# Grazing and Biodiversity Conservation: Highlights on a Natura 2000 Network Site

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**Abstract** This paper provides a summarisation of information on the biodiversity of Natura 2000 sites of Basilicata and the impacts of grazing on protected habitats and species. Besides, using a case study of a site particularly rich in biodiversity as an example, we described the application of the Driving Force, Pressure, State, Impact and Response (DPSIR) framework to evaluate the impacts of grazing and to propose corrective measures for ensuring restoration and conservation of habitats.

Similar situations to those described on grazing in the study site can arise for any kind of anthropogenic disturbance, which makes the approach here described and discussed suitable for a large-scale use.

However, the challenge for Natura 2000 network in Basilicata is not strictly to propose measures aiming at conserving biodiversity, but rather to build a better awareness of the 'natural heritage' concealed within the sites, in order to create an active involvement of the stakeholders in the process of devising policies toward biodiversity conservation.

## 1 Introduction

The agroecosystems of Basilicata region and, more in general, of south of Italy, have been shaped over the centuries through the perpetuation of traditional agricultural practices (e.g. grazing, mowing and burning), based on the balance between exploitation and conservation of available resources. Seminatural Mediterranean grasslands are a paradigmatic example of sustainable exploitation of natural resources in this regard.

Nowadays, a major threat to flora and fauna of many European agroecosystems such as those of Basilicata is the rapid mutation of agricultural practices: seminatural grasslands, heathlands, arable steppes and agroforestry systems are actually experiencing significant loss of biodiversity of flora and fauna. This is mainly due to

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A. Vastola (ed.), *The Sustainability of Agro-Food and Natural Resource Systems in the Mediterranean Basin*, DOI 10.1007/978-3-319-16357-4_18

the intensification of agriculture on productive sites (Dorrough and Scroggie 2008) and to the concurrent abandonment of traditional practices in marginal areas (MacDonald et al. 2000).

Relaunching traditional agricultural practices is often seen as a potential solution to biodiversity loss. The establishment of the Natura 2000 network in application of Council Directives 79/409/EEC on the conservation of wild birds and 92/43/EEC on the conservation of natural habitats and of wild fauna and flora may represent a promising restoration strategy to relaunch these traditional practices. Once fully operational, this ecological network will consist of a system of protected areas [i.e. Special Areas of Conservation (SACs) and Special Protection Areas (SPAs)] designated to assure the long-term survival of Europe's most valuable and threatened species and habitats.

An innovative feature of this ecological network is to ensure the protection of biodiversity taking account of 'economic, social and cultural requirements and regional and local characteristics' (Directive 92/43/EEC, art. 2). This means that the areas making up the network are not considered as exclusively reserved, inviolable and fully protected areas where any human activity is forbidden, but rather as areas in which man's traditional activities must be compatible with the conservation of habitats and rare, endangered or vulnerable wild species (fauna and flora), seeking a sustainable management from the ecological, economic and social point of view.

Among traditional agricultural activities, grazing is considered as a complex disturbance capable of altering natural processes, affecting species persistence and influencing the structure and composition of plant communities (Olff and Ritchie 1998). Grazing influence on biodiversity is generally negative when livestock are managed in a way which is not ecologically rational (Bakker 1998; Rook et al. 2004). For instance, high stocking rates may result in a homogenising of the vegetation pattern (Bakker 1998). Conversely, if properly managed and carefully controlled, grazing can be a promising tool to maintain or restore open landscapes, to hinder forest encroachment and, hence, to preserve and enhance biodiversity (Bakker 1998; Pykälä 2004; Sutherland 2002).

In order to relaunch grazing through the enhancement of its ecological role, it is important to identify its critical factors affecting negatively biodiversity to define appropriate actions which ensure a sustainable management of land resources.

This paper describes the grazing impacts on the integrity of Natura 2000 sites of Basilicata, focusing especially on the problems of biodiversity conservation concerning a site particularly affected by poor grazing management. The challenge for a site like this is not only to identify some policy measures capable of enhancing the positive and mitigate the negative effects of grazing, but also to involve the stakeholders in the process of devising policies toward biodiversity conservation.

## 2 Overview of Basilicata's Natura 2000 Network

In Basilicata there are 50 Sites of Community Importance (SCI), which protect rare, endangered or vulnerable natural habitats and species of plants or animals (other than birds) of European importance, and 17 Special Protection Areas (SPA), which protect significant numbers of wild birds and their habitats. The overall extension of these sites is 170,479 ha (17.1 % of the regional area); the total area of SPAs is 160,540 ha (16.1 % of the regional area), whereas the surface of the SCIs is equal to 61,179 ha (6.1 % of the regional surface).

Overall, these sites comprise a complex spatial pattern of biodiversity as Basilicata region has a remarkable morphological and geological variability. In fact, its territory (9,992 $km^2$) comprises mountains (70 %), hills (20 %) and plains (10 %); besides, it comprises small coastal areas, which are situated along the Ionian and Tyrrhenian Seas.

## 3 Community Habitats of Basilicata's Sites

To provide a better understanding of the complex mosaic of different habitats found in Basilicata, the regional sites can be distinguished in terms of altitude according to three main areas:

1. Mountain environments (ME)
2. Hills and plains (HP)
3. Coastal relieves and shoreline (CS)

Concerning the 50 SCIs, most of them (29) fall in mountain areas, whereas the remainder is distributed between hills and plains (13) and coastal relieves and shoreline areas (8) (Musto et al. 2013).

These sites protect 303 habitat types listed in Annex 1 of the Habitats Directive. Most of them are distributed between ME (142; 46.86 %) and CS (102; 33.66 %) SCIs, whereas the remainder (59; 19.47 %) has been found in HP SCIs. This means that ME and CS sites support greater biodiversity than HP sites.

The most common habitat found in these sites is the 6210 [seminatural dry grasslands and scrubland *facies* on calcareous substrates (*Festuco-Brometalia*) (*important orchid sites)]: it has been recorded in 26 SCIs on 50. In most of the cases (84.62 %), the habitat falls in ME SCIs, whereas the remainder (15.38 %) is equally distributed between HP and CS SCIs. Other common habitats in Basilicata's sites are 91 M0 (Pannonian–Balkanic turkey oak–sessile oak forests), 9210 (Apennine beech forests with *Taxus* and *Ilex*) and 9180 (*Tilio-Acerion* forests of slopes, screes and ravines). These habitats have been identified mainly in ME SCIs (91 M0: 69.57 %; 9210: 95.45 %; 9180: 87.50 %) and, to a lesser extent, in CS SCIs (91 M0: 30.43 %; 9210: 4.55 %; 9180: 12.50 %). The third most common habitat is the 6220 [Pseudo-steppe with grasses and annuals of the *Thero-*

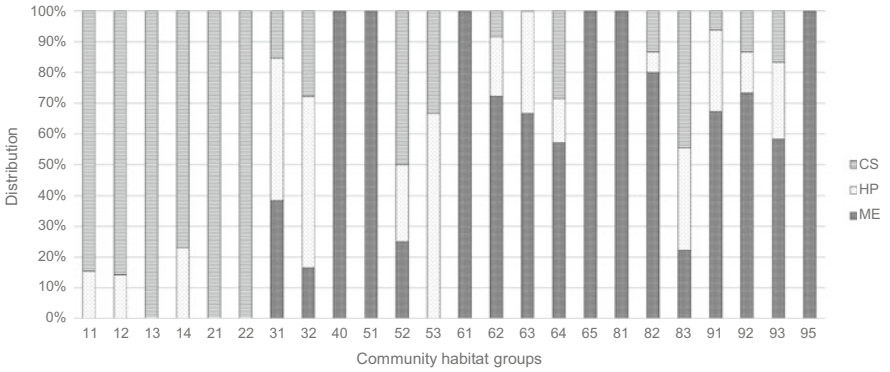


**Fig. 1** Distribution of community habitat groups found in Basilicata by site type. Community habitat group codes: 11 = open sea and tidal areas; 12 = sea cliffs and shingle or stony beaches; 13 = Atlantic and continental salt marshes and salt meadows; 14 = Mediterranean and thermo-Atlantic salt marshes and salt meadows; 21 = sea dunes of the Atlantic, North Sea and Baltic coasts; 22 = sea dunes of the Mediterranean coast; 31 = standing water; 32 = running water—sections of water courses with natural or seminatural dynamics (minor, average and major beds) where the water quality shows no significant deterioration; 40 = temperate heath and scrub; 51 = sub-Mediterranean and temperate scrub; 52 = Mediterranean arborescent matorral; 53 = thermo-Mediterranean and pre-steppe brush; 61 = natural grasslands; 62 = seminatural dry grasslands and scrubland facies; 63 = sclerophyllous grazed forests (*dehesas*); 64 = seminatural tall-herb humid meadows; 65 mesophile grasslands; 81 = scree; 82 = rocky slopes with chasmophytic vegetation; 83 = other rocky habitats; 91 = forests of Boreal Europe; 92 = Mediterranean deciduous forests; 93 = Mediterranean sclerophyllous forests; 95 = Mediterranean and Macaronesian mountainous coniferous forests

*Brachypodietea* (*important orchid sites)]: it has been found in 12 sites, and most of them are ME SCIs (50 %), while the remainders are CS and HP SCIs (both 25 %).

The habitats found in Basilicata can be aggregated into 24 community habitat groups by using the classification scheme according to the Interpretation Manual of European Union Habitats (European Commission—DG EUR27 2007). As shown in Fig. 1, some groups are present only in some type of sites (e.g. 40, 51, 61, 65, 81 and 95 only in ME SCIs). Instead, other groups are shared by two (e.g. 11, 12, 14, 53 and 63) or three site types (e.g. 31, 32, 52, 64, 82, 83, 91, 92 and 93).

The conservation status of the community habitat groups is quite varied (Table 1). It ranges from ‘bad’ to ‘good’ in ME and CS SCIs, with some groups (e.g. 61 and 83 in ME SCIs; 31 in CS SCIs) showing bad structure with insufficient conservation and unfavourable future prospect. Conversely, the habitat groups found in HP SCIs are in a better conservation status, with most of them being at good conservation status, and two at excellent status (i.e. 81 and 82).

**Table 1** Conservation status[a] of community habitat groups found in Basilicata by site type (mean + SD)

| Habitat group[b] | Natura 2000 SCI types[c] | | |
|---|---|---|---|
| | ME | HP | CS |
| 11 | – | – | 1.44 + 0.49 |
| 12 | – | – | 1.71 + 0.49 |
| 13 | – | – | 2.00 + 0.00 |
| 14 | – | 1.67 + 0.58 | 2.30 + 0.45 |
| 21 | – | – | 1.40 + 0.42 |
| 22 | – | – | 1.53 + 0.24 |
| 31 | 2.12 + 0.25 | 1.70 + 0.84 | 1.00 + 0.00 |
| 32 | 2.00 + 0.00 | 1.57 + 0.53 | 2.00 + 0.00 |
| 40 | 2.00 + 0.00 | – | – |
| 51 | 2.50 + 0.71 | – | – |
| 52 | 2.00 + 0.00 | – | 1.50 + 0.71 |
| 53 | – | 2.00 + 0.00 | 2.00 + 0.00 |
| 61 | 1.00 + 0.00 | – | – |
| 62 | 1.98 + 0.33 | 1.86 + 0.38 | 1.67 + 0.56 |
| 63 | 2.00 + 0.00 | 2.00 + 0.00 | – |
| 64 | 2.00 + 0.00 | 2.00 + 0.00 | 2.00 + 0.00 |
| 65 | 2.00 + 0.00 | – | – |
| 81 | 2.00 + 0.00 | 3.00 + 0.00 | – |
| 82 | 2.04 + 0.47 | 3.00 + 0.00 | 2.33 + 0.58 |
| 83 | 1.00 + 0.00 | – | 2.00 + 0.00 |
| 91 | 2.09 + 0.24 | 1.83 + 0.41 | 2.25 + 0.50 |
| 92 | 2.06 + 0.22 | 1.25 + 0.50 | 1.90 + 0.22 |
| 93 | 2.14 + 0.38 | 2.33 + 0.58 | 2.00 + 0.00 |
| 95 | 1.75 + 0.50 | – | – |

[a]Within the Natura 2000 Standard Data Form, the degree of conservation of the structure and functions of each habitat is recorded into three levels, 1, 2 and 3, respectively, indicating an average or reduced, good and excellent conservation status. – not present. *SD* standard deviation

[b]Community habitat group codes: 11 = open sea and tidal areas; 12 = sea cliffs and shingle or stony beaches; 13 = Atlantic and continental salt marshes and salt meadows; 14 = Mediterranean and thermo-Atlantic salt marshes and salt meadows; 21 = sea dunes of the Atlantic, North Sea and Baltic coasts; 22 = sea dunes of the Mediterranean coast; 31 = standing water; 32 = running water —sections of water courses with natural or seminatural dynamics (minor, average and major beds) where the water quality shows no significant deterioration; 40 = temperate heath and scrub; 51 = sub-Mediterranean and temperate scrub; 52 = Mediterranean arborescent matorral; 53 = thermo-Mediterranean and pre-steppe brush; 61 = natural grasslands; 62 = seminatural dry grasslands and scrubland *facies*; 63 = sclerophyllous grazed forests (*dehesas*); 64 = seminatural tall-herb humid meadows; 65 mesophile grasslands; 81 = scree; 82 = rocky slopes with chasmophytic vegetation; 83 = other rocky habitats; 91 = forests of Boreal Europe; 92 = Mediterranean deciduous forests; 93 = Mediterranean sclerophyllous forests; 95 = Mediterranean and Macaronesian mountainous coniferous forests

[c]SCI types: *ME* mountain environments, *HP* hills and plains, *CS* coastal relieves and shoreline

## 4 Livestock Farming within Basilicata's Sites

Livestock production is underrepresented in Natura 2000 Basilicata Network, as most of farms with livestock are located in the surroundings of the sites, with only a few farms within the site boundaries.

These farms vary widely in the number and kind of livestock (Freschi et al. 2013). Some raise few but different livestock, primarily for home consumption, whereas others specialise in a single livestock type, especially the larger farms. In some cases, livestock are raised in semi-extensive or extensive system, whereas in others animals are kept in confined conditions.

Many of the farms also raise crops, but others specialise in animal production and have few hectares. However, most of the sampled farms are small- and medium-sized farms with pastured livestock types (e.g. sheep, goats and cattle) and few other livestock (e.g. horses, pigs and poultry).

During hiking, Podolian cattle were found to be the most common breed kept in the sites. This breed is the most important Italian cattle breed raised in extensive conditions of south of Italy, and it is particularly widespread in Basilicata, where it is observed the highest consistence (Anabic 2014). The spread of this breed is mainly due to its ability to exploit marginal areas and to display site-specific adaptations. This type of rearing is based on cow–calf production system, with livestock grazing on the pastures almost year-round. The adoption of this system often has a dual-purpose, producing milk (mainly to make Caciocavallo cheese) other than meat. For this autochthonous cattle breed, the occurrence of a seasonal migration to high pastures was also observed in some sites: between June and October, some herds of Podolian cattle from neighbour regions (e.g. Campania and Calabria) were found to graze within the sites on summer pastures.

Small-sized flocks/herds of sheep and goat were also observed to graze/browse extensively and seasonally on sites' surfaces. These animals of local hardy breeds are characterised by relatively low nutritional requirements, high resistance to disease and low productivity (they are mainly used for cheeses and meat). Small herds of two or three horses kept at pasture were also met, but to a lesser extent than cattle, sheep and goats.

## 5 Grazing Impacts on Basilicata's Sites

Within the Natura 2000 Standard Data Form, grazing is listed as an impact (code: 140) that may have an influence on the conservation and management of the site. Information available on grazing impact within and around each site includes the following:

- Influence, recorded into three categories: positive, negative or neutral
- Surface (i.e. the percentage of the surface area of the site affected by grazing)

– Intensity, recorded into three levels, 1, 2, 3, respectively, indicating a low, medium and high intensity

These data were elaborated to provide a better understanding of how the vegetation resources of the sites are used by livestock.

Our results showed that over a half (53.85 %) of the grazing impacts recorded in the Natura 2000 Standard Data Forms exert a negative influence on Basilicata's SCIs. As shown in Table 2, half of the cases of negative influence have been observed on ME SCIs, where the largest percentage of surface damaged by livestock has been found (50 %). The remainder cases of negative influence are distributed between HP (28.57 %) and CS (21.43 %) SCIs, where the percentage of damaged surface is around 30 %. In ME and HP SCIs, grazing intensity has a mean value >2, indicating that grazing exerts an influence that goes beyond the threshold of a medium influence. The cases of neutral influence on Basilicata's SCIs account for 34.62 %; they have been mainly found on ME SCIs (77.78 %; Table 2) and to a lesser extent on the other sites (11.11 % for both HP and CS SCIs). The percentage extension in which grazing's neutral influence has been recorded ranges from 20 (HP SCIs) to 44.43 % (ME SCIs), whereas the intensity ranges from 1.50 (both HP and CS SCIs) to 1.64 (ME SCIs). A few cases of positive influence have been observed (11.54 %) and are equally distributed in ME and in CS SCIs (50 % in both; Table 2). The percentage extension is greater in ME SCIs than in CS SCIs (30.66 % vs. 16.67 %, respectively), whereas no difference has been observed in terms of intensity.

The negative influence of grazing manifests itself through a series of degradation phenomena, such as reduction of ground cover, trampling and fouling, soil compaction, increased or accelerated erosion, loss of vegetation as a result of selective grazing or browsing, increased species rarity as a result of excessive grazing/browsing, bush encroachment, weed invasion and damage to nesting birds and other wildlife. These phenomena are responsible for the low conservation status of some community habitat groups (e.g. 61, 95, and 62; Table 1), and are essentially due to:

1. Overgrazing, as livestock food requirements exceed the productive capacity of the grazing land
2. A poor distribution of livestock, with overutilisation of some areas of the sites and over-resting of others

Conversely, positive effects on biodiversity have been observed in those sites characterised by positive and, in many cases, neutral influence of grazing. For instance, moderate levels of grazing have been found important for increasing fertility soils and promoting species richness at the local scale as well as vegetation cover, which contributes to protecting the soil from erosion. Moreover, grazing at a low stocking rate was also important for controlling the succession of scrub into woodland. Besides, in some lightly grazed patches of grasslands, grazing resulted in higher plant species diversity with many precious floristic elements flowering

**Table 2** Distribution, extension and intensity of grazing on Basilicata's SCIs by site type

| | Influence of grazing | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Negative | | | Neutral | | | Positive | | |
| SCIs | Distribution[a] | Extension[b] | Intensity[c] | Distribution[a] | Extension[b] | Intensity[c] | Distribution[a] | Extension[b] | Intensity[c] |
| ME | 50.00 | 52.21 | 2.21 | 77.78 | 44.43 | 1.64 | 50.00 | 30.67 | 1.67 |
| HP | 28.57 | 31.13 | 2.38 | 11.11 | 20.00 | 1.50 | 0.00 | – | – |
| CS | 21.43 | 30.00 | 1.67 | 11.11 | 33.50 | 1.50 | 50.00 | 16.67 | 1.67 |

[a]Percentage distribution of cases of grazing's influence by site type
[b]Mean percentage extension of sites' areas where grazing exerted its influence
[c]Average value of the intensity of grazing's influence on the integrity of the sites
– Not present

(e.g. *Anacamptis morio*, *Orchis italica*, etc.), thus confirming that grazing is very important for the conservation of orchids (Pihl et al. 2001).

Reducing negative grazing's impacts is a major need to maintain and enhance these examples of biodiversity within Basilicata's sites. This can be achieved by determining thresholds for optimum herbage utilisation and land resource conservation and, hence, by developing and encouraging the adoption of appropriate grazing management practices. In the following pages, we present the detrimental effects of grazing on a site and delineate the directions of future changes for assuring a sustainable conservation of the site.

## 6 A Focus on Grazing Impacts on a Basilicata's Site

The SCI Valle Basento Grassano Scalo-Grottole (IT9220260) is situated in the centre (longitude: 16°14´37´´; latitude: 40°35´53´´) of Basilicata and extends for 882 ha into four municipalities (Calciano, Garaguso, Grassano and Grottole) of the Province of Matera. With an altitude ranging between 172 and 309 m above sea level, the site represents a stretch of the Basento river, one of the five rivers which cross the regional territory.

Several aspects make this site a territory of huge natural interest. A particular feature is the presence of ravines, characterised by gorges with vertical walls and originated from clayey ground. The vegetation along the river comprises a riparian forest, whose arboreal and shrubby hygrophilous elements are associated with grassy steppe elements. Thanks to its geomorphological and microclimatic conditions, the site hosts 94 animal species of the Nature Directives: 88 birds, 3 fishes, 1 mammal species and 2 reptiles declared 'endangered' and put under protection status through EU Directives 79/409 and 92/43. Moreover, this area is one of the breeding sites of otters (*Lutra lutra*), birds of prey (e.g. *Ciconia nigra*, *Milvus migrans*, etc.) and endemic insect fauna.

The site protects seven habitat types of the Habitats Directive (Table 3), with one of them being a priority habitat: 6220*. A high proportion (>20 %) of the site is covered by the grasslands included in this habitat. In general, its occurrence is related to extensive grazing (sheep and cow), though its pastoral interest is low (San Miguel 2008). The second largest habitat is the habitat 92A0 (*Salix alba* and *Populus alba* galleries), accounting for 148.18 ha (16.80 % of the whole site extension). The smallest habitat is 3250 (constantly flowing Mediterranean rivers with *Glaucium flavum*) with only 1.76 ha (Table 3).

Overall, the community habitats cover an area of 521.27 ha (>59 % of the whole site territory), and the priority habitat alone accounts for >34 % of the total area of the community habitats. The Natura 2000 Standard Data Form of the site shows that, in most cases, the degree of conservation of the structure and functions of the community habitats has been classified as 'average', meaning that their conditions should be monitored, albeit they are not so severely damaged. Conversely, the

**Table 3** Main characteristics of the habitat types present on the site

| Habitat | | Habitat assessment | | | |
|---|---|---|---|---|---|
| Type | Cover (ha) | Representativity[a] | Surface[b] | Conservation[c] | Assessment[d] |
| 1430—Halo-nitrophilous scrubs (*Pegano-Salsoletea*) | 3.53 | A | C | B | B |
| 3250—Constantly flowing Mediterranean rivers with *Glaucium flavum* | 1.76 | A | C | B | B |
| 3280—Constantly flowing Mediterranean rivers with *Paspalo-Agrostidion* species and hanging curtains of *Salix* and *Populus alba* | 71.44 | A | C | B | B |
| 5330—Thermo-Mediterranean and pre-desert scrub | 112.90 | B | C | B | B |
| 6220—Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea* | 179.93 | A | C | B | B |
| 92A0—*Salix alba* and *Populus alba* galleries | 148.18 | B | C | C | B |
| 92D0—Southern riparian galleries and thickets (*Nerio-Tamaricetea* and *Securinegion tinctoriae*) | 3.53 | B | C | C | C |
| Total | 521.27 | – | – | – | – |

[a]The degree of representativity of the natural habitat type on the site can be excellent (A), good (B) or significant (C)

[b]The area of the site covered by the natural habitat type in relation to the total area covered by that natural habitat type within the national territory can be classified as follows: A (15.1–100 %), B (2.1–15 %) and C (0–2 %)

[c]The degree of conservation of the structure and functions of the natural habitat type can be excellent (A), good (B) or average or reduced (C)

[d]The global assessment of the value of the site for conservation of the natural habitat type can be excellent (A), good (B) or significant (C)

conditions of the habitats representing the vegetation along the river (i.e. 92A0 and 92D0) are a matter of high concern, as their conservation status is 'reduced'.

According to the Natura 2000 Standard Data Form, there are three main activities influencing negatively the conservation status of the site: grazing (code: 140),

**Fig. 2** Cattle grazing on a floodplain of the Basento river

cultivation (code: 100) and leisure fishing (code: 220). Whereas cultivation and leisure fishing have been identified as 'external' activities, grazing has been listed as the only one activity exerting its negative influence within the site (Fig. 2). Therefore, to restore, maintain and preserve the integrity of the site, it is essential to explore the reasons behind the impacts of grazing on the habitats of the sites.

## *6.1 Application of DPSIR Framework to Analyse Grazing Impact Within the Site*

Nowadays, the need to make the economic growth and development compatible with preservation of natural resources and the environment cannot prescind from the adoption of strategies enabling the parallel assessment of socio-economic and environmental parameters. This goal can be achieved by using the DPSIR framework (EEA 1999). In recent years, this framework has become widely adopted by the majority of the European Community nations, as it is the best way to structure environmental information concerning specific environmental problems and to reveal existing causes, consequences, effective responses and trends and the dynamic relationships between these components (Pillman 2002). This is possible thanks to the definition of policy-relevant indicators (i.e. sets of physical, biological or chemical variables) in order to describe (1) the driving forces, (2) the resulting environmental pressures, (3) the state of the environment, (4) the impacts resulting from environmental changes and (5) the possible societal response.

The application of this framework allows the identification of the driving forces (e.g. industry, transport, tourism, agriculture, etc.) that produce pressures on the environment (e.g. pollution, soil excavation, climate change, etc.), which then degrade the state of the environment, which then impacts on ecosystems and human health, causing society to respond with various policy measures (e.g. regulations, information and taxes), which can be directed at any other part of the system.

In the following sections, we describe the application of DPSIR framework to assess the impacts of grazing on the habitats of the SCI Valle Basento Grassano Scalo-Grottole. The components in the DPSIR framework were defined as follows.

**Driving forces** Only three farms are situated within the site (Fig. 2). Most of the animals (369 on 375) owned by these farms are sheep (308) and goats (61) reared under semi-extensive rearing conditions (Table 4). This means that grazing is usually limited: its duration is variable and is about 4–6 h per day, usually in the late morning or evening. The animals are then housed and given some forages, crop residues or concentrates.

Overall, these animals do not pose a real threat to the habitats of the site. However, as the protected area is not fenced, the natural resources of the site are important sources of forage also for grazing livestock from farms situated in the surroundings of the site. Indeed, the site is also attractive to livestock for the presence of Basento river, which represents the only available water source to drink in the area.

Therefore, to assess the impacts of these farms on the habitats of the site, we used a geographic information system to create different buffer zones of 500-m radius around the site and recorded all those farms situated within a distance of 2.5 km from the boundaries of the site. As can be seen in Fig. 3, there are many farms in the surroundings of the site, which may explain the impacts on the habitats of the site. To better asses this phenomenon, we analysed the main characteristics (i.e. rearing system, species and their consistence) of all the farms located within two different buffer zones (with radii of 500 and 1,000 m) around the site. We restricted the analysis to a distance of 1 km because the farms located within this distance are more likely to be responsible for the conservation status of the habitats. However, this restriction does not exclude the possibility that livestock reared under semi-extensive or extensive conditions from farms located at a greater distance may also graze on the site.

As shown in Fig. 3, four farms are located within the 500-m buffer zone. In these farms, there are, under semi-extensive conditions, 113 cattle, 398 sheep, 45 goats and 6 horses (Table 4). A total of 1,022 animals are reared in the three farms located within the 1,000-m buffer zone (Fig. 3; Table 4). However, the semi-extensive rearing system is adopted only by one farm, which raises 115 animals (45 cattle, 7 sheep, 4 goats and 59 horses).

**Pressures** Our inspections showed that the livestock reared under semi-extensive or extensive conditions are among the main pressures in the site, as the animals

**Table 4** Livestock population within and in the surroundings of the site

| Rearing system | Domestic species | Distance from boundaries of the site (m) | | | Total animals |
|---|---|---|---|---|---|
| | | 0 | 500 | 1,000 | |
| Semi-extensive or extensive | Cattle | 0 | 113 | 45 | 158 |
| | Sheep | 308 | 398 | 7 | 713 |
| | Goats | 61 | 45 | 4 | 110 |
| | Pigs | 0 | 0 | 0 | 0 |
| | Horses | 0 | 6 | 59 | 65 |
| | Total | 369 | 562 | 115 | 1,046 |
| Intensive | Cattle | 6 | 137 | 7 | 150 |
| | Sheep | 0 | 0 | 0 | 0 |
| | Goats | 0 | 0 | 0 | 0 |
| | Pigs | 0 | 0 | 900 | 900 |
| | Horses | 0 | 0 | 0 | 0 |
| | Total | 6 | 137 | 907 | 1,050 |

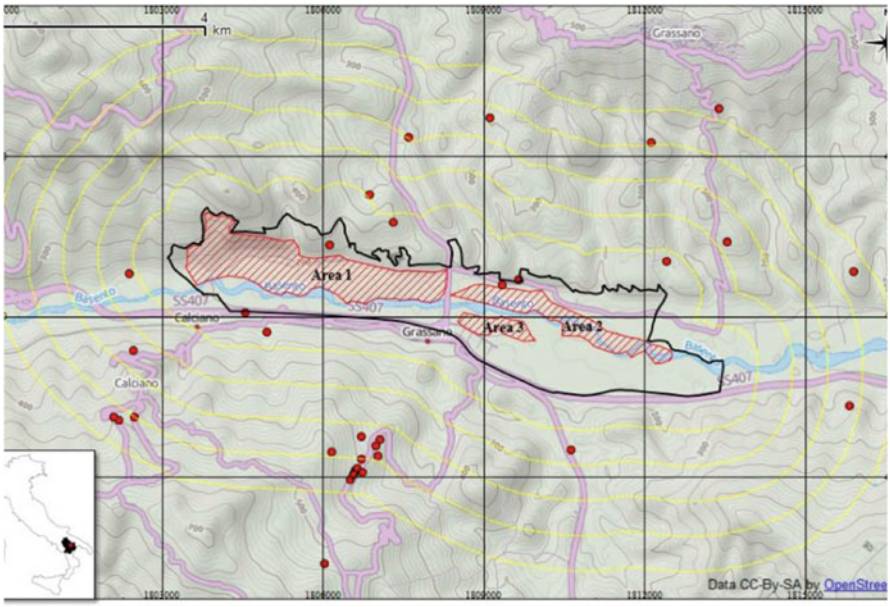


**Fig. 3** Map showing the farms (*points*) located within (*black solid line*) and in the surroundings of the site. *Lighter lines* represent buffer zones of 500-m radius around the site. Polygons filled with *diagonal stripes* indicate the areas where the negative effects of grazing were mainly observed

exert a significant impact on its vegetation. The key factors responsible for grazing land degradation are essentially:

1. Excessive animal density

2. Lack of rotation
3. Grazing at inappropriate times relative to the flora productivity cycle

Grazing is often 'uncontrolled', with Podolian cattle usually grazing all the year round, whereas small ruminants are grazing for a fraction of the day. Moreover, cattle, sheep, goats and horses often graze together on most of the grasslands and other habitats of the site. According to the European Corine Land Cover classification, the extent of the available surface for grazing is 464.70 ha (52 % of the whole site extension). Considering this surface and the number of grazing animals from farms located in the surrounding of the site (<1,000 m), the grazing pressure (number of grazing animals per ha of grazing surface) is 0.65 livestock units (LU) per ha. Indeed, this density value may be undervalued: as stated before, the grazing animals from farms located at a distance greater than 1,000 m were excluded from our analysis, although they may reach the site to graze and drink.

**State** The pressure exerted by grazing produced many negative effects on the state of the site, such as deterioration of vegetation cover, change in state of threatened species and endemic species, soil degradation, etc. This is particularly evident in the three main areas (Fig. 3), which together account for 46.96 % (414.22 ha on 882 ha) of the total surface of the site and 89.14 % of the total grazing surface (414.22 ha on 464.70 ha). By combining the current vegetation biomass available for grazing, its nutritional value and the nutritional requirements of livestock, the grazing capacity of these areas should not exceed 0.25 LU $ha^{-1}$ $year^{-1}$. In the remaining part of the site, grazing does not produce negative effects. However, the grazing capacity in these areas should prudently remain at moderate levels for habitat conservation (i.e. 0.35 LU $ha^{-1}$ $year^{-1}$). These proposed values for this site are consistent with those for year-round grazing reported in literature (Piek 1998; Putfarken et al. 2008).

**Impacts** In the three main areas of the site (Fig. 3), the conservation status of much of the vegetation is very poor as a consequence of selective grazing. In many parts of these areas, selective grazing leads to a homogenisation or trivialisation of the floristic composition. Under uncontrolled grazing, in fact, livestock tend to repeatedly graze the most palatable species leaving behind the less or non-desirable species such as *Eryngium campestris*, *Ononis spinosa*, *Silybum marianum*, *Onopordum acanthium* and *Asphodelus microcarpus*.

The productivity and biodiversity of these areas are also affected by fouling: faeces and urine caused some patches of these areas to be unattractive to livestock. In other parts, we observed the destruction of much of the herbaceous vegetation as livestock compacted soil by trampling it, making paths and tracks, or repeatedly congregating in the same areas. Among them, some riparian zones within the area 1 (Fig. 3) were very crowded especially in hot weather as livestock congregate along the Basento river to graze and drink. They overgrazed and trampled riverside plants, leaving bare banks and depositing manure and urine in concentrated areas around riparian areas or directly into the river. In these areas, soil compaction by trampling also reduced water infiltration and increased surface run-off and erosion.

Moreover, in some points, livestock trampled and break down riverbanks through the pressure exerted by the hooves. The reduction (and, in many cases, the destruction) of vegetation by trampling was also observed on the slopes, where soil erosion and sediment transport were increased by the reduction of both the interception of rainfall by plants and the resistance to run-off created by the plants themselves.

Overgrazing is also detrimental to the wild fauna of the site. For instance, some grasslands of the areas 1 and 2 (Fig. 3) belong to the habitat 6220*, which is considered the ideal habitat for many threatened or rare bird species (San Miguel 2008). However, changes in its vegetation structure and species composition associated with uncontrolled grazing are the most likely cause for some breeding failures. It has been reported that grazing alters habitat structure and thus the suitability of the sward for nesting and feeding birds (Vickery et al. 2001). This has probably led to a decline of some birds such as stone curlew (*Burhinus oedicnemus*) in the grasslands of the site.

**Responses** To tackle the identified pressures and minimise their impacts on the site, the responses (measures) to be developed should be effective in restoring or maintaining the habitats and wildlife that have been disturbed by overgrazing. Therefore, the measures should aim at promoting a rational use of existing vegetation resources for grazing. To achieve this goal is fundamental the introduction of regulating grazing: the farmers who want to use the vegetation resources of the site have to evaluate the nutritional needs of livestock, assess forage quality and quantity, regulate the acreage of access and control which parts of the pasture/range that the animals have access to. By controlling livestock density and through appropriate rotation periods, farmers can improve the forage production, while still being beneficial to the land.

In this context, the introduction of some management facilities is important. Permanent and/or temporary fences may be used to keep livestock from particular areas at specific times of the year or to exclude it from vulnerable areas such as the riparian zones. Fencing off these areas of the site as a vegetative buffer is perhaps the only way to limit livestock river access and protect riverbanks from hoof traffic or overgrazing. The exclusion of livestock from riparian zones makes essential to consider the introduction of drinking troughs in different areas of the site, where water may be pumped from near or far sources by the use of solar-powered pumps. According to Putfarken et al. (2008), the placement of such management facilities should be carefully considered when different herbivore species are kept on the same pastures as they guarantee that all habitats are grazed and thus are kept in a management status favourable to conservation.

An improvement of grazing management may also be achieved by introducing alternating grazing between different species of livestock into the habitats of the site, since they differ in diet preferences, terrain use and their potential to influence vegetation development (Walker 1994; Bakker 1998; Rook et al. 2004). As a general rule, cattle should be used to graze off tall late season grasslands initially, to be followed by sheep or horses once the grassland height has been reduced to a level that these other grazers can cope with more effectively. The adoption of an

alternate grazing system does not necessarily imply the cessation of the year-round grazing system adopted for the Podolian cattle, but rather a rethinking of its role as a tool to maintain or to create highly diverse ecosystems involving minimal livestock care. Moreover, at low densities, a year-round grazing system comprising both cattle and sheep appears to be suitable for the conservation of diverse pasture landscapes, since both species have complementary feeding preferences, and these also show seasonal changes (Putfarken et al. 2008).

A better management of the different grazing behaviours of cattle, sheep, goats and horses found in the site may lead to the consumption of different species and parts of plants, resulting not only in a better utilisation of grazing resources (Frame 1992; Rinehart 2006) but also in a substantial improvement of biodiversity of flora and fauna (Bakker 1998; Osoro et al. 1999; Evans et al. 2006). It has been reported that the 'multispecies grazing' at low stocking rates may both increase the structural and compositional variation of the vegetation and help to control the encroachment of woody species (Bakker 1998). According to Osoro et al. (1999), the management of mixed flocks of goats with other livestock under moderate grazing pressure may contribute to the diversification of the production and to enhance animal performance of other domestic herbivores, landscape biodiversity by reducing fire risk and the economic conditions in marginal areas. Moreover, it has also been reported that, on condition that stocking rates are low, the abundance of some bird species may be enhanced in areas that have seen significant shifts from mixed livestock grazing to grazing dominated by single species of animals (Evans et al. 2006).

## 7 Conclusion

Achieving conservation objectives within Natura 2000 sites may represent a big challenge, since protection cannot be accomplished simply through a suite of measures aimed at restricting and/or forbidding the use of the available resources, as it happens in other protected or conservation areas.

As stated before, the idea underpinning the creation of the Natura 2000 network is that certain human activities inside a site should be performed in order to contribute to the biodiversity conservation. Obviously, this implies an understanding of the relationships between anthropogenic disturbance regimes and biodiversity, thus allowing the adoption of targeted protection policies aimed at avoiding the most negative impacts and enhancing the positive interactions among activities.

Concerning grazing, in this paper we focus on the main impacts of this traditional activity on the integrity of Basilicata's sites and provide recommendations for improving its management and ensuring biodiversity conservation. However, this translates not only into the proposition of corrective measures, but it also requires an active stakeholder participation, as farmers or other individuals who are potentially affected by the measures need to be involved and contribute to the setting of priorities and objectives of the management plans of the sites.

Therefore, managing grazing activities in the sites presents a challenge in terms of devising policies that are compatible with the ecological integrity mandate and that are acceptable to stakeholders. This means that the establishment of the Natura 2000 network has, above all, to contribute to the forging of a culture promoting the concept of 'natural heritage', in order to value, utilise and conserve the available resources in Basilicata appropriately for the benefit of all, present and future.



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