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Low-Impact Sheep Production as A Restoration Technique in England

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Introduction

In the United Kingdom today, 50% of the land is urban. Of the remaining fifty percent, 39% is used for agricultural purposes (Department for Environment, Food, and Rural Affairs [DEFRA], 2003). More often than not, environmental groups perceive that agricultural practice, of any form, is inherently damaging (Bignal & McCracken, 1996). Unfortunately, this statement has some truth to it. One example is areas intensively grazed by livestock. Such agricultural systems often become damaging when they are managed to be productive at the expense of the surrounding landscape either by overgrazing and/or by over-application of fertilizers. In particular, overgrazing and intensive soil fertility management can increase soil and nutrient runoff, which eventually modifies landscape structure and function.

Currently the UK is addressing the problem of agricultural-based ecosystem degradation by changing agricultural policies. This policy change favors extensive management: grazing lands are to be more sustainably managed by reducing stocking rates and fertilizer inputs. In some cases, land may be removed from livestock use entirely or may be grazed in a different season (Marriott et al. 2002). However, the overall loss of livestock productivity seems likely to increase government subsidies or increase the likelihood of farm abandonment. Since neglected or abandoned land is thought to be of lower potential wildlife value than extensively managed land, it is critical that these new policies are implemented in a way to be financially viable for the producer (Hulme et al., 1999; Marriott et al., 2002).

The shift from intensive to extensive livestock production offers the possibility that wildlife habitat will actually be restored within the agricultural landscape of the UK. (Ovenden et al. 1998). Life history needs of specific species of conservation interest can be incorporated into grazing schemes so that their habitat needs are met and their populations increase (Ovenden et al., 1998). In other cases, general changes in sward (i.e., area of land covered in meadow or grassy turf) management can target overall increases in biodiversity. Experiments on extensive grazing management have yielded encouraging results, like significant increases in the abundance of various grassland plant species (Jones & Hayes, 1999; Bullock et al., 2001).

Extensive management will be considered a conservation success if pastures have increased vegetative diversity, have decreased dominance by one or two species (i.e., better balance among grassland species), or improved populations of special concern conservation species.
The main considerations that are important for achieving these restoration goals include the season and the intensity of grazing. However, other factors like livestock forage selectivity and plant response to grazing can be uncertain and site-specific, making restoration progress difficult to predict. This report will investigate the primary strategies for manipulating extensive grazing management system to achieve sward restoration. In addition, specific guidelines will be suggested.

Season of Grazing

Season of grazing is an important factor sward restoration because plants will be favored that are not suppressed by livestock during their peak growth period. More traditional systems of haying and grazing put livestock out to pasture in early spring and remove the livestock in mid-May to grow the hay crop. The hay is cut in late-July/early August after which the livestock are returned to pasture until the winter weather prohibits grazing. These traditional systems have been ‘improved’ to maximize livestock productivity by cutting the hay crop early and making silage. Harvested hay eventually became less important other food sources, swards management shifted to focus on summer food supply (Smith et al., 1994). This intensive grazing regime relies on maintaining high productivity of *Lolium perenne* (perennial ryegrass) and *Trifolium repans* (white clover) throughout the growing season (Marriott et al., 2002). This requires fertilization. Yet, as grazing strategies change and agricultural policies favor extensive management, the most traditional systems, which vary the season of grazing are, relatively speaking the most promising for sward restoration.

Research has illustrated that colonization of diverse plant species is significantly greater when autumn, winter, and spring grazing regimes were employed (Jones et al., 1999; Bullock et al., 2001). Yet, no single season of grazing was responsible for a significant change in community composition. For instance, Bullock et al. (2001) found that winter grazing alone had no effect on species composition, but also found that the combination of winter and spring grazing increased the number of dicotyledonous species. Jones and Hayes (1999) found that autumn/ winter grazing had the highest seed establishment rate. Unfortunately, there is optimal livestock management strategy that combines any two of these three seasons (autumn/ winter/ spring). Yet, Marriott et al. (2002) speculate as to whether winter grazing is the key, as topographical and climatic constraints limited the possibility to use winter grazing. The most logical explanation for the positive effect of winter grazing is the affect of removing dead vegetation, whereby reduction of a shady vegetative cover promotes healthy development of spring germinating seed. Yet, it is also probable that the difference in soil texture and fertility give rise to variable efficacy of the management practice.

Intensity of Grazing

Intensity of grazing, also called sward height management, can impact plant establishment and seed production (Smith et al., 1994). For example, vegetation that is grazed heavily in the summer may restrict flowering and setting fruit later in the season. Marriott et al. (2002) found that some species are intolerant of high intensity grazing, such as *Poa trivialis,* whereas others that are not shade tolerant, such as *Poa annua* and *Trifolium repens*. These species increase under high intensity grazing. Marriott et al. (2002) found that removing grazing allowed a few tall grasses to become more dominant. Their data also suggested fertilization may cause some species to be lost from swards (although these results were not statistically significant). Since high intensity grazing greatly minimizes sward height, invertebrates (e.g., spiders, insects) are also potentially impacted (Dennis et al. 2001). Taller vegetation may harbor more invertebrate diversity because it provides greater protective cover from predation as well as habitat for breeding.

In addition to sward height, grazing intensity also changes the proportion of gaps that exist in the vegetation (Smith et al., 1994; Bullock et al., 2001). Gaps are created when livestock graze the vegetation to the crown, limiting regrowth. Since these gaps can be colonized (by seed or vegetatively) by new species, overall sward diversity can increase, if propagules are available (for instance, by overseeding). Jones et al. (1999) found that seed establishment was increased when gaps existed in a sward.

The highest overall species diversity is likely to occur on lands with a varying grazing intensity (e.g., Dennis et al. 2001). This condition would be most likely to occur in systems of rotational grazing, basing management decisions on sward height.

Contingencies in Long-Term Vegetative Management

The pattern of how intensely the grassland is managed and the season during which grazing takes place, however, does not always yield a predictable response over the years. Climatic variability can make detecting long-term trends in sward conditions difficult (Smith et al. 1994). This climatic variability can be coupled to differential plant growth and seed production among species.

Variability in vegetation response to intensity and season of grazing also occurs because the capacity of certain species to either tolerate or avoid grazing differs, affecting species composition. Some plants avoid being grazed because their growth habit or form makes them less visible or accessible. Others avoid grazing because they are less palatable than their neighbors (Hulme et al., 1999; Bullock et al., 2001; Marriott et al. 2002). Grazing tolerance, in contrast, is a physiological response (Marriott et al. 2002). Ultimately, plant's ability to withstand grazing likely determines its rate of reproduction and limits that plant's existence in the future community. According to Bullock et al. (2001), tolerance is likely a more common and important factor in determining sward composition.

Ironically, grazing management as a restoration technique has a long time frame. Yet, achieving the same goals, on such expansive areas of land, without the use of some form of management has proven to be even slower (Marriott et al., 2002). There is no true endpoint to the management practice as the site continues to respond to the surrounding environmental impacts. Yet, because the time frame for such a process is so long, it becomes difficult to be certain of the positive effects of such practices. For instance, in the twelve years of research Bullock et al (2001). suggest:
"It may be dangerous to assume that treatment responses… represent a gradual evolution[.] [An] extreme scenario may be that the differences [in plant communities between years] represent variation around a mean that has stayed constant over the years. However, the great change over the whole [grassland (in Bullock's experiment)] and the large increase in treatment effects suggest [Bullock et al.] saw a true time trend, although some individual species' responses may be transitory."

Recommendations

Experimental trails on aspects of extensive grazing management have broad implications for full-scale implementation. While some restorative processes are not completely understood it is increasingly apparent that something must be done to change current practices. Therefore, the remainder of this report offers guidelines for sward restoration, based on what is currently understood and what could be important in the future.

The first step in adopting extensive grazing management is to determine the necessity for such action. In general, the need to restore a sward will be greatest in highly degraded sites, in riparian areas, and on lands with high potential for wildlife habitat that have been adversely affected by overgrazing. Speaking with the land caretaker will help determine the levels of degradation and influence that these agricultural practices have had on the ecosystem. For example, lands that have become significantly less productive, despite the intensity of management practices, could indicate a reduction in the potential of the soil to be productive because of erosion, compaction, or a lack of fertility. Once the decision to shift grazing management strategy has been made and the areas of highest degradation have been identified, the site must be evaluated for what kind of restoration actions should be undertaken. In the event that a large area of the property needs to be restored, low-impact sheep production may be a reasonable option.

Secondly, the species diversity and viability of the soil seed bank and the surrounding undisturbed habitat should be investigated. The investigation should look into the length of time the site has been in intensive production. This will give the first indication on the difficulty of restoration, as the viability of the soil seed bank decreases with age. If the soil seed bank is an unlikely source for vegetative change any undisturbed vegetation in the surrounding landscape will be most important and will direct what the seed/ plant mix should be if seed and/ or plant materials need to be introduced from a removed source (e.g. private seed company or plant nursery) (Smith et al., 1994; Hulme et al., 1999; Bullock et al., 2001; Marriott et al., 2002). A possible cause of this may be high fertility from pre-existing site conditions, which ultimately favors fewer, more dominant, species (Bullock et al., 1994; Jones et al., 1999; Marriott et al., 2002).

In the event of high populations of undesired species and low populations of desired species in the soil seed bank/ rain the following should be considered before continuing: First, at least one year before grazing management begins, the majority of the undesirable species must be killed either by spot spray herbicide application or by treating the entire area and tilling up the soil. It might be a good idea to seed the area (post weed control) with early successional specie(s). Examples of these early successional species include: annual(s) that could be desired (early season of application) or an annual that would not go to seed before the dormant season (late season of application). These early successional species render a good cover preventing erosion as well as keeping the soil moist for germinating seeds the following spring.

The next step in the restoration process is to seed the area with a diversity of indigenous species. This seed could be collected locally or purchased from a seed company that sell local seed. The decision to collect or purchase seed will be affected by the financial resources available for the project and commercial availability of indigenous seed. Inexperienced managers should work with an experienced restorationist (i.e., apprenticing) until they gain sufficient expertise with indigenous plant materials and the process of seed collection.

The land manager should create paddocks (enclosures) by cordoning off the area to be restored into relatively equal parcels of land before grazing management would begin. Experimental setups have used .25- .5-hectare (ha) enclosures, although in practice they should be much larger. Grazing can begin at virtually any time after these steps have been accomplished.

Rotational grazing is highly recommended: Grazing certain plots to an overall sward height that is coordinate with the season of grazing is the key. An example would be to set a randomized pattern for grazing plot X at a set height of L cm in season A, a set height of M in season B, a set height of N in season C and a set height of O in season D. Then, randomize this pattern for all plots within the compound and allow for, up to one plot per every five plots, to go fallow per grazed plot respectively. Plots can be allowed to go fallow for an entire year, but longer periods may prove to be detrimental. The pattern should change annually or biannually to encourage a variety of diverse species to colonize the various plots. [Note: this definition of rotational grazing is this author's perception and should not be taken as the only way of rotational grazing management. It is strongly encouraged that other examples of rotational grazing management be studied and understood.]

Taller, more aggressive species should be managed so they do not crowd out shorter, desirable species. In addition, summer grazing should be managed to avoid the extirpation of desired plant species that are still establishing. Fall and winter grazing likely have the most beneficial effect of grazing on the establishment of incoming propagules (Jones et al., 1999).

Livestock densities should change in accordance with sward height. Sward heights can be referenced using a "Hill Farming Research Organization Swardstick (Treweek et al., 1997)." In collusion with stocking densities and sward height management, Treweek et al. (1997) suggested that 'higher stocking densities promote more uniformity in sward height in shorter swards.' Yet, the size and distribution of land will also dictate the stocking rates. Moderate-stocking densities typically vary from 8 sheep/ ha to 20 sheep/ ha, however, there is no one accepted value for a typical scenario. Therefore, land managers should include in their variable rotational grazing management strategy, a tertiary stocking rate variable, until the appropriate stocking densities can be determined.

Conclusion

In conclusion, the effect of grazing management appears to have, at least in the short-term, a positive impact on increasing and maintaining species diversity in England. Ultimately, the practice of extensive management and sward restorations short-term benefit could carry over into positive (or negative) long-term effects. However, it is difficult to be one hundred percent sure that this practice can be used into the long-term. Nevertheless, the most important goal is to significantly reduce the impact of agriculturally degrading practice such as overgrazing and over application of agricultural chemicals. Extensive agricultural practice in any form is likely to achieve such a task. Yet it is just as important to sustain the livelihood of the farm. The programs that support extensive grazing management are likely to be the best source for a start on such a practice. However, extensive grazing management should eventually be a sustainable practice. Some believe that the loss in productivity, as a result of eliminating extraneous inputs, may bring in the same or slightly less profit as normal production (per head). In particular, the cost of maintaining a highly productive system increases the cost of operation thereby driving down the profit. The key is to understand the cost/ benefit of intensive vs. extensive management. Subsidies may be needed for land to be managed sustainably yet profitably. If society thinks restored agricultural land will offer broad values, such as tourism and conservation (Ovenden et al. 1998, Bignal and McCracken 1996), then it may be logical for livestock managers to receive public financial support.

Literature Cited

Bignal, E.M. & McCracken, D.I. 1996 Low-intensity farming systems in the conservation of the countryside. *Journal of Applied Ecology* 33: 413-424.

Bullock, J.M., Clear Hill, B., Dale, M.P. & Silvertown, J. 1994 An experimental study of the effects of sheep grazing on vegetation change in a species-poor grassland and the role of seedling recruitment into gaps. *Journal of Applied Ecology* 31: 493-507.

Bullock, J.M., Franklin, J., Stevenson, M.J., Silvertown, J., Coulson, S.J., Gregory, S.J. & Tofts, R. 2001 A plant trait analysis of responses to grazing in a long-term experiment. *Journal of Applied Ecology* 38: 253-267.

Dennis, P., Young, M.R. & Bentley, C. 2001 The effects of varied grazing management on epigeal spiders, harvestmen and pseudoscorpions of *Nardus stricta* grassland in upland Scotland. *Agriculture, Ecosystems and Evironment* 86: 39-57.

Hulme, P.D., Pakeman, R.J., Torvell, L., Fisher, J.M. & Gordon, I.J. 1999 The effects of controlled sheep grazing on the dynamics of upland *Agrostis- Festuca* grassland. *Journal of Applied Ecology* 36: 886-900.

Jones, A.T. & Hayes, M.J. 1999 Increasing floristic diversity in grassland: the effects of management regime and provenance on species introduction. *Biological Conservation* 87: 381-390.

Marriott, C.A., Bolton, G.R., Barthram, G.T., Fisher, J.M. & Hood, K. 2002 Early changes in species composition of upland sown grassland under extensive grazing management. *Applied Vegetation Science* 5: 87-98.

Ovenden, GY.N., Swash, A.R.H. & Smallshire, D. 1998 Agri-environment schemes and their contribution to the conservation of biodiversity in England. *Journal of Applied Ecology* 35: 955-960.

Smith, R.S. & Rushton, S.P. 1994 The effects of grazing management on the vegetation of mesotrophic (meadow) grassland in Northern England. *Journal of Applied Ecology* 31: 13-24.

Treweek, J.R., Watt, T.A. & Hambler, C. 1997 Integration of sheep production and nature conservation: experimental management. *Journal of Environmental Management* 50: 193-210.