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# Management of wet meadows in the Lavours marsh, implementing grazing



RESULTS OF 15 YEARS OF CONSERVATION

***The Lavours marsh is a vast wetland covering 2000 hectares, located to the south of the last sections of the Jura mountain range and linked to the alluvial system of the northern section of the Rhône river in France. It occupies a dip in the land dug out by Würm-period glaciers and later filled in by post-glacial alluvial deposits.***

## THE LAVOURS MARSH, A ZONE UNDERGOING COMPLETE CHANGE

**The traditional marsh activities, the role and function of livestock farming over time.** It was during the 1100s, following the installation of Cistercian monks in the Hautecombe Abbey, that the Lavours marsh took on its role as grazing land (Jouannaud in Beauvallet *et al.*, 1999). The best meadows are found on substrata made up of clay or silt and given the rich supply of forage plants, they constituted a supply of hay for horses, while waiting for the later hay-harvesting time in the meadows on the nearby mountains. The "marsh meadows" on peaty terrain supplied low-quality hay, called "sedge hay", that was used as stable litter for the animals and to protect the vines. The grazing tradition started with sheep, then shifted in the 1600s to the breeding of horses and mules when travel between the provinces intensified. At the time of King Henry the Fourth, the "Lavours meadow" was known far and wide as a breeding centre. After the French Revolution and during the 1800s, the various town councils issued strict regulations concerning the management of the marshes. Grazing was forbidden starting in May in the zones where the "sedge hay" was cut, generally at the end of July. Then the meadows were opened as common grazings. Horses remained very numerous in the marsh, several hundred in number. The First World War, however, marked the start of a decline in livestock farming and the abandonment of the meadows. The Second World War reinforced the trend and the marsh started to be invaded by shrubs.

**Incorporating the current paludal vegetation in a comprehensive dynamic system**. For centuries, the Lavours marsh constituted a system for exporting grass and hay. In spite of the extreme division into small plots, the same management system was implemented throughout the marsh. The type of usage, mowing or grazing, and the corresponding periods were imposed by the forage quality of the plant populations (Manneville *et al.*, 1994). Consequently, until the end of the 1800s, the Lavours marsh landscape was totally open with a virtual absence of all types of woody plants. That is also the reason why the inhabitants cut peat from the marsh to heat their homes.

The existence of a very slight gradient in terms of the hydrological conditions, combined with a pedologic gradient running from the outer edges of the marsh to its centre, resulted in a rich floristic environment and high diversity in vegetation groups (Pautou, 1975). The pedologic sequence, starting with the Séran river in the west and running to the peaty mound in the centre, is the following: soil made up of recent alluvial deposits, alluvial soil containing gley, humus soil containing gley, eutrophic peat interspersed with gley and finally, eutrophic peat with high organic-material content. The corresponding herbaceous vegetation groups are the following: meadows with *Bromus erectus* and *Arrhenatherum elatius,* sedge formations with *Carex gracilis* (= *C. acuta)* and *Valeriana officinalis,* sedge formations with *Carex gracilis* and *Thalictrum flavum*, sedge formations with *Carex elata, Molinia coerulea* and *Filipendula ulmaria*, and finally a group with *Schoenus nigricans* and *Cladium mariscus*.

The end of the traditional methods, which had maintained these groups, enabled the vegetation dynamics to come into play. The spatial gradient presented above was replaced by a time gradient corresponding to the gradual closing in of the vegetation. Starting from the wooded areas along the waterways, woody plants and trees again occupied the centre of the marsh. The copses of oak and ash trees growing on the alluvial mound of the Séran gained ground and alder trees (*Alnus glutinosa*) and thickets of *Frangula alnus* and *Viburnum opulus* spread to the peaty zones (Pautou, 1985).

When mowing and grazing were halted, the organic plant matter accumulated in greater quantities and modified the floristic composition of the meadow vegetation groups. If a further factor is mentioned, i.e. the modification in the marsh hydrology, due to the increase in the quantity of cereals planted during the 1970s and the construction of hydroelectric dams on the neighbouring Rhône, it is easier to understand why the formerly uniform sward of the meadow broke up into a mosaic of new combinations, more or less temporary, but which in the end all resulted in the growth of woody plants and trees.

**New techniques to manage the marsh.** It was in a context of general loss of vegetal (disappearance of

the pioneer and low-herbaceous stages) and animal (those species found in meadow environments) biodiversity that the Lavours Marsh Nature Reserve was created in 1984, covering a total area of 474 hectares. The primary goal of the managing body[1] for the nature reserve was to restore and correctly maintain the habitats specific to this riverside marsh, the main target being the wet meadows on the eutrophic-peat substratum. On the basis of a number of experiments implementing grazing, deemed successful in the field of conservation management, notably the Mannevilles reserve (Lecomte *et al.*, 1981, Lecomte & Leneveu, 1986) and in Tour du Valat (Duncan & D'Herbes, 1982), it was decided to organise grazing by cattle and horses in the nature reserve (Majchrzak, 1984). It was also decided to mechanically clear out the brush and undergrowth in the most heavily invaded meadows.

## SETTING UP GRAZING MANAGEMENT IN THE NATURE RESERVE

### First experimental period (1987 to 1991)

**The herds.** The initial decision on the zone to be grazed took into account three types of factors:

• the local hydrology and the risks of flooding in the zone;

• a number of requirements for scientific monitoring of the program and the statistical comparison of the results (diversity and representativeness of the sward);

• a number of limitations resulting from the fact that the managing body was not the owner of the land.

The grazing experiment started in July 1987 with the installation of 12 Highland cattle on a 26-hectare plot. An adjacent 30-hectare plot received 9 Camargue horses in February 1989. The plots were fenced with barbed wire. The animals lived in the marsh year round without any forage supplement in the winter.

**Monitoring organisation.** The year before grazing was initiated, a map of the grass and shrub layers was drawn up. It was used as the reference point for the quantitative study of the vegetation (Majchrzak and Manneville, 1987).

To quantify the impact of grazing on the herbaceous and woody plants, two techniques were used respectively, the linear survey method (Daget and Poissonnet, 1971) and counting of woody plants within a 16-meter circle. Some 110 permanent stations were thus monitored once per year in the beginning of July (**map 1**). At the same time, linear surveys were carried out in seven control stations that were protected from the animals. This system required the work of four people over seven days. The surveys always began with the flowering of *Thalictrum flavum,* which was the means to eliminate phenological variations due to the weather (Manneville and Majchrzak, 1988). Three-mode principal component analysis (ACP-3 modes, Beffy, 1992) was used to simultaneously analyse the spatial and time co-variations in the distribution of the species encountered. The species richness (the number of species), the species diversity (Shannon's diversity index H) and the structure of the vegetation (divided into four height classes) were also studied.

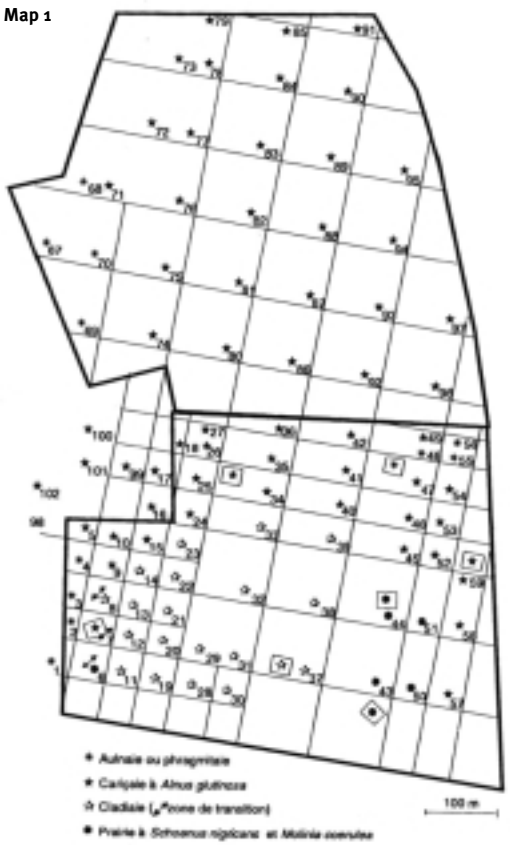
**Results and conclusions after five years of monitoring.** In the two enclosed plots, the modifications in the shrub storey were characterised by (Majchrzak, 1992):

• an increase in the area covered by *Alnus glutinosa,* which was not consumed and gained in height due to its fast annual growth;

• a decrease in the area covered by *Frangula alnus, Viburnum opulus, Salix cinerea* and *Betula verrucosa* which were consumed by both the cattle and the horses.

Generally speaking, there was little change in the species richness, but the reappearance of notable species such as *Liparis loeselii, Epipactis palustris, Plathantera bifolia* and *Gymnadenia conopsea* was observed, encouraged by the opening up of the environment. There was a decrease in the species diversity of the cattle plot and an increase in that of the horse plot[2]. This raised the question as to whether grazing by the horses was better. These changes would seem to be due to overly intensive grazing in the cattle plot, in spite of the relatively low density (0.65UMB/hectare[3] compared to 0.42UMB/hectare for the Camargue horses). The presence of a stand of *Cladium mariscus* offering very little nutritional value in the cattle lot reduced the actual useful grazing area and thus increased the density. With time, there

**Map 1**




**1** *interdepartemental project to eliminate mosquitos.*

**2** *In the cattle plot the specific diversity dropped from 2,51 to 2,32, in the horse plot it rose from 2,5 outside to 2,68 and 2,69 inside the enclosed plots.*

**3** *UMB: Medium Cattle Unity. This is used for animals from 300 kg to 500 kg heavy.*
*UGB = Big Cattle Unity. This is used for animals from 300 kg to 500 kg heavy.*
*(1 UMB = 0.8 UGB)*

**Map 1.**
*Location of the vegetation monitoring stations in the grazed lots.*

was the risk that the cattle plot could evolve toward two vegetation facies, one with dense *Cladium mariscus,* more or less invaded by Alnus glutinosa, the other with *Alnus glutinosa* sufficiently dense to cover the initial sedge stand.

In both plots, trampling by the herds resulted in small dips of bare and very wet land that encouraged the development of pioneer wetland plants with little grazing value, such as *Mentha aquatica, Hydrocotyle vulgaris, Ranunculus flammula* and *Scirpus palustris*. The overall cover by forage species was reduced, primarily that of *Phragmites australis*, but also *Molinia caerulea* and *Lotus uliginosus*. Consequently, the nutritional value of the plots was already put into question.

Following five years of experimentation and in light of the initial results, the managing body modified the grazing management policy. The goals were to:

- maintain the positive effects produced by grazing on the vegetation communities (reappearance of rare taxa, increase in the area covered by wetland plants, in the structural heterogeneity of the vegetation and in the species diversity);
- reduce the negative effects (increase in the area[3] covered by *Alnus glutinosa,* reduction in cover by forage species);
- adapt herd management to the zootechnical data acquired in the field.

**Reorganisation of grazing management (1993 to 1999)**

**The new methods used for grazing management.** Starting in 1993, the following methods were implemented to achieve the new goals:

- mechanical clearing of the *Alnus glutinosa* seedlings in the autumn;
- joining of the two grazing plots to form a single plot in order to mix the grazing conditions;
- maintenance of an open grazing meadow year round for the horses, with a forage supplement in the winter;
- wintering of the cattle outside the marsh;
- modifications in the density of the livestock, notably at the end of the summer, to limit the progression of *Alnus glutinosa*, while maintaining the specific diversity and the integral presence of the formation of *Cladium mariscus* and that of the notable plants.

**A reduction in the monitoring programme.** The initial monitoring programme required too much work, however, it produced enough data that it could subsequently be reduced (Manneville et al., 1994). The new programme comprised 76 permanent stations, of which 60 were already used formerly. The seven control stations outside the grazing plots were continued. The surveys were carried out on approximately half the stations each year, i.e. about 38 stations representing three days of work for two people.

**Results and conclusions after nine years of monitoring.** The species richness was sharply reduced in the two former lots combined into one (Morand *et al.*, 1998). From 1991 to 1995, the number of species was reduced from 96 taxons to 54 in the former cattle plot and from 80 to 26 in the former horse plot. Certain remarkable plants were no longer encountered (within the strict guidelines of the monitoring organisation), namely *Liparis loeselii, Plathantera bifolia, Gymnadenia conopsea, Gratiola officinalis, Rhynchospora alba, Orchis palustris,* etc. The reduction in the survey densities may account for a part of the drop in the species richness in that there was less chance of encountering the most rare plants.

The mechanical clearing methods did not reduce the dynamic growth of the *Alnus glutinosa*, which continued to spread rapidly, contrary to *Frangula alnus* which almost completely disappeared (**figure 1**).

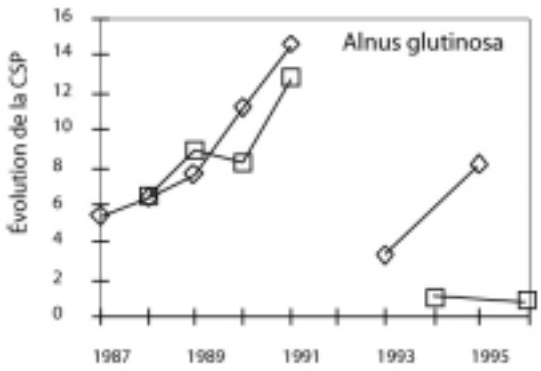



**Figure 1.**
***CSP[4] trend from 1987 to 1996 for Alnus glutinosa.***
*□ : horses plot*
*◇ : cattle plot*

**4** *CSP: The Contribution Specifique Présence is the ratio, expressed as a percentage, of the frequency of one species to the sum of the frequenties af all species. It shows the relative area covered by each species.*

*Highland cattle in Lavours reserve.*

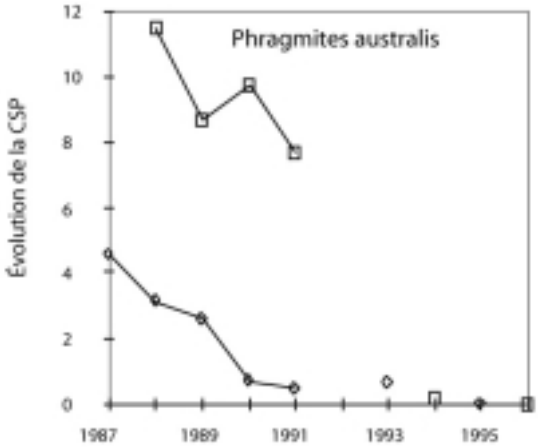
The overall cover by forage species was again reduced (**figure 2a**). The population of *Phragmites australis*, a highly palatable plant that appeared to determine the feeding itinerary of the horses (Majchrzak, 1992), decreased sharply over the last four years (**figure 2b**). The mechanical clearing probably accelerated the phenomenon. The amount of *Molinia caerulea* decreased locally in the overgrazed zones, but nonetheless remained fairly abundant (**figure 2c**). The same trends were observed for the leguminous plants (Papilionacées), however their initial standing in terms of cover was much lower. As a result, the problem concerning the forage quality of the grazed plot was not only confirmed, but worsened.

The increase in the cover of species encouraged by trampling continued, i.e. *Mentha aquatica,*

**Figure 2 :**

2 a


2 b

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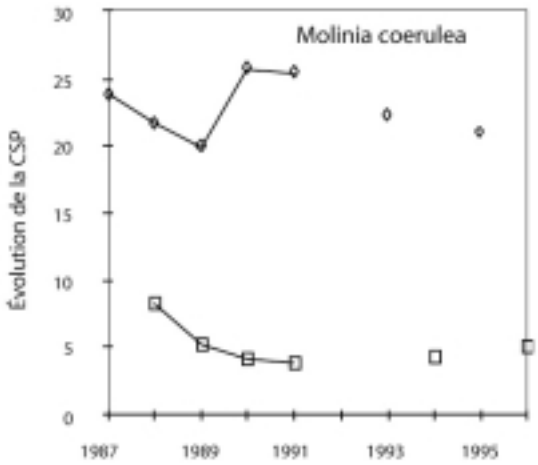
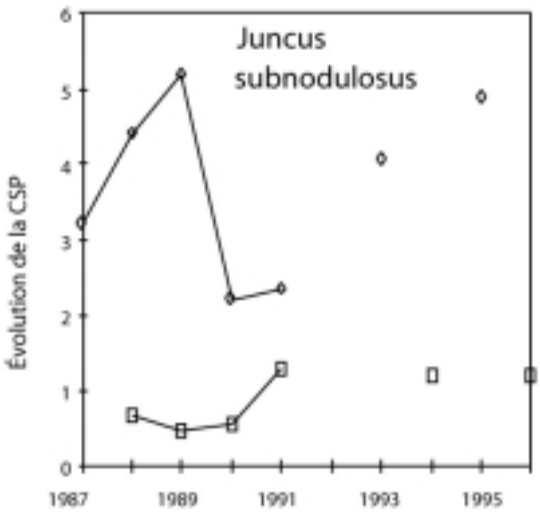



**Figure 3 :**



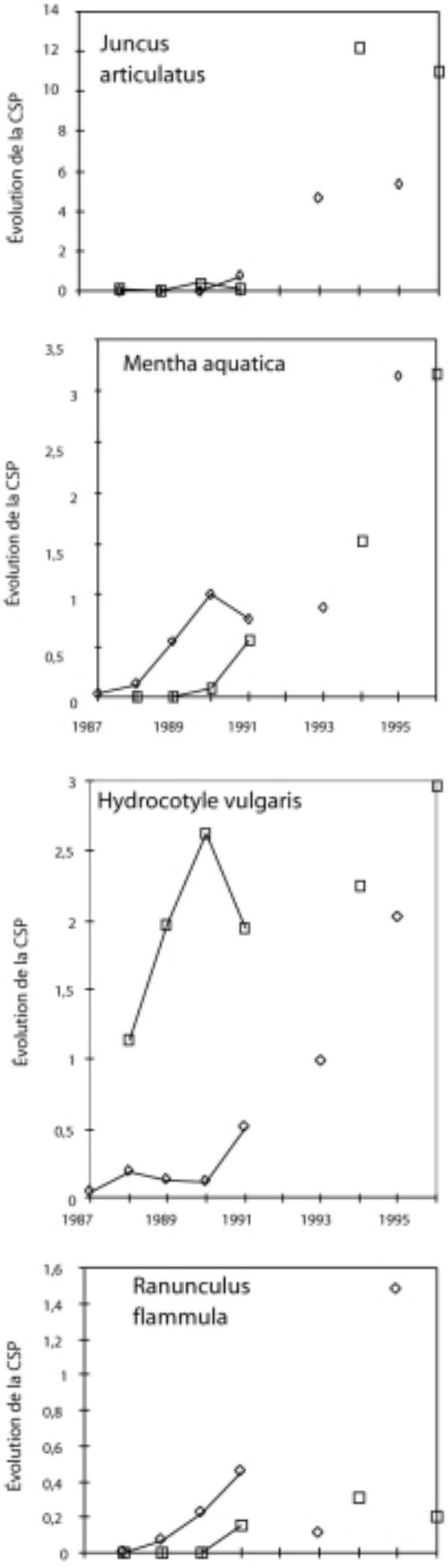




**Figure 2.**
***(a)*** *Evolution in the percentage of grass from 1987 to 1996.*
**(b)** *Evolution in the CSP of* Phragmites australis *from 1987 to 1996.*
**(c)** *Evolution in the CSP of* Molinia caerulea *from 1987 to 1996.*

**Figure 3.**
*Evolution of the CSP from 1987 to 1996 for Juncus subnodulosus,* Juncus articulatus, Mentha aquatica, Hydrocotyle vulgaris *and* Ranunculus flammula.

*Hydrocotyle vulgaris, Scirpus palustris, Juncus articulatus* and *Ranunculus flammula* (**figure 3**). The horses consumed *Cladium mariscus* in the beginning of the spring, which led to severe damage of the stand. This damage was increased by the repeated passage of the herds and use of the area as a rest and ruminating zone by the cattle.

Among the plants that tended to disappear is *Sanguisorba officinalis*, the exclusive host plant for two very rare species of *Maculinea* butterflies, *Maculinea telejus* and *M. nausithous*. The consequences for the conservation of these butterflies in the grazed lot were very clear. Very few *Maculinea* continued to fly in the plot and they could not reproduce due to the lack of the host plant where the eggs are laid (Morand et al., 1994). More precisely, the few *Sanguisorba officinalis* plants that remained could not be used by the butterfly because the floral scape was consumed. Only the rosette of basal leaves was left.

**Second reorganisation of grazing management (2000 onward) incorporating major changes**

Twelve years after the start of grazing and in light of the results produced by the vegetation-monitoring program, the managing body decided to modify the methods implemented for a second time. The goals remained the same, i.e. restore and correctly maintain the wet meadows on the peat substratum. However, a number of new elements had to be taken into account in drawing up the new grazing plan.

Precise maps of the herbaceous communities in the nature reserve were prepared (Darinot et al., 1998). Study of the various types of vegetation is essential to determine the chronological sequence of grazing in the various plots, depending on their nutritional value. This parameter was the major new feature in the reorganisation of the grazing plan. The sedge communities have mediocre nutritional value, however, the presence of reeds considerably increases their forage value. They should be grazed at the start of the season. Conversely, the areas of *Molinia caerulea* continue to provide good forage at the end of the season. As for the areas of *Cladium mariscus,* their nutritional value is very low and they should not be grazed. What is more, grazing damages their structure and eliminates the notable invertebrates found in the formations.

The distribution of species with high environmental value (flora and fauna) was better understood and could then be factored in, taking into account the sensitivity of each species to grazing. Among the species requiring particular attention in preparing the grazing plan were *Numenius arquata* and *Crex crex,* two species that do not accept the presence of herds while they nest. It was necessary to avoid the zones with large quantities of *Sanguisorba officinalis* until the middle of August to provide the *Maculinea* enough time to finish their cycle. These zones may coincide with the nesting sites of *Numenius arquata,* which simplified management. This is, of course, a very partial list of the species that must be taken into account.

Finally, some 100 hectares of wet meadows were progressively cleared and/or mowed around the grazing plot and had to be incorporated in the new grazing plan.

Consequently, given all the above elements, the managing body set up a conservation management program for the 150 hectares of wetland meadows on a peat substratum structured around the following points:

**1.** Three-year rotation system (grazing/rest/mowing) on identified plots;

**2.** Over the year, the herd moves to different places in the reserve, depending on the available forage and ecological sensitivities;

**3.** The calibrated herd is made up of horses which are easier to handle than cattle and mobile paddocks are set up using electric fences;

**4.** The Highland cattle, the animals symbolising the reserve, were moved to a plot closer to the public;

**5.** The 56-hectare lot was put to rest for two years (no management action).

## DISCUSSION AND CONCLUSIONS

**Results of the experiments in the Lavours march**

Many lessons may be drawn from the experience gained in the Lavours march in terms of grazing management. Over a period of 15 years, the management system progressively adapted to the environmental conditions in the marsh in step with the knowledge and know-how gained by the managers. Three major remarks may be made:

• starting with a purely "extensive grazing" approach, the management system was obliged to evolve toward a combination of grazing with other methods such as periodic mowing or trimming for maintenance purposes;

• in the process, the management system increasingly adopted the ancestral work habits which alternated grazing and mowing;

• maintenance of such a large meadow (150 hectares) by a single entity has a high cost and the management system must find a compromise between conservation of the natural environment and economic considerations.

**Lessons concerning the vegetation.** The example of the Lavours marsh nature reserve shows that destruction of *Phragmites australis* may encourage the growth of other, less palatable species (Alnus glutinosa), thus hindering the original goal of the grazing-management program. Majchrzak (1992) suggests that the exposing of peaty zones encourages renewed development of many orchids (*Liparis loeselii, Epipactis palustris, Platanthera bifolia* and *Gymnadenia conopsea*). The opening up of the environment would seem to be favourable to the orchids and they may also be consumed by herbivorous animals. The observations of the eating habits of the horses would indeed suggest that the orchids are grazed (e.g. *Dactylorhiza* sp.) (Morand & Tracol, 1991). In that the grazing plots have very diverse

environments, free roaming by the herbivores results in over and under-grazing depending on the spatial distribution and the availability over time of the forage resources, as well as on their palatability.

Similar consequences have already been observed on other sites. For example, in the Camargue, observers noted the development of *Scirpus littoralis* and *Typha latifolia* (Duncan & D'Herbes, 1982), to the detriment of the consumed *Phragmites australis*. In LPO[5] reserves, the animals are removed from the beginning of May until the end of June in order not to disturb the flowering of the many orchid species (*Ophrys apifera, O. sphegodes, Orchis fragans, O. laxiflora, O. palustris*) (Egreteau, 1995).

**Lessons concerning the bird wildlife.** The presence of the animals over the winter results in damage to the zones least capable of bearing their weight. The coexistence of the herbivores and the abundant waterfowl populations occasionally causes problems. This antagonism may result in competition for space or food resources. In the Moëze and Lilleau des Niges nature reserves, following an adjustment in the grazing-management system (decision in favour of organised grazing), combined with control over the hydrological system and the lack of disturbances to the environment, the meadows became attractive for the hibernating and migrating grass-eating ducks and geese. It then became necessary to remove the grazing animals due to the lack of food resources (Egreteau, 1993, 1995). The numbers of each species of grass-eating ducks and geese (*Anas penelope, Anser anser, Branta bernicla*) rose by a factor of ten. In the Lavours marsh, observers noted an increase in the nests of certain species such as the *Emberiza schoeniclus* and the *Saxicola*, due to the higher numbers of singing and perching stations on barrier posts (Morand, 1991 using the quadrant method), the attraction of the *Motacilla flava* during its migration to zones near the herbivores and the return of birds of prey due to the increase of their hunting grounds in open zones. However, these observations are of no particular value in the absence of an in-depth study. Concerning one of the expected species in the marsh, *Crex crex*, Broyer (1985) noted that a grazed meadow is not suitable unless the density of the animals is very low, whereas a mowed meadow is by far the most common habitat for the species. Major damage may occur through trampling of the nests. Different densities of livestock during the nesting periods of birds that nest on the ground may have positive or negative effects, depending on the species. According to British data (O'Connor & Shrubb, 1986), a density of 2.4 cows per hectare is sufficient to destroy 60% of the nests of the *Gallinago gallinago*, whereas 4.8 cows per hectare will destroy 80%.

**Lessons concerning the invertebrates.** There is even less information on the reaction of invertebrate populations to grazing, given the great number of species as well as the complexity of these populations, notably in terms of their identification and their biological cycle. In the Lavours marsh, Rozier (1999) observed that grazing had a notable effect on the population of *Sanguisorba* and *Gentiana pneumonanthe*, which are the host plants for *Maculinea* butterflies which have a high environmental value. Overgrazing, particularly when the larvae in their initial stages are still on the host plant, represents a serious threat to these butterflies. On other sites, the grazing had a positive effect on the invertebrate fauna, notably the coprophagic and coprophilic Scarab beetles, on condition however that the management system avoided certain errors concerned with worming the domestic animals. Grazing may also encourage certain specific phytophage groups or those requiring flowers, notably Syrphid flies (Lecomte & LeNeveu, 1993) due to the increase in the plant specific diversity and the reappearance of certain taxa. But any local results notwithstanding, it is not possible to generalise these positive conclusions concerning the effects of grazing on the invertebrate populations requiring flowers. Of even less value are any conclusions concerning the biodiversity of invertebrates.

Grazing produces a direct effect on animal groups through the elimination of certain host plants and an indirect effect through changes in the micro-climatic conditions and in the quality and structure of the vegetation. The notion of maximum biodiversity is too imprecise a goal for the evaluation of management results and methods. It is clear that different management systems encourage different taxa, species or groups of species.

**Conclusion**

However they are characterised, whether as a miracle solution for the return of rare taxa such as certain orchids (e.g. *Dactylorhiza maculata*), as a true "biological indicator on the improvement of the ecosystem" (Lecomte *et al.*, 1981), or as a means to maintain the initial ecological stages of the vegetation by controlling the large helophytes (*Phragmites australis*) (Duncan & D'Herbes, 1982) and the woody plants (*Salix sp.*) (Lecomte & Leneveu, 1986), domestic grazing animals have been used as a natural means to clear out scrub, offering both low cost and high effectiveness in a large number of nature reserves. The managers attempt to act on the existing populations (increase, decrease or elimination) in view of maintaining or encouraging rare taxa on the one hand, or obtaining maximum biodiversity on the other. Another possible goal of grazing management may be to conserve endangered breeds of farm animal and the use of large grazing animals, with their symbolic value, generates a considerable amount of interest and sympathy (tourism and information for the public).

Whether the goals in question concern efforts in favour of maximum biodiversity, conservation of rare species or key species, very often the managers attempt to formulate management techniques capable of reaching all their goals. For too long, grazing has had the reputation of being the ideal management method, notably for wetlands and wet meadows in particular.

Grazing, in as much as it constitutes a particular type of natural disturbance and a management technique

**5** *Ligue pour la Protection des Oiseaux*

**Figure 4.** *Camargue horses in Lavours reserve.*

for nature reserves, must be carefully and rationally assessed. It should never be considered a miracle solution, even when used on apparently identical sites.

Certain researchers have even suggested that this type of disturbance may even play a very minor role due to the multiplication of a large number of plants by purely vegetative means as well as the presence of considerable seed banks in the soil. The small number of studies on the consequences of grazing on the fauna is a further reason to avoid overly simple generalisations, if only because comparison is not yet possible.

The only way to reconcile scientific and social attitudes on this question is to set up clear goals and scientific monitoring of the management methods and results over a sufficiently long span of time. Otherwise, conservationists and the new managers of nature reserves risk losing a sizeable part of their credibility. Finally, whatever the characteristics of an ecosystem (species richness, composition, specific diversity, etc.), these factors simply describe the overall status of the system at a given point in time and in no way provide an indication on the long-term survival of the various species. Concerning the conservation of rare taxa, studies on population dynamics over considerable time spans are required to evaluate, in the most objective manner possible, the effects of grazing.

Extensive livestock farming has become a serious management technique in a society where the changes in European agriculture increasingly target sustainability under the growing influence of the social preoccupations of consumers. The mad-cow crisis has revealed the non-sustainability of the current development model for dairy farming (Landais, 1996). Concerning protected zones and nature reserves in general, considerable work is still required to assess the consequences of the extensive use of large domestic and "rustic" grazing animals on the environment and species. Extensive grazing must never be presented as a miracle solution to reconcile the interests of both nature conservationists and farmers who have decided to try these "autonomous and low-cost" solutions. There are management contradictions that have yet to be resolved. Grazing should be seen as one technique among many for the management of land and species. More rigorous scientific study and fewer blind supporters of one management technique or another are required to progress on the road to the conservation and management of nature sites. Otherwise, there is the risk of losing all credibility (Noss, 1994). To date, there is no scientific justification that may be generalised to conclude in favour of extensive grazing and against other management techniques. There is rather a set of alternatives, including some that have been tested, which should by compared and used depending on the local circumstances •

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