statistical comparison of richness indices by Tucky test demonstrated that there was a significant difference in various intensities so that the difference of Margalef index of richness between the light grazed and the ungrazed areas and also between the light grazed and the heavy grazed areas at 1% level was significant ($P<0.05$), and this index indicated a significant difference at 5% level between the heavy grazed and the ungrazed areas ($P<0.05$) (Table 5).

Table 3. Results of Tucky test for Margalef index:

Type of management(i)	Type of management (j)	Difference of averages	Standard error	Sig
Heavy grazing	Light grazing	- 0.55643	0.131	0.00**
	Ungrazed	0.33143	0.131	0.42*
Light grazing	Heavy grazing	0.55643	0.131	0.00**
	Ungrazed	0.88768	0.131	0.00**
Ungrazed	Heavy grazing	-0.33143	0.131	0.042*
	Light grazing	-0.88786	0.131	0.00**

ns: lack of significant difference *significant difference of 0.05 **significant difference of 0.01

Menhinick richness index showed a significant difference of 1% between the heavy grazing and the ungrazed areas, and also between the light grazing and the ungrazed areas ($P<0.01$). This difference between light and heavy grazing areas is also significant at 5% ($P<0.05$) (Table 4).

Table 4. Results of Tucky test for Minhinick richness index

Type of management(i)	Type of management (j)	Difference of averages	Standard error	Sig
Heavy grazing	Light grazing	- 2.2357	0.083	0.28ns
	Ungrazed	0.26249	0.083	0.008**
Light grazing	Heavy grazing	2.2357	0.083	0.28ns
	Ungrazed	0.48786	0.083	0.00**
Ungrazed	Heavy grazing	-2.2357	0.083	0.008**
	Light grazing	-0.48786	0.083	0.00**

ns: lack of significant difference *significant difference of 0.05 **significant difference of 0.01

The study of plant species indices also indicated that Shannon-Weiner indices for the heavy grazing, light grazing, and the ungrazed sites, were 1.009, 1.399, and 0.65, respectively; Hill N_1indices for the sites were 2.86, 4.08, and 1.97, respectively; and Hill N_2 indices for those three sites were 2.5, 2.995, and 1.613, respectively; and light grazing site had the highest diversity (Table 5).

Table 5. The calculated values for diversity indices

Type of management	Shannon-Weiner	Hill 1	Hill 2
Heavy grazing	1.009	2.86	2.5
Light grazing	1.399	4.08	2.995
Ungrazed	0.65	1.97	1.613

3.2 The effect of different grazing intensities on diversity indices

Unilateral variance data analysis of diversity indices suggested that the response of the applied indices to the grazing condition at 1% had been significant ($P<0.01$). Statistical comparison of Shannon-Weiner diversity indices by using Tucky test indicates a significant difference at 1% between the light and heavy grazing areas, between the ungrazed and light grazing areas, and between the ungrazed and heavy grazing areas ($P<0.01$) (Table 6).

Table 6. Results of Tucky test for Shannon-Weiner index

Type of management(i)	Type of management (j)	Difference of averages	Standard error	Sig
Heavy grazing	Light grazing	- 0.390	0.087	0.00**
	Ungrazed	0.351	0.087	0.001**
Light grazing	Heavy grazing	0.390	0.087	0.00**
	Ungrazed	0.741	0.0871	0.00**
Ungrazed	Heavy grazing	-0.351	0.087	0.001**
	Light grazing	-0.741	0.087	0.00**

ns: lack of significant difference *significant difference of 0.05 **significant difference of 0.01

Hill 1 diversity index was also analyzed statistically. The results suggested that significant difference of this index at 1% was confirmed between all treatments ($P<0.01$) (Table 7).

Table 7. Results of Tucky test for Hill 1 indices

Type of management(i)	Type of management (j)	Difference of averages	Standard error	Sig
Heavy grazing	Light grazing	- 1.220	0.231	0.00ns
	Ungrazed	0.882	0.231	0.001**
Light grazing	Heavy grazing	1.220	0.231	0.00**
	Ungrazed	2.102	0.231	0.00**
Ungrazed	Heavy grazing	-0.882	0.231	0.001**
	Light grazing	-2.102	0.231	0.00**

ns: lack of significant difference *significant difference of 0.05 **significant difference of 0.01

Comparison of Hill 2 diversities between different grazing intensities showed a significant diversity difference between the heavy grazing and the ungrazed areas and also between the light grazing and the ungrazed areas at 1%(P<0.01) (Table 8).

Table 8. Results of Tucky test for Hill 2 index

Type of management(i)	Type of management (j)	Difference of averages	Standard error	Sig
Heavy grazing	Light grazing	- 0.495	0.214	0.067^{ns}
	Ungrazed	0.886	0.214	0.001^{**}
Light grazing	Heavy grazing	0.495	0.214	0.67^{ns}
	Ungrazed	1.381	0.214	0.00^{**}
Ungrazed	Heavy grazing	-0.886	0.214	0.001^{**}
	Light grazing	-1.381	0.214	0.00^{**}

ns: lack of significant difference *significant difference of 0.05**significant difference of 0.01

DISCUSSION AND RESULTS

Livestock grazing has different effects on yield of the rangeland ecosystem depending on intensity. McCann (2000) states that with increasing the ungrazed period, quantity of the species or key species group that are responsible for creating a difference in the ungrazed area increases and thereby sustainability of ecosystem will increase. Elimination or addition of the species could make major changes in the structure and dynamics of the society and if conservation of the ecosystem and the species elements is the objective, the specific conservation of the individual species is the best way.

The results of this study indicated that richness and diversity of the rangeland ecosystem had significant differences with each other under different grazing intensities. Difference in rangeland yields under the grazing and the ungrazed conditions has been confirmed in some studies (Basin et al. 2003). Also, Mesdaqi (2000) recognized this effect. The study of Margalef and Minhinick indices in the heavy and light grazing and the ungrazed sites suggested that the highest species richness was seen under the light grazing conditions. The results of using species diversity are the same as the results obtained from other researchers' works such as Ejtihadi et al. (2002) and Salami et al. (2007) and also are consistent with the results obtained by Mligo (2006) and Hendricks et al. (2005) that indicate the highest species diversity occurs under relatively light grazing pressure. The study of the plant species indices demonstrated that the numerical values of Shannon-Weiner, Hill N_1 and Hill N_2 have the highest rates in the light grazing site and also the highest diversity occurs under the light grazing condition. Investigating the relationship between grazing levels and the plant diversity, West (1993) found that the middle to light grazing increased diversity and heavy grazing as well as ungrazing may cause domination of the specific species and reduction in diversity. Under grazing condition, nutrients return to the soil by distribution of humus, however, reduced plant vigor and nutrient storage to grow within the next season reduces production.

In the present study, it was specified that if the grazing was light, domination of one or few species did not appear when harvesting, and richness and diversity were dominant in the ecosystem and with increasing grazing and double pressure on palatable species, the species that are sensitive to grazing replaced relatively more resistant species, and diversity of vegetation will be reduced. The presence of the highest richness and diversity under light grazing condition might be attributed to the modulation of competing species by the livestock grazing that has made the more competitive plants unable to limit growth of the low competitive plants or unable to eliminate them completely. Low indices of richness and diversity under the heavy grazing suggests that large harvest of biomass of palatable plants has allowed their stamina, persistence and regeneration deplete and as a resultthey have been eliminated whereas the unpalatable or low palatable plants with relatively low grazing could have turnedthe herbal composition to its own advantage and made a relative uniformity that is consistent with the findings of Ejtehadi et al. (2009).

If the rangeland is not grazed, most of the low competitive plants will be beaten by more adjustable species, will lose their places in the composition and finally the presence of favorable condition makes high competitive species be at lower levels under some conditions including relative limitation of the food sources, more uniform area and as a result species diversity and richness as compared to the light grazing condition Findings of Tahmasebi et al. (2011) showed the same results. Virginie et al. (2003) also concluded that the highest diversity was achieved under the light grazing condition. According to the findings of this research, it could be said that if conservation of diversity and dynamics of the ecosystem is the objective, management should be targeted based on the middle and the light grazing and if the soil conservation plan and/or the forage production are to be considered, ungrazing offers the best response.

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