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Impact of enclosure on some of vital ecosystem attributes in El-Bayadh region, North-West Algerien steppe

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Abstract

Protection of degraded rangelands is widely considered to be the most effective and practical way to conserve plant diversity and maintain ecosystem composition and structure, for this purpose we carried out this study in the region of El-Bayadh, located in North–West Algerien steppe, aiming at assessing the effect of the enclosure technique on plant cover structure and productivity, in both enclosure (protected) and grazed rangelands. Several vital ecosystem attributes such as diversity, richness, total plant cover, perennial plant cover, annual plant cover, soil surface elements cover and pastoral value were compared between enclosure and grazed areas. The findings revealed considerable positive effects of protection on the scored parameters. However, the results emphasized a negative effect of enclosure on vegetation dynamics. This was observed by the occurrence of crusts on the soil surface which may constitute an obstacle to water infiltration and seeds germination, for this we suggest that this parameter be retained for the opening of these aminaged rangelands (enclosure) for grazing.

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Introduction

Algerian steppe is considered ecologically a buffer zone between coastal and Saharian Algeria (Nedjraoui and Bedrani, 2008). It is limited to the north by the Tellian Atlas and to the south by the Saharian Atlas, and extends over a length of about 1,000 km from the Est border to the West border. It covers an area of 20 million hectares (Slimani *et al.*, 2010).

According to the biogeography, these steppe rangelands belong to the Mediterranean basin, one of the 25 biodiversity hotspots of the globe (Myers *et al.*, 2000) This wide area makes the Algerian steppe an ecosystem characterized by a diversity of landscapes submitted to a great variability of ecological factors (Bencherif, 2011).

Several studies (Le Houerou, 1969; Djebaili, 1978; Aiduod *et al.*, 1983; Aidoud and Touffet, 1996; Slimani *et al.*, 2010) confirm that in the Algerian steppe, the reduction in floristic diversity is not only occurring as a result of climatic factors (dryness and heightened aridity), but it is also strongly impacted by anthropic factors (primarily fires and grazing), which are prompted by irrational land exploitation such as overgrazing and land clearing. Land degradation is one of the most important problems affecting a wide range of ecosystems worldwide. The intensive exploitation of rangelands, under high stocking rates, is a driver of land degradation [Le Floc'h and Bocconea, 2001) and loss of biodiversity (Jacobo *et al.*, 2006). The ecology of restoration and rehabilitation is part of the possible actions more to limit the extansion of the degradation of this ecosystem and erase or mitigate the consequences. but, it is necessary to know the performance of the steppe ecosystem (Le Floc'h, 2001).The aim of restoration is the natural resources sustainable management in areas heavily damaged by desertification in order to safeguard the land courses.

To remedy this situation, the Algerian State and by the creation of the "HCDS" (High Commission for the Development of the Steppe) has undertaken since November 1994 various measures of restoration or rehabilitation which are part of a national strategy of pastoral improvement of the degraded steppe and the fight against silting to combat desertification (Amghar *et al.*, 2012; Salemkour *et al.*, 2016).

Among techniques implemented, revegetation to stabilize the sediment, planting of forage species and grazing exclosure have been extensively used in the Maghreb and Middle East (Amiraslani and Dragovich, 2011). The grazing enclosure is a known technique which has been practiced for centuries by our ancestors like that of "Agdal" in North Africa, the system of "Hema" in the Middle East and Arabia or the system of "ngitili" in Tanzania (Selemani *et al.*, 2013), this technique is almost always an effective instrument for the regeneration of the steppe vegetation (Le Houérou, 1985). It has been widely applied in arid Australia, United States, dry tropical Africa and North Africa. In situations where degradation has not overcome the threshold of irreversi-bility (Holling, 1973; Wissel, 1984), spontaneous recovery of vegetation can be initiated by a prolonged period of grazing enclosure (Le Houérou, 1985).

In this context, the purpose of this study that's conducted in El-Bayadh (North West Algerian steppe) is to evaluate the impact of enclosure as a technique for the restoration of degraded rangelands on plant community structure. Some of vital ecosystem attributes such as diversity, richness, total plant cover, perennial plant cover, annual plant cover, soil surface elements cover and pastoral value between enclosure (protected) and grazed areas were compared.

Materials and Methods

Study Area

The study was conducted in 04 sites of El-Byadh department, two sites in the town of Stitten located within and adjacent to enclosure area and two other sites in the town of Rogassa located within and adjacent to enclosure area (Fig 01).

These stations are situated within the steppe area of North Africa (Quézel, 1978). The main soils in the study area are colonized by vegetation dominated by

Stipa tenacissima, Lygeum spartium, Artemisia herba alba (Pouget, 1980; Le Houérou, 1992; Amghar, 2002). Stitten and Rogassa sites have an average altitude of 1372 m and 1054 m respectively. They are characterized by a Semi-arid bioclimate. The average annual rainfall is 232mm and 260mm for Stitten and Rogassa respectively.

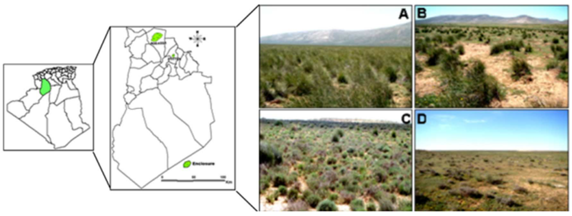

Fig. 1. Location and general view of the studies areas: (A) Stitten enclosure area; (B) Stitten grazed area; (C) Rogassa enclosure area, (D) Rogassa grazed area.

Sampling method

Data collection was made during the 2014/2015 growing season, at four sites located within and adjacent to enclosures area (Stitten enclosure and Rogassa enclosure). To study the effect of vegetation protection (enclosure), some vital ecosystem attributes were measured: Diversity, richness, total plant cover, perennial plant cover, annual plant cover, soil surface elements cover and pastoral value index.

The quadrat point method (Daget and Poissonet, 1971; Floret, 1988) was used within and adjacent to enclosures area. A total of 20 tapes of 20 m length each were randomly established (10 within and 10 adjacent to Stitten enclosure and 10 within and 10 adjacent to Rogassa enclosure).

A fine pin was descended to the ground every 10cm along the tape. Each of the 200 hits per tape was recorded according to the plant species touched and, in the absence of plants, the other elements of the soil surface such as: litter, stones (size > 2mm), bare silty crust and wind veil are noted.

The total plant cover, in each tape, was calculated as: TPC = (n/N)*100 with n: the number of hits of all plant species and N: the total number of hits (200 hits in our case).

Percentage cover data was used to calculate the Shannon-Weaver diversity index (H') and Pielou eveness index (E) (Piélou, 1966), calculated by the usual formulas:

$H' = -\sum Pi \ln Pi$ Where, H' is diversity index and *Pi* is relative importance value of species *i*.

$E = H' / H_{max}$ Where, H_{max} is the maximum possible value of H', and is equivalent to ($\log_2 S$)

The quality of the forage supply is expressed by the Pastoral Value Index (*PVI*) on the basis of the Is_i quality index assigned to each species according to its palatability. Is is a "score" ranging from 1 (unconsumed plant) to 10.

The assignment of the indices was established on a bibliographical basis (Le Houérou and Ionesco, 1973), supplemented by surveys of breeders (Aidoud, 1989). For each statement, a *PVI* value is calculated on the basis of the following equation:

$PVI = 0{,}1 * \Sigma\, Csi * Is_i$.

This formula, having been established (Daget and Poisoned, 1972) for meadows with a cover often close to 100%, the bias due to the bare soil is negligible. For steppe vegetation whose cover rarely exceeds 50%, the formula has been adapted by introducing a weighting (Aidoud *et al.*, 1983) as follows:

$PVI = 0.1 * TPC\, \Sigma\, Csi * Is_i$

The detailed eco-characterization of plant taxa and plant nomenclature was based on the flora of Quezel and Santa (1963) and flora of Ozenda (1977).

Data analysis

All data were subjected to analysis of variance (ANOVA) using SPSS v 17 (SPSS Inc., 2009). Stations (within and adjacent to enclosure areas) were the independent variables, whereas diversity, total plant cover, perennial plant cover, annual plant cover, soil surface elements cover and pastoral value index were the dependent variables.

Results and discussion

Floristic richness, diversity (H' and E) indexes and pastoral value index (PVI%)

A total of 108 species were recorded from the study sites. Most of the species belong to the Asteraceae family with 26 species, followed by Poaceae with 18 species, Fabaceae with 13 species, Brassicaceae with 9 species and 5 species for Lamiaceae, Boraginaceae, Caryophyllaceae families, the other families such as Chenopodiaceae, Apiaceae, Cistaceae, Geraniaceae, Plantaginaceae, Ranunculaceae, Resedaceae are represented by 1 to 4 species (Table 1).

Table 1. Family, life cycle and acceptability index of main species recented in the different study areas.

				Rogassa		Stitten	
Species	Family	Life cycle	Accept. Index	Enclo. area	Graz. area	Enclo. area	Graz. area
Aizoon hispanicum	Aizoaceae	A	2	*		*	*
Adonis dentata	Ranunculaceae	A	2	*			
Alyssum linifolium	Brassicaceae	A	6	*			
Alyssum granatense	Brassicaceae	A	6			*	
Alyssum macrocalyx	Brassicaceae	P	6			*	
Ammochloa pungens	Poaceae	A	8			*	*
Ammodaucus leucotrichus	Apiaceae	A	3	*			
Anacyclus cyrtolepidioides	Asteraceae	A	8	*	*	*	
Anacyclus clavatus	Asteraceae	A	6			*	
Androsace maxima	Primulaceae	A	2			*	
Anthemis stiparum	Asteraceae	A	4			*	*
Arnebia decumbens	Boraginaceae	A	6	*	*		
Artemisia campestris	Asteraceae	P	4	*	*		
Artemisia herba alba	Asteraceae	P	7	*	*	*	
Argyrolobium uniflorum	Fabaceae	P	9	*		*	
Astragalus armatus	Fabaceae	P	3	*	*		
Asteriscus pygmaeus	Asteraceae	A	3	*		*	*
Astragalus cruciatus	Fabaceae	A	7	*		*	
Astragalus sinaicus	Fabaceae	A	7	*	*		
Astragalus tenuifolius	Fabaceae	P	8	*		*	
Atractylis cancellata	Asteraceae	A	4	*		*	
Atractylis humilis	Asteraceae	P	2	*	*		
Atractylis prolifera	Asteraceae	A	3	*	*	*	*
Atractylis serratuloides	Asteraceae	P	4	*	*	*	*
Avena bromoides	Poaceae	A	7			*	
Bromus rubens	Poaceae	A	5	*		*	
Bupleurum semicompositum	Apiaceae	A	3	*		*	
Calendula aegyptiaca	Asteraceae	A	6	*	*		
Carduncellus pinnatus	Asteraceae	P	2			*	*
Centaurea incana	Asteraceae	P	6			*	
Ceratocephalus falcatus	Ranunculaceae	A	8			*	
Coris monspeliensis	Primulaceae	A	3			*	*
Coronilla scorpioides	Fabaceae	A	6			*	*
Ctenopsis pectinella	Poaceae	A	6	*		*	
Cutandia dichotoma	Poaceae	A	6	*		*	
Dactylis glomerata	Poaceae	P	10			*	*
Diplotaxis harra	Brassicaceae	A	4			*	
Echiochelon fruiticosom	Boraginaceae	P	4		*		
Echinaria capitata	Poaceae	A	7	*		*	
Echium humil	Boraginaceae	P	4	*	*	*	*
Enarthrocarpus clavatus	Brassicaceae	A	5	*	*		
Erodium guttatum	Geraniaceae	P	6			*	*
Erodium triangulare	Geraniaceae	A	6			*	
Eruca vescicaria	Brassicaceae	A	6	*	*	*	
Evax argentea	Asteraceae	A	4		*	*	*
Filago spathulata	Asteraceae	A	3	*	*		*
Hedypnois cretica	Asteraceae	A	6	*			
Glaucium corniculatum	Papaveraceae	A	4			*	
Helianthemum lippii	Cistaceae	P	7	*		*	*
Helianthemum virgatum	Cistaceae	P	7	*	*	*	*
Helianthemum apertum	Cistaceae	P	7		*		*

Species	Family	Life cycle	Accept. Index	Rogassa		Stitten	
				Enclo. area	Graz. area	Enclo. area	Graz. area
Herniaria hirsuta	Caryophyllaceae	P	4			*	
Herniaria fontanesii	Caryophyllaceae	P	4	*	*		*
Hippocrepis bicontorta	Fabaceae	A	8	*			
Hippocrepis multisiliquosa	Fabaceae	A	8	*		*	
Hordeum murinum	Poaceae	A	5	*	*		*
Iris sisyrinchium	Iridaceae	P	3				*
Koelpinia linearis	Asteraceae	A	8	*		*	
Lappula redowskii	Boraginaceae	A	7	*		*	
Launaea nudicaulis	Asteraceae	A	6		*	*	
Launaea resedifolia	Asteraceae	A	8	*	*	*	
Leontodon hispidulus	Asteraceae	A	7			*	*
Lolium rigidum	Poaceae	A	9	*		*	
Lygeum spartum	Poaceae	P	5	*			
Malva aegyptiaca	Malvaceae	A	6	*	*	*	*
Matthiola livida	Brassicaceae	A	7	*	*	*	
Medicago arabica	Fabaceae	A	9			*	
Medicago laciniata	Fabaceae	A	9	*		*	
Micropus bombycinus	Asteraceae	A	3			*	*
Minuartia campestris	Caryophyllaceae	A	5			*	
Muricaria prostrata	Brassicaceae	A	5	*	*	*	*
Noaea mucronata	Chenopodiaceae	P	5		*	*	*
Nonea micrantha	Boraginaceae	A	5	*		*	*
Onobrychis alba	Fabaceae	A	4	*			
Ononis natrix	Fabaceae	P	6			*	*
Papaver hybridum	Papaveraceae	A	3			*	*
Papaver roheas	Papaveraceae	A	3			*	
Paronychia arabica	Caryophyllaceae	P	3			*	*
Paronychia argentea	Caryophyllaceae	P	3	*	*		
Peganum harmala	Zygophyllaceae	P	4	*	*		
Plantago albicans	Plantaginaceae	P	8	*		*	*
Plantago ciliata	Plantaginaceae	A	7	*		*	
Plantago psyllium	Plantaginaceae	P	6	*		*	*
Poa bulbosa	Poaceae	P	8			*	
Ranunculus bulbosus	Ranunculaceae	P	4			*	
Reichardia tingitana	Asteraceae	A	6			*	
Reseda decursiva	Resedaceae	A	4			*	
Reseda lutea	Resedaceae	A	4			*	*
Salsola vermiculata	Chenopodiaceae	P	7	*			
Salvia clendestina	Lamiaceae	P	5		*	*	
Salvia verbenaca	Lamiaceae	A	6	*	*		*
Scabiosa arenaria	Dipsacaceae	A	5			*	
Schismus barbatus	Poaceae	A	7	*		*	*
Sisymbrium runcinatum	Brassicaceae	A	5	*			
Scorzonera laciniata	Asteraceae	A	7			*	
Scorzonera undulata	Asteraceae	A	7			*	*
Sedum sediform	Crassulaceae	P	2			*	
Sonchus oleraceus	Asteraceae	A	7			*	
Stachys brachyclada	Lamiaceae	P	6	*	*	*	
Stipa barbata	Poaceae	A	7	*			
Stipa parviflora	Poaceae	P	8	*	*	*	*
Stipa tenacissima	Poaceae	P	4	*	*	*	*
Teucrium polium	Lamiaceae	P	6	*		*	
Thymelaea microphylla	Thymelaeaceae	P	1	*			
Thymus capitatus	Lamiaceae	P	7			*	
Trigonella polycerata	Fabaceae	A	8	*		*	
Valerianella coronata	Caprifoliaceae	A	7			*	
Xeranthemum inapertum	Asteraceae	A	7			*	*

Note: Life cycle: A: annual; P: perennial; Accept. Index : acceptability index (scale from 1 to 10, provided by the CRBT (1978)); Encl. area: Enclosure area; Graz. area: Grazed area; * : Presence of the species

69 of species were annual and 39 were perennial.

The annual species are therophytes, this dominance of therophytes is called therophytisation. This Therophytisation is related, on one hand, to the harsh climate and, on the other hand, to the anthropogenic actions that degrade more the conditions of new species settlement (Benaradj, 2009). Emberger (1939) said that the rate of therophytes increases with the environment aridity. For Daget (1980), the therophytisation is a characteristic of arid zones, it expresses a coping strategy toward the unfavorable conditions and a form of resistance to harsh climate conditions. Higher species richness was encountered in the enclosure areas (protected) than in the grazed areas. Species richness in enclosure areas varied from 62 to 80 species with 22 to 26 species are perennial and 40 to 54 species are annual, while in grazed area the richness varied from 33 to 38 species with 17 species are perennial and 16-21 species are annual (Table 2).

Table 2. Richness, diversity and pastoral value index on enclosure and grazed areas and their significans**.**

	Rogassa			Stitten		
Vegetation attributes	Enclo. area	Graz. area	P_{value}	Enclo. area	Graz. area	P_{value}
Total species	62	33	-	80	38	-
Perinnial species	22	17	-	26	17	-
Annual species	40	16	-	54	21	-
Diversity (H')	3.86±0.18	2.88±0.21	***	3.88±0.19	2.84±0.29	***
Evenness (E)	0.90±0.03	0.82±0.02	***	0.86±0.03	0.80±0.04	**
Pastoral value index (%)	44.15±2.33	15.94±1.70	***	43.90±2.60	15.46±1.41	***

*= p<0.05, **= p<0.01, ***= p< 0.001 according to the *T-test*.

Grazing reduces the seed production of perennial species due to the reduction of photosynthetic tissue and the removal of flowers and seeds stalks (Sternberg *et al.*, 2000; Sternberg *et al.*, 2003; Bakoglu *et al.*, 2009), but the protection (enclosure) allows plants to complete their phenological cycles and produce seeds, thereby increasing their stocks in the soil (El Gharbaoui *et al.*, 1996; Msika *et al.*, 1997; Sidi Mohamed *et al.*, 2004; Aidoud *et al.*, 2006), in this context, several studies in different countries, as Morocco (Berkat, 1986; El Nrabti, 1989), Turkey (Koç *et al.*, 2013), China (Hu *et al.*, 2019), Mexico (Ma *et al.*, 2021), and others showed that the supply of seeds bank in the soil is weaker in grazed areas than in protected areas (enclosures). In addition, trampling linked to overgrazing causes soil compaction, preventing the infiltration of water and therefore, the proliferation of annual species (ephemeral) (Floret and Pontanier, 1982; Schlesinger *et al.*, 1990, Fleischner, 1994, Van de Koppel and Rietkerk, 2000).

Grazed species generally have less seed production ability because grazing encourages vegetative reproduction over sexual reproduction (Sternberg *et al.*, 2003). In addition, seeds produced by grazed plants have a short-term persistence in the soil (Champness and Morris, 1948; Peco *et al.*, 1998; Sternberg *et al.*, 2003). Noy-Meir *et al.* (1989) reported that when there is a decrease in perennial species, whose superficial roots encourage soil aeration, there is a decrease of water infiltration coupled with ligneous species reduction. In the South of Tunisia, for example, the monitoring of the vegetation dynamics of a park put in fencing, showed that the floristic richness was about four times higher inside than outside the park (Sidi Mohamed *et al.*, 2004; Ferchichi and Abdelkebir, 2003).

Rergarding Shannon-weaver (H') and Pielou eveness (E) diversity indexes (Table 2), the analyses showed that there were significant differences in Shannon-Weaver (H') diversity between enclosure and grazed areas, this index was varied from 3.86 to 3.88 in enclosure areas and from 2.84 to 2.88 in grazed areas, it was increased by 1.34 times compared with the grazed area in Rogassa, and by 1.36 times compared with the grazed area in Stitten.

The Shannon-weaver (H') index is used for the qualitative characterization of the ecosystem, since any increase in floristic richness can be at the origin of a self-restoration process of a degraded ecosystem (Zhang *et al.*, 2005).

The low value of H' alters the capacity of the free-grazing range to react to disturbances, and reflects a rarefaction or even disappearance of some species, especially those of good pastoral value. This drop is explained by a homogeneous system that is more fragile in its ecological contributions (N'zala, 1997).

The higher Shannon diversity index in the enclosure areas (protected) indicate that there is better species diversity in the enclosure areas compared to grazed areas and it indicate also the importance of enclosure practices for the conservation of genetic resources of species, particularly rare and unique species that are under threat of extinction. Comparable findings were reported by Amghar *et al*., (2012); Salemkour *et al*., (2013); Merdas *et al.* (2017) in Algeria, Ouled Dhaou *et al*., (2010); Gamoun (2014) in Tunisia, Acherkouk *et al*., (2012); Hachemi *et al*., (2015) in Morocco; Eweg *et al*., (1998) in Ethiopia; Shaltout *et al*., (1996) in Saudi Arabia and Hosseini *et al*., (2013); Ghollasimood *et al*., (2014) in Iran.

Similarly for the evenness (E) index, the analyses showed that there were significant differences in evenness (E) diversity, it was greater in the enclosure areas than in the grazed areas, the low equitability value in grazed areas means that there is dominance of one or more species in the community. While high equitability means that there is a uniform distribution among the species in samples, demonstrating that individuals are well-distributed (Cavalcanti and Larrazabal, 2004 cited in Kibret Mamo, 2008).

Various studies have found that species diversity declines with an increase of grazing intensity in different regions (Amghar *et al*., 2012; Salemkour *et al*., 2016; Todd, 2006, Hanke *et al*., 2014; Hassani *et al*., 2008 and some others).

Changes in plant species composition are mostly due to the replacement of palatable by unpalatable species and annual plants when degradation occurs (Archer and Smeins, 1991; Briske, 1991; Milton *et al*., 1994; Tarhouni *et al*. 2006, 2007b).

Concerning the pastoral value, the results obtained show significant differences between the enclosure and the grazed areas, the pastoral value was higher in enclosure areas than in grazed areas (Table 2). It was increased by 2.76 times between enclosure and grazed area in Rogassa and increased by 2.83 times compared with the grazed area in Stitten.

The low pastoral value index in grazed areas is due to the overgrazing in this areas, the effect of intense grazing is expressed by the appearence and the increased of the proportion of undesirable species and poisonous weeds (Abdallah *et al*., 2008; Amghar *et al*., 2012; Salemkour, 2016), which have a poor pastoral quality index, such as in our study: *Atractylis humilis, Atractylis serratuloides, Iris sisyrinchium, Peganum harmala, Echiochelon fruiticosom, Herniaria fontanesii*, conservely, protected areas are dominated by many species which have high pastoral quality index such as *Stipa parviflora, Schismus barbatus, Plantago albicans, Medicago lactiniata, Koelpinia liniaris, Helianthemum apertum, Helianthemum lipii, Helianthemum virgatum, Astragalus cruciatus, Anacyclus cyrtolepidiodes, Artemisia herba alba, Argyrolobium uniflorum.*

In southern Tunisia, Waechter (1982) noted a decline in pastoral value under grazing pressure, in Syria Deiri (1990) noted an increase in pastoral value as a result of protection, also Le Houérou *et al.* (1983), reported in detailled study of five protected areas totaling 140000 ha in Libya, that, after five years of enclosure (protection), the pastoral value of the vegetation had tripled with a spectacular regeneration of palatable species. It should be made clear that the considered areas had previously suffered a strong degradation, but not extreme, the species sought had been reduced, but not eliminated.

In grazed areas, pasture is generally selective, the palatable species are very threatened. Overgrazing of rangelands often results in highly competitive palatable perennial species being replaced by less palatable species which are often considered less desirable or even worthless plants (Callaway and

Tyler, 1999; Olff and Ritchie, 1998). In agreement with many other studies (Aronson and Le Floc'h, 1995; Amghar *et al.*, 2012; Hachmi *et al.*, 2015; Salemkour *et al.*, 2013 & 2017), our results prove the rarefaction of species witch have a good pastoral quality index in the grazed areas, likewise, Sasaki *et al.* (2012) suggest that nutritive value and yield of herbage can be modified greatly in responses to livestock grazing environmental quality.

Total plant cover and soil surface elements

The rate of vegetation cover reflects the health and quality of the rangeland, and is an indicator of vegetation (Gounot, 1961), Odum in 1969 determined a list of vital attributes at the ecosystem level to compare the different stages of a succession, including total vegetation cover (total cover of perennial species and total cover of annual species) and soil surface condition (Aronson *et al.*, 1995).

The changes that occur on the soil surface induce modifications in the distribution of the different elementary surface states, which can be characterized by simple field observations (Jauffret, 2001). The state of the soil surface is an indicator, which is primarily a reflection of the "state of health of the soil", and which helps the observer in the diagnosis of degradation, desertification and regeneration of the environment (Tarhouni, 2008). The results of plant cover and soil surface conditions in the studied enclosure areas compared to the grazed areas are presented in table 3.

Table 3. Total plant cover (cover of perennial species and cover of annual species), Soil surface elements cover on enclosure and grazed areas and their significans.

	Rogassa			Stitten		
Vegetation attributes	Enclo. area	Graz. area	P_{value}	Enclo. area	Graz. area	P_{value}
Total species	62	33	-	80	38	-
Perinnial species	22	17	-	26	17	-
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Pastoral value index (%)	44.15±2.33	15.94±1.70	***	43.90±2.60	15.46±1.41	***

*= $p<0.05$, **= $p<0.01$, ***= $p< 0.001$ according to the *T-test*.

The statistical analyses of total plant cover produce a significant difference between the enclosure (protected) and the grazed areas, also for the total cover of perennial species and total cover of annual species. Total plant cover, perennials cover and annuals was higher in enclosure areas than in grazed areas. Total plant cover was increased by 1.82 and 2.12 times compared with grazed areas in Rogassa and Stitten enclosure areas respectively, with an increase on perennials cover by 2.23 and 3.52 times and an increase on annuals cover by 1.46 and 1.40 on enclosure areas compared with grazed areas in Rogassa and Stitten respectively.

The total plant cover, as a better indicator of plant community health (Meyer and Garcia-Moya, 1989), the gradual evolution of vegetation cover between enclosure and free grazing areas is due to the phenomenon of "biological recovery" induced by the resting and protection of the rangelands. According to Le Houérou (1995), The biological recovery process is the set of processes reversed from those of steppisation and desertification, it’s characterized by an increase in the permanent cover of perennial biomass, organic matter in the soil, structural stability, permeability and water balance, biological activity and primary productivity, while the variability of annual production decreases.

The results demonstrated that protection significantly increased the total plant cover. Similar results were reported in similar agroecological zones earlier (Ayyad and El-Kadi, 1982; Floret and Pontanier, 1982; Alyemeni and Zayed, 1999; Oueld Belgacem and al., 2005; Ouled Belgacem *et al.,* 2013; Tastad *et al.*, 2010; Gallacher and Hill, 2006; Louhaichi and al., 2009; Amghar *et al.*, 2012; Salemkour *et al.*, 2016), indicating progressive increase of total vegetation cover in protected areas as compared to grazed areas which are often characterized by the expansion of bare soil. Higher plant cover reduces water losses by evapotranspiration, maintains a favorable microclimate for regeneration of annual herbaceous species and permits the developpment of perennial species (Floret and Pontanier, 1982; Oueld Belgacem and *et al.,* 2005), knowing that the rarefaction of perennials species constitutes, according to several authors (Sidi Mohamed *et al*., 2002; Le Houérou, 1977), a good indicator of the determination of the plant cover. Also, the increase in vegetation cover in protected rangelands can be explained by improved soil conditions (temperature, moisture, nutrient cycling) within these rangelands that favor species regeneration and development (Yates *et al*., 2000), however, in free grazed rangelands, overgrazing frequently acts through the reduction of the vegetation cover, followed by the disappearance of vegetation, the reduction of the size and/or number of species, which directly affects the quality of the soil by increasing crusting, reducing infiltration, increasing the susceptibility to soil erosion and causing a decrease in soil fertility (Hiernaux *et al*., 1999; Lavado *et al*., 1996, Yates *et al*., 2000).

The significant increase of perennial cover in the enclosure rangelands sites may be attributed to the improvement of organic matter content in the soil, and thus, the development of the vigor of adult individuals and the good establishment of new seedlings (Ouled Belgacem *et al*., 2006b; Tarhouni *et al*., 2007a & b). In contrast, the decrease of annual species cover in free grazed areas is due to overgrazing, as animals, especially small ruminants prefers to graze fresh annual species before the perennials. Concerning the soil surface elements cover (litter, stones, wind veil, bare silty crust), the results showed significant difference for all soil surface elements cover among the enclosure and grazed areas. The stones and wind veil cover are significant and greater in grazed areas, however, the litter and bare silty crust cover are significant and higher on enclosure. Litter is an component important of the soil surface, it's vital for the environment, because when it is not consumed, litter favors infiltration and germination in the next rainy season (Floret, 1981). Its strong presence in the enclosure areas is explained by the strong mortality of perennial plants. In addition, the dead parts of the plants are trapped by the vegetation in place (tufts), but in grazed range areas, this material is either ingested by the livestock or transported by the wind (absence of natural obstacles). Litter plays a very effective role in combating desertification. For example, the dead strands of esparto grass promote increased plant productivity and allow biological recovery by fixing soil and wind deposits (Bourahla and Guittonneau, 1978).

The low rate of litter cover in free grazed areas can be attributed to the overgrazing of annuals and the lack of trapping of dead parts that can be carried by the wind. Also, overgrazing negatively affects perennial grasses especially (*Stipa tenacissima* and *Lygeum spartum*), inducing a reduction of litter that results in a decrease of organic carbon in the soil (Gonzalez-Polo and Austin, 2009; Prieto *et al*., 2011). Conversely, enclosure (protected) areas have a higher litter rate, which is related to the cessation of grazing, which increases the amount of litter entering the soil (Hai *et al*., 2007; Mikola *et al*., 2001) and improves its carbon and nitrogen content. Several authors agree that litter rate increases with protection and guarding (Su *et al*., 2004; Pei *et al*., 2004; Zhao *et al*., 2005), and its presence in protected environments can provide "islands" of fertility where sediment and nutrients are trapped (Tongway *et al*., 1989), contributing to increased floristic diversity in these environments.

The high rates of stones and wind veil in grazed areas is due to the degradation of bedrock by wind erosion induced by overgrazing and trampling by livestock (Amghar, 2012). Carriere and Toutain (1995) report that trampling related to overgrazing reduces the standing biomass by breaking up dried stubble, which increases the surface area of bare soil and favors erosion, Yong-Zhong *et al.* (2005), report that frequent trampling by sheep and cattle leads to denudation of the soil and makes it exposed to wind and water erosion which alters the calcareous crust and causes the appearance of stones and wind veil. For the bare silty crust cover its importance in enclosure areas is due to the absence of trampling by animals. In addition to the water constraints that they generate, including evaporation of rainwater, these surfaces constitute a physical barrier that prevents the penetration of seeds to the ground and opposes the germination of seedlings, especially annual species (Tarhouni, 2008; Wallace and Wallace, 1986a; Borselli *et al.*,1996 a&b). According to Aguiar and Sala (1997) the bar cilty crust plays a negative role in the recruitment of new seedlings in the steppes of Patagonia. Also and according to Le Houérou, (1992) the formation of the bar cilty crust on the surface of the soil, reduces the infiltration and favors the runoff. Faced with this situation, several authors attest that a reasoned grazing in the plots with film rates is beneficial, because the trampling breaks the film formed on the surface, imbricates much more plant material in the soil and consequently improves its structure and porosity (Valentin, 1983; Savory and Parsons, 1980). Our results are consistent with those of several authors (Amghar *et al.*, 2012; Khalid *et al.*, 2015; Salemkour *et al.*, 2016).

Conclusion

Rangelands in Algeria are heavily degraded due to the combined effects of overgrazing and severe environmental conditions. However, it appears that these ecosystems have not lost their resilience and that the soil seed bank is potentially still important. The case study conducted in steppic rangelands of El-Bayadh highlighted the beneficial effect of enclosure (protection) on some vital attributes of the ecosystem compared to the free grazing rangelands located near the restored and protected areas.

Results indicate that enclosure are significantly stimulated the regeneration of vegetation in these rangelands by increasing floritic richness and diversity (Shannon (H') and equitability (E)), which translates the progressive evolution of the vegetation and consequently, a greater ecological stability compared with free grazed rangelands. As well the enclosure permitted a quantitative and qualitative increase in plant cover and pastoral value index by maintaining a favorable microclimate for regeneration of annual herbaceous species and permits the development of perennial species and palatable species which have high pastoral quality index.

For the soil surface elements, the enclosure (protection) decreases the cover stones and wind veil due to the cessation of the degradation of the bedrock by wind erosion and a good fixation of the sand by the vegetation, also the fencing has allowed the increase of the litter cover which is vital for the environment, because when it is not consumed, litter favors infiltration and germination of seeds and its presence can provide "islands" of fertility where sediment and nutrients are trapped contributing to increased floristic richness and diversity in these environments. However the results emphasized, on the other side, a negative effect of the enclosure expressed by the increase of the bare silty crust on the soil surface, which may constitute an obstacle to water infiltration and seeds germination, the works consulted agree on the negative effect of this element, which is why we suggest to the High Commission for the Development of Steppe (HCDS, the organization responsible for managing these managed rangelands) that this parameter be retained as an indicator, in addition to the state of the vegetation, for the decision to opening these rangelands for grazing.

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