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Chapter #2.- Ungulate management and conservation: certified quality for game management in the XXI Century.

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Game management and conservation

Many protected areas in Europe were historically used for hunting ungulates, which suggests a relationship between ungulate management and conservation of biodiversity. We currently know that other uses of the territory such as livestock or agriculture typically produce higher impacts on the environment than hunting, but the association between hunting and conservation has occurred mainly because hunting was normally related to a general situation of low use of marginal lands, and consisted only of harvesting a natural resource with little or no management. However, this situation that dominated hunting activities in the past has changed during the last few decades. Production excedents in the European Union have promoted that many areas, especially in less productive environments like mountains or some regions in the Mediterranean basin, have abandoned their traditional production systems based on agriculture or livestock. At the same time, the economic value of game ungulates has increased, so that many areas have shifted to alternative uses such as game management.

Under this productive context, the general tendency with ungulates has been towards a more intensive management, aimed to increase productivity and profitability, and leading to the increment of population densities. Despite hunting is an ancestral activity, management of game ungulates is very recent, and there is no clear tradition about how to do it. In fact, management has

started in many areas without clear principles or adequate regulation that can guarantee that it will be a sustainable, environmentally friendly activity. Game species, including ungulates, are members of natural faunas of each region. Most endangered wild species like large carnivores or birds of prey are only indirectly affected by human activity that reduces their suitable habitats. By contrast, wild ungulates and their habitats are directly affected by management decisions because of their economic value. This fact may promote the maintenance of ungulate populations but also represents a high threat for the conservation of their natural features as well as for the conservation of the whole ecosystems that may be oriented only to maximize ungulate productivity without caring other natural values. This problem has become very clear in some areas in the southwest of Spain, that have moved from traditional livestock to the production of wild ungulates, mainly red deer together with some accompanying species such as wild boar, mouflon and fallow deer. The general tendency in these areas has been to translate livestock practices that people formerly used with cattle or sheep to increase productivity and profitability of wild ungulates. These practices may entail serious concerns for the maintenance of ungulate characteristics as wild species molded by natural selection as well as for the conservation of the ecosystems where they live.

Problems of applying livestock practices to wild ungulates: the case of Mediterranean ecosystems

Livestock practices applied to wild ungulates may affect their habitats, with potential effects on biodiversity, as well as their own natural populations that may be fragmented and altered in their age structure, sex ratio or reproductive conditions, with potential long-term effects on genetic features that compromise the conservation of the managed species.

1) Habitat management in Mediterranean areas

Traditional practices for livestock include the management of habitats to increase vegetal productivity. In Mediterranean ecosystems of Southwestern Iberia, oak (*Quercus ilex* or *Q. suber*)

forests have been extensively transformed to open structures called dehesa. Dehesas typically result after removal of the shrubby understorey layer, and consist of scattered mature oak trees throughout fields of natural pasture or patches of cereal crops. In many areas, the remaining forests that maintain the understorey layer are relegated to mountains where slopes are steeper and soil preservation from erosion requires the maintenance of shrub vegetation (Figure 1: laderas de Monfragüe). Dehesas are more productive than forests, mainly because of higher herbaceous productivity together with some improvement in the production of acorns by large, isolated oak trees. However, productivity in Mediterranean dehesas is highly seasonal. Acorns are available in october-november and grass productivity has two peaks, a small one in autumn and the biggest one in spring. After June, grass becomes completely dry due to the high temperatures and absence of rainfall during the long Mediterranean summer, so that the shortage lasts until the next production of acorns in October. Thus, summer is a strong limiting season for herbivores in these habitats. Traditionally, livestock used to migrate to northern latitudes during the summer, what constitutes one of the most typical uses in Iberia from Middle Ages called trashumancia. Large herds of cattle or sheep moved twice a year, from central-south Iberia to the north in late spring and backwards in autumn, across well established traditional routes that still today have the right to be used by livestock and cannot be legally interrupted by private or public constructions. Today, when most uses of trashumancia have been abandoned, livestock in these areas have to be supplementary fed during the summer.

When dehesas have recently been redirected to the production of wild ungulates, they cannot provide almost any natural food during the summer. In facing this situation, farmers tend to provide supplementary food during two or three months, from July to September. Providing supplementary food entails several problems. Among them, the frequency of aggressive encounters between males (including serious fights) increases (Carranza et al. 1995) with the risk of increasing damages and antler breaks, harem size and the degree of polygyny also increase (Sánchez-Prieto et

al. 2004) with potential consequences on the increment of homozygosity across generations (Martínez et al. 2002; Carranza & Martínez 2002; Figure 2: problemas de suplementación).

In a more natural landscape that would include open dehesas together with forest or shrublands, deer feed during the summer mostly on the shrub vegetation (Rodríguez-Berrocal 1978; Carranza et al. 1991; Bugahlo and Milne 2003) that remains green and productive during most of the summer after the grass has already dried up. Deer produce a considerable impact on arbustive vegetation, but it becomes lower when the proportion of the area occupied by forest or shrub is higher (Figure 3: browsing vs. density). Therefore, a good practice to provide natural food during the summer is to increase the surface occupied by forests and shrublands, ideally intercalated with open dehesas that provide pasture and acorns, thus complementing the differences in productive phenology of different vegetal resources.

On the other hand, traditional use of transforming Mediterranean ecosystems into large areas of dehesas entails several conservation problems. First, natural regeneration is seriously compromised in the absence of scrub vegetation (Pulido 1999; Figure 4 de regeneración natural); and second, although dehesas can accommodate a considerable variety of species, most typical forest species may disappear if dehesas are extended over very large surfaces, so that biodiversity can notably increase when dehesas are intercalated with patches of scrubs and forests (Pulido & Diaz 1992; Figure 5 de riqueza de passeriformes). Consequently, mosaic landscape represents a good management from various points of view and most importantly, changing territory use from livestock to wild ungulates may have beneficial effects on the conservation of natural ecosystems in Mediterranean areas, which may also be potentially applicable to other ecological scenarios throughout Europe (Figure 6: mosaico, por ejemplo Valero).

2) *Management of ungulate populations*

When wild ungulates are managed as livestock, populations are fragmented into isolated subpopulations, potentially leading to genetic problems; densities are increased with damages on

natural vegetation and the raise of diseases due to overabundance; natural vegetation losses importance because diet is increasingly based on supplementary food; individuals from distant areas are introduced and admixed with local populations with the result of loss of local genetic differences/adaptations and the increase of sanitary risks; and under most intensive practices, reproductive individuals are selected on the basis of productive criteria (notably antler size in red deer), with the result of genetic changes by artificial selection. The increasing trend towards these practices may also damage the perception of modern Society towards game management, which can hardly be accepted if any threats to the natural values of species and habitats were added to the raising controversy about hunting as an ethical activity in modern world.

Most of these practices have been taking place in Europe during the last several decades, and may have contributed to the general rejection of hunting uses by public opinion. Notable examples are the hybridization between species, such as the case of red deer and sika deer in the United Kingdom, or between distant subspecies as is the case for roe deer (Randi et al. 2004) and red deer (Carranza et al. 2003) resulting from indiscriminate translocation practices throughout Europe.

c) Farming

Farming is one of the most important threats to the conservation of wild ungulates. Farming is a common practice for deer, wild boar and other ungulates in many areas in the world including many European countries. Despite farming is extended all over Europe, this is far from being a recommendable practice for wild ungulates. Some farms are oriented to produce velvet or venison, and the animals may not be released into natural areas. However, competition in the international market of velvet and even of venison frequently makes more profitable the production of live males for hunting areas. In these cases, mixed genetic lines produced after several generations of artificial selection are introduced in natural areas and admixed with native populations. In Europe, the introduction in nature of domestic strands resulting from farm rearing is a serious problem with red

deer and more recently with the wild boar. Farms not only produce genetic changes due to artificial selection, but also deliberately cross different genetic lineages that include for instance red deer and wapity or wild boar and several breeds of domestic pig that increase productivity and docility for management. The widespread existence of farming in Europe associated with the introductions of animals from farms into natural areas reflects the little care that public administrations have paid to the conservation of wild ungulates.

Farming has only recently reached Spain. There are only a handful of red deer or wild boar farms. Some deer farms are declared as producers of venison but soon shift to providing live males for hunting estates. Although there are still few farms providing deer and wild boars in Spain, their effects in natural populations are already noticeable. For instance, genetic matriline (based on mtDNA) of Scottish red deer, woburn breeds, and Eastern Europe red deer have been found in samples of red deer populations in Spain (Fernández et al. 2006). Recent legal regulations tend to reduce this practice in some regions of Spain but unfortunately not in all of them.

Reconciling ungulate management and conservation

Applied research can provide tools to reconcile productivity and conservation. The main objective should be to find management criteria that can favour both economic and environmental benefits. Information so far available for red deer populations in Mediterranean ecosystems of Southern Iberia indicates that this goal can be achieved under certain management practices for habitats and populations (Carranza 2004).

For habitats, we have already mentioned that traditional livestock practices promote the removal of the understorey level to form the typical dehesa structure. Dehesas, however, are not sustainable because natural regeneration of oak trees under such conditions is extremely low (Pulido & Diaz 2005). Also, species richness of any indicator taxa tends to be smaller if large areas are occupied by dehesas compared to mixed habitat structures that include patches of dehesas and forests or scrublands (Diaz et al. 1997). Conversely to the case of livestock, arbustive plants are

valuable for red deer and other wild ungulates because they provide food during the extremely dry summer (Rodríguez-Berrocal 1993), which is the limiting season for wild herbivores in Mediterranean ecosystems (Bughalo and Milne 2003). Thus, both producing deer and promoting biodiversity recommend maintaining understorey vegetation. This leads to the general recommendation (Carranza 1999; Carranza 2004) of favouring a mosaic structure with forests and open dehesas, which can optimize vegetal productivity for deer throughout the year and provide habitat diversity that maximizes species richness, and at the same time favours natural regeneration of arbustive and arboreal species.

A further practical issue is the optimal size of fragments in a mosaic of natural vegetation. Obviously this should depend on the topography and other ecological features of the area, but scientific information from several points of view can provide some general indications. For Mediterranean ecosystems, studies on biodiversity indicate that forest fragments should be larger than 100 hectares to guarantee the establishment of forest faunistic communities (Tellería & Santos, 2001; Santos et al., 2002). On the other hand, studies on red deer ecology and behaviour show that hinds use home range sizes between 250 and 400 hectares and stags between 600 and 1000 hectares (Carranza et al. 1991; Lazo et al., 1994), which sets an upper limit for fragment size in order to favour the presence of variety of habitats within any individual home range.

Two main management issues regarding ungulate populations are densities/overabundance and genetic aspects. Ungulate populations in Europe have increased during the last three decades (Morellet et al. 2001). The same trend has occurred in the Iberian Peninsula (Sáez-Royuela & Tellería 1986; Gortazar et al. 2000) but particularly in the south-west (Carranza 1999; 2004) where decreasing profit of livestock and increasing demand of hunting has favoured the use of large private properties (most typically between 1,000 and 4,000 hectares) to produce wild ungulates. These private estates are sometimes fenced to prevent deer movements, but either in open or fenced areas ungulate densities, particularly of red deer, tend to be considerably higher than in any other parts of Europe. Red deer densities, for instance, may average 40 individuals per square kilometre

in many of these areas (Carranza 1999; 2004; Carranza et al. 2006; Figure 7 of densities).

Overabundance is not desirable for many reasons that include impacts on the natural vegetation as well as on the ungulate populations, including body condition and performance as well as the prevalence of diseases (Côté et al. 2004; Gortázar et al. 2006). One key point, however, is to determine to which extent these figures actually represent situations of overabundance (Caughley 1981). Information so far available suggests that Mediterranean areas of Southwestern Spain can support quite elevated densities of deer with acceptable impact on the natural vegetation (Pulido et al., in press) and with little reduction in population performance (Carranza 2004). Taking fertility as an indicator of overabundance, the proportion red deer hinds on Rum island (Scotland) that conceived decreased from 0.80 to 0.40 when density raised from 10 to 18 individuals per km², while this figure was 0.75 in Sierra de San Pedro (Cáceres, Spain) with a density of 40 individuals per km² (Carranza et al. 2006; Figure 8 density vs. fecundity). Two main reasons may contribute to explain this difference. First, productivity of Mediterranean ecosystems for wild herbivores is very high (Fernández-Llario, unpublished), which also corresponds with high levels of biodiversity (Davis & Richardson 1995), and may explain why red deer use so small home ranges in these type of habitats compared to other areas of Europe (Carranza et al. 1991; Sánchez-Prieto 2005; Figure 9: home ranges in Europe). Second, an adequate structure of natural vegetation can buffer the limiting season in Mediterranean habitats (shrub plants during the summer, see above) better than in northern latitudes, where cold winters may set a very low level for carrying capacity.

Moderate densities constitute an appropriate recommendation for management that can put together objectives of trophy quality and habitat sustainability, but the possibility that sustainable densities in Mediterranean areas may be higher than in other parts of Europe, opens up an interesting opportunity to promote the exploitation of wild ungulates in these areas as an alternative to livestock, with the added benefit of higher compatibility with conservation than agriculture or traditional livestock practices (Carranza 2004; Carranza et al. 2006).

Management of ungulate populations must also take into account their conservation as wild species and members of local faunas. As wild species, game ungulates deserve management practices designed to not interfere in natural evolutionary processes (Carranza & Martínez 2002). When populations are highly fragmented and intensively managed, their genetic properties are also affected by processes as genetic drift, lost of allele diversity, reduced heterozigosity (Martínez et al. 2002), together with other more dramatic changes such as intense artificial selection or genetic introgression caused by the introduction of individuals belonging to different subspecies (Carranza et al. 2003a). Some particular initiatives aimed to mitigate these problems have recently been implemented in Spain or are under consideration. For example, genetic introgression is since year 2003 controlled by a genetic test that is applied to red deer trophies when they are submitted to the Spanish Trophy Commission where they are measured and catalogued according to the criteria of the International Game Council (CIC). If genetic tests indicate that some trophies do not belong to pure Iberian red deer specimens, then the Spanish Commission rejects them as candidates to be included in the Spanish records (Carranza et al. 2003b). This measure produces the effect of decreasing the value of hybrids as trophies and is producing the desired effect of reducing the introduction of foreing deer in Spain (CIC unpublished report). At the same time, some public Administrations have started using the genetic test as a prerequisite before authorizing translocations, and some owners ask for the application of the genetic tests to samples of their live animals in order to implement programs aimed at purging hybridization from their populations. Genetic problems related to fragmentation have promoted the reccomendation to increase the size of management units in the South of Spain, by joining several estates into areas regulated by a common management project. In a further step, artificial selection is starting to be considered an undesirable process (Carranza & Martínez 2002). This idea is in clear disagreement with traditional livestock criteria, where selection was seen as a desirable practice with the objective of "improving" the quality of animals under exploitation. This makes it difficult to be understood and accepted by many people, although hopefully the situation is changing. For instance, the Administration of

Andalucia, in the south of Spain, is implementing new legal regulations that prevent any procedures that interfere with the natural reproduction of game ungulates, such as artificial insemination or mating arrangements by direct choice of breeders (Ortega-Alegre & Rodriguez-Benavente 2006).

Principles for certified quality of game management

Despite biological information may advocate for more natural management principles, current market tendencies for game ungulates favour intensification, hybridization, artificial selection, and many other practices not compatible with conservation. Natural management as a whole and integrate approach to game practice with ungulates is highly difficult to achieve only on the basis of prohibitions. This problem is being faced in Southern Spain under the new approach called the “quality of game management system” (Vargas et al. 2005; Ortega-Alegre & Rodriguez-Benavente 2006). This quality system is being implemented by regional administrations, and is aimed to promote the type of management more compatible with conservation, on the basis of the following main ideas: 1) Land owners can apply for a certificate of quality, 2) Regional government in agreement with a research institute evaluates and gives the certificate, 3) Main benefit for owners is the access to funds oriented to conservation and the launch of their products (game offer) to the market with a quality brand (Carranza & Vargas, 2006).

Key aspects of the system are at least the two following ones. First, that the application for the certificate is voluntary for land owners, so there must be some reward in doing so, either because hunters may find more valuable a hunting experience in these naturally managed areas or because public administration gives advantages to estates that get the certificate (a necessary incentive at least for the initial stages of the system). And second, that the certificate is based on quite restricted management criteria based on conservation principles. Even among scientists and much more easily among associations related to hunting or management, these principles and management criteria are clearly a matter of debate and potential disagreement. This concern motivated a group of scientists to organize a couple of workshops with the goal of promoting

discussion and unifying criteria, first among research groups and then with representatives of the main associations and public administrations involved in hunting and game management in Spain. The result was a high level of agreement that appears in a publication resulting after these two workshops (Carranza & Vargas, 2006).

In the field of practice, the administration of Andalusia has already produced the first legal regulation to start with the quality system in this key region of Southern Spain, which surely will promote that other neighbouring administrations follow to apply similar regulations. So far we only have the norms and we need to observe the starting of the application to evaluate the success of the system, which at least appears as a promising strategy to promote a shift from intensive, livestock practices to a more natural, environmentally friendly management of ungulates and other game species.

Conclusions

Ungulate populations and their habitats in Spain will be increasingly managed because of their economic importance (they even tend to replace livestock in many areas). An adequate management of wild ungulates may be more compatible with conservation than livestock practices, which opens a great opportunity for integrating management and conservation. Habitat management should make economic productivity compatible with the conservation of biodiversity, for which mosaic landscape in Mediterranean areas is proposed as the most favourable structure. Management of ungulate populations should take into account their economic value but also that they are elements of the faunistic community and deserve conservation not only of their census numbers but also of their genetic integrity maintained by the process of natural selection. The pioneering game quality system being currently implemented in some areas of Spain may be a promising procedure to promote natural management of wild ungulates in the XXI century in Europe.

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