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Wild Ungulates vs. Extensive Livestock. Looking Back to Face the Future

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Abstract. Foraging of herbivores has been one of the most ancient and important causes of heterogeneity in Mediterranean landscapes. Its ecological role has been so extensive, diversified and deep, that much of their current biological and cultural heritage (including many Nature 2000 grassland habitat types) depends upon extensive livestock management systems. However, extensive livestock numbers are decreasing while wild ungulate populations are increasing. Our aim, following the "rivets and redundancy" theory, is to discuss how much of the traditional contribution of livestock to the preservation of those cultural landscapes and to Sustainable Rural Development can be assumed by wild ungulates as well as to describe potential opportunities and risks. Although we lack sufficient knowledge about the role wild ungulates play within their environments, we think they can partially assume some essential functions traditionally played by extensive livestock. However, due to their wild nature and to different potential risks, their stocking rates should be much lower than those of livestock. Hence, especial attention should be paid to risk prevention and particularly to population control.

Keywords. Cultural landscape – grazing - management model – Mediterranean - Nature 2000.

Ongulés sauvages vs. élevage extensif*. *En regardant en arrière pour affronter l'avenir

Résumé. *Le pâturage des herbivores a été l'une des causes les plus importantes et les plus anciennes de l'hétérogénéité des paysages méditerranéens. Son rôle écologique a été si prononcé et diversifié qu'une grande partie du patrimoine biologique et culturel méditerranéen actuel (y compris de nombreux habitats Nature 2000 de type prairial) dépend de la gestion des systèmes d'élevage extensifs. Cependant, le nombre d'élevage extensif est en baisse alors que les populations d'ongulés sauvages sont en augmentation. Notre objectif, en s'appuyant sur la théorie des rivets et de la redondance, est dans un premier temps de discuter de la part de la contribution à la préservation des paysages culturels méditerranéen assurée actuellement par l'élevage traditionnel qui pourrait être assumée par les ongulés sauvages. Dans un second temps l'objectif sera de décrire les possibilités de mise en place et les risques potentiels associés. Bien que nous manquions de connaissances sur le rôle que jouent les ongulés sauvages au sein de leur environnement, nous pensons qu'ils peuvent se substituer, avec différents degrés d'intensité et d'adéquation, à certains rôles joués par l'élevage extensif. Toutefois, en raison de leur nature sauvage et de différents risques potentiels, leur taux de chargement devrait être beaucoup plus bas que ceux du bétail. Par conséquent, une attention particulière devrait être accordée à la prévention des risques et particulièrement au contrôle de la population.*

Mots-clés. *Paysage culturel – pâturage - modèle de gestion – Méditerranéen - Nature 2000.*

I – Introduction

The Mediterranean Basin has been described as a hot spot of biological diversity (Myers, 1990) which is expressed in many different scales, from landscapes to species and genetic variations within species. Four factors have been cited as major causes for that situation: biogeography, geology, ecology and history (Blondel and Aronson, 1999). However, although natural factors can explain much of the outstanding Mediterranean biodiversity, it has been humans who have largely made it what it is today. The "design" or "sculpture" of Mediterranean cultural landscapes by humans started in the Pleistocene, much earlier than the end of the last glacial period, and it was carried out, at a first stage, by fire and foraging of wild herbivores (Naveh and Carmel, 2004). Nevertheless, since humans began to domesticate plants and animals, they started to deeply transform primary or semi-primary Mediterranean ecosystems. For around ten millennia, and with an increasing intensity, our ancestors eliminated many wild species (Blondel and Aronson, 1999; Tsahar *et al*., 2009) or rivets, according to the hypothesis of rivets and redundancy proposed by Ehrlich and Walker (1998). In compensation, they also introduced new ones and caused deep changes in natural processes. Much of that change has been described as degradation (Naveh, 1982). However, it was difficult to explain how such a supposed deep degradation was compatible with the current high levels of diversity and efficiency. Further studies demonstrated that traditional extensive management models superimposed on primary Mediterranean ecosystems resulted in higher levels of efficiency and genetic diversity (Perevolotsky and Seligman, 1998; Blondel, 2006, Montserrat, 2008). Although obvious cases of degradation are found, most landscapes submitted to moderate stress are simply altered, but not degraded. Thus, the interwoven of natural and cultural processes and patterns has resulted in the great heterogeneity, biological diversity and adaptative resilience of most Mediterranean landscapes (Perevolotsky and Seligman, 1998; Naveh and Carmel, 2004). Due to their human origin and stabilization, they have also been described as agrobiosystems or cultural landscapes (Pedroli *et al*., 2007; Montserrat, 2008). And hence, those high levels of heterogeneity and biological and cultural diversity which we, Mediterranean countries, can feel proud of and responsible for, depend upon traditional management models (Bernáldez, 1991; San Miguel, 2003, Olsvig-Whittaker *et al*., 2006; Moreira *et al*., 2008).

Foraging of herbivores has been one of the most ancient and important causes of heterogeneity in Mediterranean landscapes. Its ecological role has been so extensive, diversified and deep, that livestock species have been described as ecosystem engineers (Derner *et al*., 2009). They have contributed to create gaps within forest ecosystems, woodlands and shrublands, and also to their seed dispersal. But most of all, their role has been essential for the creation, diversification, improvement and preservation of natural grasslands, many of them currently protected under the 92/43/EEC "Habitat" Directive. However, the role played by wild ungulates and livestock has been far different. Since the beginning of the Neolithic until the 1960s, the role played by livestock has increased both in extension and intensity. On the contrary, that of wild ungulates has decreased dramatically, since some species were eliminated by humans through intensive hunting and land transformation while the rest of their populations were reduced to minimal densities consigned to marginal upland territories.

The current situation of livestock vs. wild ungulates regarding nature conservation is far different from the one occurring at the 1960s. Environmental preservation has become a major objective of the European Agricultural Policy. There is a general agreement about the necessity to preserve the so-called cultural landscapes, where biological diversity is closely interwoven with traditional management models and cultural heritage. However, most traditional management models are set to disappear and, thus, the preservation of most natural or semi-natural grasslands protected under the 92/43/EEC Directive (Nature 2000) requires active management, especially extensive grazing by livestock (San Miguel, 2003; Moreira *et al*., 2008).

Nevertheless, extensive livestock is suffering from a severe reduction due to social and economic reasons. On the contrary, wild ungulate populations have vastly increased over the last five decades as a result of three major causes: rural abandonment, an outstanding growth of big game demand and a parallel increase of protected areas. One of the questions that arise within that situation is whether, following the theory of rivets and redundancy (Ehrlich and Walker, 1998), increasing wild ungulate populations could substitute, up to some point, the environmental function of the reducing extensive livestock. In a certain way it could be regarded as looking back to face the future.

II – The role of extensive livestock in Mediterranean cultural landscapes

The role of extensive livestock within Mediterranean cultural landscapes is not only an environmental one. The preservation of much of the Mediterranean flora, fauna and habitats protected under European Directives depends upon extensive livestock management models (San Miguel, 2003; Moreira *et al*., 2008). However, extensive livestock rearing also supports major cultural, social and economic aspects which are essential for Sustained Rural Development. Although it is difficult to summarize every single function, some of the most important ones are:

- Increasing the heterogeneity of landscapes and plant communities at a suitable scale to enhance biodiversity (Gabay *et al*., 2008). Livestock movements and foraging create gaps within forest ecosystems, woodlands and shrublands. Woody plants are not so well adapted to being eaten as herbaceous plants. Therefore, browsing reduces its ability to regenerate, creates gaps in dense woody vegetation and could be harmful for highly palatable woody species, while it benefits herbaceous plant communities.
- Creation, diversification, improvement and preservation of grassland communities. Foraging of livestock benefits herbaceous communities in its competition with woody ones. Grazing improves grassland communities, contributes to their diversification, increases their biological diversity and, above all, is the most important tool for their preservation. Wherever the potential vegetation is forest, woodland or shrubland (most the Mediterranean Basin), the preservation of grassland communities requires somewhat intense grazing.
- Preserving cultural landscapes, which have been usually described as patchworks of different land uses. The scale of individual single pieces within those patchworks is important as far as biodiversity levels are concerned (Gabay *et al*., 2008).
- Dispersion of seeds of woody and herbaceous plant species (Malo and Suarez, 1996; Parks *et al*., 2005).
- Recycling of organic matter, acceleration of nutrient cycles. Directional movement of nutrients (Bernaldez, 1991; Montserrat, 2008).
- Increasing the diversity and activity of soil biota (Montserrat, 2008).
- Increasing levels of biological diversity: worms, dung beetles, birds, reptiles, mammals and many other life forms (Dennis *et al*., 2008).
- Providing food for wild scavengers, many of them endangered and protected under the “Birds” and “Habitats” European Directives.
- Preserving the cultural heritage linked to pastoralism and landscapes. Those ecosystem functions are the basis for the so-called ecosystem cultural services (Wallace, 2007).
- Creating and sustaining economic and social activities which are essential for Sustained Rural Development.

Therefore, the reduction of extensive livestock in Mediterranean territories is resulting in severe conservation problems. Some of them are shrub encroaching, increase of wild fire risk, reduction of biodiversity levels, degradation or disappearance of protected grassland habitat types, homogenization of landscapes (the so-called green desert), problems for endangered flora and fauna, lack of food for insectivore birds and carrion-eating animals, loss of cultural heritage and difficulties for achieving Sustained Rural Development. As a consequence, many LIFE-Nature Projects have been carried out in most Mediterranean European countries with the aim of recovering those habitat types through the preservation or recovery of traditional extensive livestock management systems: http://ec.europa.eu/environment/life/themes/grassland/thematic.htm.

III – Wild ungulates vs. extensive livestock

Following the rivets and redundancy theory (Ehrlich and Walker, 1998) we could assume that since the beginning of the Neolithic period livestock substituted, up to a high degree, much of the environmental role played by pre-existing wild ungulates within the Mediterranean basin. Therefore, the current reduction of extensive livestock could be compensated, up to some point, by the natural or artificial recovery of wild ungulate populations. As a consequence of their general herbivore character, most wild ungulates share some ecological functions with extensive livestock. However, their wild nature results in some major differences which should be taken into account to ensure the quality and amount of that compensation. Some of them have been already described:

- The lack of control on wild ungulates browsing increases their negative effects on woody vegetation. Feeding preferences, natural recruiting of trees and shrubs and preservation of the most palatable species are essential topics to bear in mind when estimating carrying capacities (Augustine and McNaughton, 1998; Parks *et al*., 2005; Mysterud, 2006; Gill and Morgan, 2009).
- The lack of control on wild ungulates foraging reduces instantaneous stocking rates and, therefore, their beneficial effect on natural and artificial grasslands. Those grasslands benefit from intensive grazing, which is easy to achieve with livestock but difficult with wild herbivores (San Miguel *et al*., 2009). Most Mediterranean grassland types protected under the 92/43/EEC Directive could benefit from wild ungulate grazing, but in a lesser degree than from that of extensive livestock (San Miguel, 2008).
- The efficiency of wild ungulates in dung beetle conservation seems to be also lower than that of extensive livestock grazing (Jay-Roberts *et al*., 2008). However, the conservation of other insect groups seems to be achieved only by wild herbivores (Theuerkauf *et al*., 2006).
- The effects of wild ungulates on plant or animal communities might indirectly affect other plant or animal species. That is the case of wild boar (*Sus scrofa*) and red deer (*Cervus elaphus*) on wild rabbit (*Oryctolagus cuniculus*) or rodent populations and, indirectly, on endangered predators and scavengers (González and San Miguel, 2004; Lozano *et al*., 2007; Muñoz *et al*., 2008).
- Wild ungulates could increase the risk of non-native plant invasions on forests and rangelands (Parks *et al*., 2005).
- Wild ungulates have been considered as natural reservoirs of parasites and diseases, some of them very dangerous for livestock and even humans: tuberculosis, bluetongue, brucellosis, paratuberculosis, and many others. On the other hand, some parasites and diseases which can be easily controlled in livestock populations could become very dangerous for wild ungulates (e.g. sarcoptic mange or infectious keratoconjunctivitis). Hence, disease risks should be considered as major constraints when dealing with wild ungulate carrying capacity (Gortázar *et al*., 2006, 2007).

- As a consequence of their wild nature and their increasing numbers, wild ungulates have become a major traffic hazard in most European countries (Groot Bruinderink and Hazebroek, 1996; Malo *et al*., 2004; Milner *et al*., 2006)
- Due to the previously described potential risks, wild ungulate stocking rates should always be much lower than those of extensive livestock. In any case, wild ungulate sustainable stocking rates should never be based only on the estimation of food availability (dry matter, energy, nitrogen matter), since there are always major environmental constraints.
- As a consequence of the ancient substitution of several extinct wild ungulates by livestock, some arid and semi-arid Mediterranean territories are not currently occupied by any native wild ungulate species. Hence, Mediterranean species, such as the Corsican moufflon (*Ovis ammon mussimon*) or the aoudad (*Ammotragus lervia*), could become opportunities for complementing or substituting extensive livestock (San Miguel *et al*., 2009).

IV – Current trends of Mediterranean wild ungulate populations

Many studies have documented the extinction of several Mediterranean wild ungulate species and the intense population decrease of the remnants due to human causes along the Holocene, and especially during certain periods (Blondel and Aronson, 1999; Tsahar *et al*., 2009). However, that trend changed dramatically in the last decades of the XXth century. Since that date, the numbers of most wild ungulate species increased dramatically as a result of both increases in density and range expansion (Weisberg and Bugmann, 2003; Côte *et al*., 2004; Gordon *et al*., 2004; Milner *et al*., 2006). The most important causes for that shift are related to social and economic changes. One of them was the abandonment of traditional landscape management models and the sudden decrease of human density in rural areas. That situation promoted natural succession, shrub encroaching, expansion of forest areas and hence, a higher availability of shelter and food for wild ungulates. The result was both the recovery of native populations and the spontaneous re-colonization of long lost ranges. Another major cause was an exponential increase in the demand of wild ungulate hunting and watching throughout most European countries (Milner *et al*., 2006). Thus, wild ungulates suddenly became a major economic resource for many European regions (Gordon *et al*., 2004; Arenas, 2009). As a result, many landowners contributed to the increase of their numbers both through re-introduction and through habitat and population management (sometimes a sophisticated and intensive one) aimed at increasing both their densities and their trophy quality.

We lack sufficient knowledge about regional censuses for every wild ungulate species in the Mediterranean region. However, wild boar (*Sus scrofa*) is probably the species showing the highest increase both in numbers and in range and both at a European and at a Mediterranean scale. In Spain the annual harvest of wild boar has increased by tenfold during the last 35 years (Arenas, 2009), and the species has spread from the high Pyrenees, on alpine pastures over 2400 m above sea level, to the European most arid environments located in SE Spain, where the species thrives even on *Stipa tenacissima* communities. As a consequence, problems have been reported describing severe damages to agricultural crops, natural grasslands, biodiversity, parasites and diseases, traffic collisions and many other aspects (Acevedo *et al*., 2006; Herrero *et al*., 2008; Tsachalidis and Hadjisterkotis, 2008; Bueno *et al*., 2009). Red deer (*Cervus elaphus*) numbers have also increased at an exponential scale (Mattioli *et al*., 2001; Milner *et al*., 2006; Arenas, 2009). In Italy, red deer numbers have increased by tenfold during the last 28 years (Mattioli *et al*., 2001) while in Spain the red deer annual harvest has increased by eightfold during the last 35 years (Arenas, 2009). Somewhat lower increases have been described for other European wild ungulate species, such as the roe deer (*Capreolus capreolus*) (Tellería and Virgós, 1997; Burbaite and Csányi, 2009), the Iberian ibex (*Capra pyrenaica*) (Acevedo and Cassinello, 2009) or the chamois (*Rupicapra pyrenaica* and *R.*

rupicapra) (Dupré *et al*., 1998), and also for introduced species, such as the north-African aoudad (*Ammotragus lervia*) (Cassinello *et al*., 2006).

V – Looking back to face the future

Wild ungulates might be seen as either an opportunity, for their contribution to economic and social activity in rural areas, or as a threat, for their potential impact on human activities: agriculture, livestock rearing, forestry, traffic. Something similar might be stated from the environmental point of view: they can complement or partially substitute many beneficial effects of extensive livestock, and contribute to the preservation of landscape heterogeneity and biological diversity, especially to that of grassland habitat types. However, they can also cause serious impacts on environmental structures and processes. A holistic, system oriented and multiple-scaled approach is therefore needed to take advantage of the opportunities as well as to reduce threats to a minimum. Our ability to find solutions to those problems is limited because we lack sufficient understanding of how wild ungulate species interact with predators, habitat, forage, competing species, and humans at multiple scales, from small foraging patches to large regions (Weisberg and Bugmann, 2003; Fernández-Olalla *et al*., 2006). Therefore, much effort should be placed on scientific research on all those topics if future decisions are to be based on solid knowledge. However, we can and should learn from our common past and both from successes and mistakes. We have already learned many things from extensive livestock management since millennia. We know how to manage livestock herds and their habitats with the aim of harmonizing production and environmental conservation. Hence, that knowledge could be used with the aim of partially achieving those objectives with wild ungulate species and different management models. It could be regarded as retracing our own historical steps to face the future. We have also learned much about problems caused by the uncontrolled increase of wild ungulate populations in the past decades. We know that the most important constraint for the management of most wild ungulate populations is not limiting harvesting rates with the aim of avoiding overexploitation but controlling their population increase to avoid overabundance and disease risks. Population control is, therefore, a major challenge for the future (San Miguel *et al*., 1999, 2009; Fernández-Olalla *et al*., 2006; Milner *et al*., 2006). However, the task is a really difficult one, since population control methods are difficult to be carried out and, sometimes, to be understood by our urban society, especially within protected areas. In any case, if any mistake is to be made, it is better a slight over-harvesting, whose recovery would be easy, than a slight under-harvesting, whose recovery could become even more difficult and whose environmental effects could take time to heal.

A final problem is that of the non-native species. Although we are all concerned with potential threats coming from exotic invasive species, every particular case should be carefully analyzed. Some concepts, such as “exotic” or “invader”, are not as well defined and understood as they should be, and are dependent on the time, space and genetic scales considered. The modern flora and fauna of the Mediterranean Basin have been greatly altered for millennia, and colonizers constitute a vast majority of present-day species (Blondel and& Aronson, 1999). Therefore most livestock species could be considered as exotic species, as well as some formerly introduced wild ungulates. Likewise, most native wild ungulate species could also be considered as invaders since they are expanding their ranges to areas where they had not been present for centuries or millennia as a consequence of recent shifts in human activities. As a matter of fact, irretrievable losses of genetic diversity could result from the current translocation of exotic genetic material at an infra-specific scale (e.g. different red deer subspecies with the aim of improving the quality of trophies). On the other hand, some arid and semiarid environments which are not currently occupied by native wild ungulates in southern Europe could offer possibilities for species which are native to other Mediterranean regions, obviously after a careful system oriented and multiple-scaled analysis.

VI – Conclusions

The reduction of traditional extensive livestock management models is resulting in losses of heterogeneity and biological diversity in many Mediterranean cultural landscapes. It is also negative for the achievement of Sustainable Rural Development. On the other hand, wild ungulate populations have increased dramatically for the last few decades and have become a major economic resource. Our proposal is that wild ungulates could partially compensate the reduction of extensive livestock from both the environmental and the social and economic points of view. However, a careful, system oriented and multiple-scaled approach is needed. Stocking rates should be much lower than those of traditional extensive livestock and population control becomes a major challenge for the future, since overabundance and disease are to be minimized. Much effort should be paid to research since we lack sufficient knowledge to design and implement solid science-based management models for those systems

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