GRAZING AND THE CONSERVATION OF LOW-NUTRIENT OPEN LANDSCAPES

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A lot of nature conservationists worry about the future of flora and fauna in low-nutrient open landscapes. They fear that a more natural grazing management will stimulate the process of succession, until these semi-natural habitats are overgrown and many rare species are lost forever. Are there grounds for their concern?

In most of Europe, dry low-nutrient open areas are semi-natural. Grazing by herded livestock, fire and haymaking have maintained these landscapes for thousands of years. For centuries, seasonal herding on the sandy soils of north-western Europe provided essential manure for sedentary arable farming. From the mid 19th century on, however, industrial fertiliser, barbed wire and cheap wool from Australia sounded the death knell for this agricultural system. Pastures on depleted soils were abandoned, sold and transformed for commercial forestry and modern agriculture. In the Netherlands, about 60,000 hectares (3%) was preserved for traditional management: about 40,000 ha of heath and shifting sand, 15,000 ha of coastal dunes, a few thousand hectares of salt marsh, some 30 ha of chalk grassland and 500 ha of low-nutrient river basin grassland. These areas are now important habitats for many of the species targeted by Dutch and European nature conservation policy.

In the last two decades, nature managers have introduced various animals to graze fenced areas, with the aim of restoring and preserving these type of semi-natural habitats. In addition, parcels of adjoining forest and farmland are often added to sites which previously comprised only unfertilised pastures. Experiences of the last ten years have shown that this type of management reduces the rate of succession on heath and shifting sands. The key question is whether natural grazing can adequately preserve the open character and nutrient scarcity on heath and shifting sands for the survival of numerous target species here. Could semi-natural management be an essential condition here?

Fenced grazing versus herding

Grazing by free-ranging grazing animals, with the direct aim of benefiting nature, was introduced in the 1970s. For practical and ecological reasons, fenced grazing was chosen in favour of traditional herding. Fenced grazing with introduced animals is relatively easy to put into practice, and therefore inexpensive. It was also seen as the more natural option. In only a handful of locations were herds of sheep tended by a shepherd in the traditional way.

It is now evident, however, that fenced grazing increases the chance of eutrophication and succession. About two-thirds of the daily production of manure and urine is deposited in the animals' rest areas in the field, rather than in a barn or shelter. Unlike in the semi-natural situation, nutrients do not leave the area. In addition, there is no shepherd (or sheepdog) to force the animals to make full use of the terrain and consume the less tasty plants as well. When given the choice, animals avoid plant species that they do not like to eat and this causes a site to become overgrown and susceptible to succession, and accelerating the nutrient uptake from the air. Species which are less vulnerable to predation, such as Scots pine, silver birch and, on more fertile soils, blackberry colonise the open terrain, causing a reduction in food supply so that animals go hungry. When animals go hungry, site managers tend to reduce their numbers per hectare. After all, emaciation and death do not go down well with the public, and supplementary feeding is not allowed on principle. The result is a downward spiral of avoidance, succession, food shortage, loss of condition and declining population density.

Without human intervention, large grazing animals lose out in the competition with plant species which are not susceptible to predation. In traditional husbandry systems, this process was halted by bringing the animals indoors in winter, providing them with supple-

Poor soils are by definition short on food. This photo shows how a cow resolves the mineral shortage by eating a dead rabbit. Photo: Michiel Wallis de Vries.

mentary feed and by grassland management. However, the essence of controlled natural management is that animals graze year-round without grassland management, supplementary feeding or other forms of human assistance. Enlarging areas to include adjoining woodland and agricultural land solves the food problem but creates a management problem: the animals abandon the heath where food is scarce in favour of the more abundant supply in the new areas.

Enlarging areas to include woodland

Enlarging areas to include woodland gives freely grazing animals a place to rest and an alternative site to graze. Researchers on the Wolfhezerheide found that cattle tended to rest rather than graze in the woods. This meant that there was a flow of nutrients from the heath to the woodland. In effect, the woodland acted as a "barn" and the animals' access to it increased the nutrient out-flow from the open heath.

Wild grazing animals display similar behaviour. Very shy animals only leave the forest at night to forage in the open fields. When there are small open, grassy sites in the forests, they prefer to forage there during the day. This behaviour not only stimulates the development of woodland meadows but also reduces the intensity of grazing on the open heath. This process becomes more pronounced when access to more, especially mature, woodland is created. In 1994, the Wildbaan (3200 ha of heath, shifting sand and barren Scots pine forest) in Hoge Veluwe National Park was expanded to include 1800 ha of mature, ungrazed cultivated woodland. This resulted in a spectacular migration of red deer and wild boar from the Wildbaan to the newly accessible woodland. In only a few months, the population density of wild boar in the woods exceeded that of the abandoned Wildbaan area. In the red deer population, this point was reached after two years. Attempts to counter the migration by providing additional meadows, salt licks and quiet areas in the Wildbaan failed.

Extensive grazing cannot prevent eutrophication and acidification in areas of poor soil. As long as the complement of herbivores is not complete and density is high, supplementary management is required.

Enlarging controlled natural areas accelerates their succession into a dynamic mosaic of woodland and meadows. Large herbivores counter the regeneration of broadleaved trees (oak, rowan, birch, beech) in older forest and in open areas in the forest. At the same time, the animals avoid Scots pine and silver birch which grow on the open heath. Trees thus grow up on the heath while the adjoining forest is transformed into grazing lawns. This process can be observed in Wolfhezerheide (grazing by cattle), Hoge Veluwe (red deer) and the New Forest (cattle, horse, red deer).

Adding farmland to nature areas

Enlargement with farmland can also accelerate succession on open heath. The fertile grasslands lure animals and reduce the grazing intensity on heath, especially in the growing season. The period when heath is grazed shifts from summer to winter. This effect increases the greater the distance to fertile pastures. In Wolfhezerheide, for instance, the addition of 6 ha of farmland in 1993 led to a five per cent increase in blackberry coverage on the heath in five years' time. This sharp rise was due to decreased stripping of blackberry bushes, because of the migration of animals to the farmland. Within these higher and more expansive blackberry bushes, English oak, rowan, alder buckthorn and currant are now growing up for the first time since 1983.

Real grazing animals prefer to forage on fertile grassland because they can optimise their intake of nutrients and calories. Grazing animals do not move to the nutritionally poorer heath until the food supply on grassland becomes insufficient for the herd, usually in the winter although farmland on drier soils also tend to have a mid-summer dip in grass production.

In the absence of grazing, open heath falls prey to succession and eutrophication. When animals use the heath more for resting than for grazing, there is a net input of nutrients. In the past, there had always been a net output as flocks of sheep grazed on the heaths deposited these nutrients in barns, and the manure was deposited on agricultural fields. The situation now is therefore one of "re-eutrophication".

As yet, we are uncertain what the consequences are of winter grazing on heath. On wet heath, purple moorgrass is the staple diet of freely roaming cattle and horses in summer. This benefits bell heather and common heather. In the winter, when purple moorgrass has a very low nutritional value, the animals

Wildlife viaducts contribute to the Veluwe's ability to support a larger number of nomadic grazers

prefer to eat common heather. Thus, the shift of more intensive grazing to winter results in a completely opposite competitive advantage and leads to grass encroachment. This effect is less pronounced on dry heath with small-leaved undergrowth (such as wavy hair-grass, common fescue and bent grass), whose quality is more consistent.

Grazed farmland loses its fertility in the course of time due to nutrient output, run-off and erosion. Rooting and digging activities accelerate this process. Nevertheless, former farmland remains distinct in a heath landscape for a long time; the idea that grazing causes the sharp manmade boundaries to fade more quickly is a misconception. In the New Forest, for example, heath which had only been exploited for a brief period after World War II has been integrated again in the grazed woodland-heath landscape, but the plots still stand out after fifty years of grazing, as differences in grazing intensity, structure and species persist.

The role of natural soil fertility

A switch to controlled natural management implies that in the future, ever larger areas with larger natural fluctuations in soil fertility will be grazed. Natural meadows are found on salt marshes, on the banks of rivers and along lakes, in dune valleys and along streams. Adjacent dry, low-nutrient areas such as dunes, lateral moraine, sandy soil areas or chalk slopes will remain open if they act as a refuge for animals in times of flood or food scarcity. Adjacent fertile but wetter areas, such as dune slacks, basins and peatlands will not be accessible until late summer or fall. They will usually be grazed once, incompletely. There is a good chance that these areas will become overgrown and succeed to woodland. In traditional agricultural systems, these wetter areas were preserved because they were mown for hay.

Dry areas situated at a distance from summer grazing sites rich in food will likely be prone to succession. These areas do not naturally receive substantial, annual deposits of manure and will at most feature short-lived, small-scale meadows in a dynamic woodland-meadow mosaic. Nitrogen, phosphor and potassium, which are crucial for grass production, are supplied through the mineralisation of organic matter which has built up during the woodland phase. Depletion, declining grass production and grazing intensity gradually raise the survival rate of unappetizing woody species (both shrubs and trees) on the small meadows. In this model of cyclic succession, in which grazing intensity is regulated primarily by nutrients and geographical association, it is unlikely that large-scale low-nutrient heaths and shifting sands would occur at a larger distances from summer meadows.

Very large areas and more species of grazing animals

Dutch nature policy aims to conserve wild flora and fauna in a landscape which is as natural as possible. If grazed areas are made even larger, they will encompass a more complete eco-hydrological gradient. Re-introduction will make the range of herbivores more complete and increase the densities of herbivore populations. There are strong indications that only this combination of factors will increase the chances of retaining the open character of dry, low-nutrient regions.

Expanding large low-nutrient areas such as the central Veluwe with bordering fertile summer grazing areas increases the region's capacity for large herds of nomadic grazing animals (cattle, horses, wisent and red deer). Seasonal migration, flooding and summer overpopulation can raise the grazing intensity in the drier margins of the Veluwe far above what could be achieved with the controlled natural approach. A broader range of herbivore species would also benefit the preservation of open areas. Overlaps in habitat and diet mean that animals can both amplify and complement their effect on the landscape. Competition for food in fertile meadows can result in higher grazing intensity in marginal, poor habitats. More species of grazing animals implies a better use of the primary production. When there is species overlap, one species can fill the niche left by a population crash in another. The resulting stability in grazing intensity is conducive to openness. Each species has its own role in the food chain and the successional mosaic cycle. Browsers such as moose and roe deer can suppress regeneration in the forest, creating open areas for light-dependent grasses and grass-eating animals (cattle, horse, wisent, red deer, fallow deer, rabbit) and grazing lawns.

Encroachment by unappetizing woody species on depleted lawns can be delayed by these browsers as well as species like rabbit and hare which live in more open habitats.

What are the chances of openness on naturally grazed sites on sandy soil, loess and chalk, disregarding the effects of water stagnation and fire? My estimate is that expansive areas of heath (> 10 ha) will only occur in the direct proximity of fertile summer grazing areas and that shifting sands will only occur on these heaths at susceptible locations. At a distance of more than one kilometre from summer grazing areas, I predict that only woodland meadows would occur. The large areas of heath and shifting sands in low-nutrient areas of the central and southern part of the Veluwe are probably completely anthropogenic. Traditional farmers did not only replace extinct large herbivores here but from the Middle Ages on also had a far greater impact than the prehistoric animals ever had.

Ecobridge Veluwezoom (Terlet, 50 m wide); photo by Karsten Thomson.

Implications for policy and management

Conservationists' concerns regarding low-nutrient open landscapes and their flora and fauna are justified in part. A switch to controlled natural management creates both opportunities and threats. In the long term (> 50 years), there might be good, interesting ways of achieving openness, natural heaths and shifting sands, provided nature areas cover the full eco-hydrological gradient and are populated by the complete range of herbivore species in sufficient numbers. In the short term (<25 years) it will be difficult to realise these conditions. Non-intervention will result in succession, eutrophication and acidification, and these effects will be more acute as the grazing ecosystem is less complete.

For the time being, therefore, nature managers in the Netherlands and in many other areas in Europe, will have to take additional measures to ensure that grazed heath and shifting sands remain open. In the New Forest, bracken fern, gorse and young trees are mechanically removed. It is this fixation of succession by man which forms the crucial ecological difference with the successional dynamics of controlled natural landscapes. Successional fixation means that grazing and depletion processes are prolonged on heath. It results in larger areas, greater depletion of the soil, an increased chance of erosion by water and wind, and greater depositions in the soil acidification process. In the past, species which preferred large open areas and low-nutrient, moderately acidic and neutral soils, many of them species which prefer mild conditions, were also maintained in this way.

Low-nutrient meadow ecosystems are currently in a transitional phase. Additional management is needed to prevent the loss of biodiversity in controlled natural areas. The most vulnerable species are target species which are dependent on large open areas, early succession stages, low-nutrient soils and acid buffering, and target species which occur at greater distances from fertile meadows. The latter will have to be moved to more natural locations. Additional management is needed during the transitional stage, until new, more natural habitats are developed to be colonised by these species. It would be unwise to undo the neglect existing areas before suitable new ones are developed.

In practice, this will mean establishing temporary "exclaves". The duration during which we must maintain these exclaves will depend on the rate at which natural, low-nutrient open habitats arise and are populated by target species. It will probably take a few decades. Time will tell. Cultural-historical and recreational functions might demand permanent exclaves.

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REPTILES AND GRAZING

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Reptiles and grazing are interrelated concepts. Most reptiles in the Netherlands owe their presence at least partly to grazing. However, current grazing practices in many places are actually resulting in serious threats to reptile species. Extreme caution is thus needed.

Reptiles are cold-blooded animals for which survival depends on open landscapes comprising more enclosed and highly structured microhabitats. In the Netherlands most reptiles occur in heathlands. They prefer to sun themselves in open spots near the edges of low plant growth, in which they can cool off after having raised their body temperature sufficiently, or take cover if danger approaches. The vegetative cover also houses the majority of the small animals on which they feed.

Grazing opens up the landscape (or keeps it open), especially when combined with peat-cutting and burning, as took place centuries ago on the heathlands. Without grazing and these other interventions, the normal succession in vegetation would lead to the formation of woodlands in virtually all landscapes. Moreover, this sequence is being accelerated in the Netherlands due to the deposition of large quantities of nitrogen. This has the equivalent effect of continuous application of fertiliser, an effect which is greatest on poor soils. To halt the succession to woodland, herbivores are grazed on the land. Thus, in principle, grazing is beneficial for reptiles.

However, if we compare the current situation in nature areas with that of the period before grazing was employed, it emerges that often a distinct homogeneity arises at the micro level. Although grazing has prevented woodlands from encroaching, the large heather bushes have often completely disappeared. The macro-diversity is maintained, but the micro-diversity has vanished. It is in precisely these places where the sand lizard has declined, and species such as the viviparous lizard, blindworm and smooth snake have totally disappeared. Study of a grazing project using Scottish highland cattle showed that (in an originally homogeneous landscape) the density of the viviparous lizard was three to five times higher outside the enclosed area than inside.

Encroaching woodlands leading cause of species decline

Large-scale afforestation is the number one cause of the disappearance of reptile populations, including those in nature reserves. A study lasting over 25 years in the Overasseltse en Hatertse Vennen, a nature reserve in river dunes, showed that in no fewer than 10 of the 14 cases, this accelerated vegetation succession was the sole cause of extinction of a population. Another study, carried out in the eastern part of the province of Noord Brabant, in which 52% of the lizard biotopes present disappeared over 10 years, vegetation succession on heathland remnants and other bleak patches were definitively proven to be the main cause. All of our reptile species are more or less linked to certain intermediate stages in the sequence from open to closed vegetation types. In heathlands, these are the stages from open sand to the final oak-birch forest. Detailed studies of the viviparous lizard show that, among other things, in river-dune landscapes this species only reaches high population densities in a few intermediate stages of the local vegetation succession. They appear in the first heath-like stages and disappear once the forest becomes closed. The optimal stages for reptiles are in older heathlands with wild shoots and the initial stages of oak-birch forest.

These transitional stages last rather long in poor soil conditions, and in the past they were prolonged even more by the regular appearances of shepherds whose grazing sheep would set the succession process back. The cessation of sheep-herding and the additional fertiliser provided by air pollution have ensured that these stages now run their course rather quickly. The animals barely have time to build up the populations necessary to disseminate to any extent.

Grazing in the forms it takes today is often much too intensive for these sorts of areas. The positive effect (slowing the vegetation sequence) quickly shifts to negative, since it creates precisely the stages of vegetation succession which

Grazing is only favourable for the sand lizard if it creates sufficient micro-variation.

To allow threatened populations of target species enough time to migrate, it may be necessary to temporarily fence off certain parts of the site.

are too open or poor in structure (at micro-level).

Earlier macro-gradients in the landscape

In the original European landscape, reptile biotopes were in river and stream valleys and river deltas. The continent would have been entirely covered by forest, were it not for natural processes such as fires, storms, peat forming, water erosion, flooding and large grazing animals which kept the landscape open. The vast peat marshes were suitable for only a few reptiles, while fire and storms had only localised effects, well spread out over both space and time. Water erosion and the large herbivores had more permanent effects, again both in space and time. If the hand of man has largely subdued the first of these two factors over the course of time, it has made the second into a formidable influence on the landscape. Until recently, grazing worked to the advantage of reptiles. The large herds of domesticated grazers created macro-gradients everywhere in the landscape, more or less in rings around the old centres of habitation. This country had extensive macro-gradients around the sheep folds, from bare ground next to the pen to open forest margins in the farther reaches only seldom visited by the shepherds. These latter areas were especially well suited for reptiles. Since these gradients were so extensive, even in their less hospitable parts there were always small spots where reptiles could survive in abundance. Currently there is virtually no nature reserve in the country with sufficient space for these ancient macro-gradients.

Herding or fencing

Fragmentation of the landscape is so fatal for animals with little ability to migrate that it is making grazing a dangerous management instrument. Reptile habitats in the Netherlands have been greatly fragmented. The once-contiguous forest and heathlands were broken up into many smaller areas. Each of these can contain good habitats by itself. However, these little 'islands' cannot provide macro-gradients, which makes the survival of the animals in them very fragile. Re-colonisation from nearby areas is often no longer possible; if the animals have disappeared from an area for a reason, then this extinction is definite.

Moreover, small areas have an unfavourable proportion of perimeter to area, which makes them even more sensitive to outside influences. The accelerated sequence of vegetation, so unfavourable to reptiles, often occurs earlier and faster. This gives rise to the tendency among nature managers to intervene quickly, and sometimes drastically. In small areas this can carry huge risks.

A herder of sheep, cows, goats or pigs can graze them very precisely, i.e. he or she can determine exactly where the animals may and may not graze. They are directed to the best spots for feeding, and the herder can often ensure that given parts of the potential grazing area are spared for a time. The more frequently sought out richer grounds are thus more intensively affected, while the vulnerable leaner areas are left more or less undisturbed. Where ani-

Butterflies and grazing

All succession phases of vegetation host butterflies. To complete their life cycle, butterflies in turn depend on the presence of plants – as hosts at the caterpillar stage, for nectar as adults, and to provide suitable places for wintering and a favourable microclimate. A warm microclimate is especially important for caterpillars; within this requirement some species need open vegetation and some also need variation in structure at the micro level. Furthermore, the spatial structure on the macro scale is important to adult butterflies, since thickets and edges of forests offer shelter. It is reasonable to conclude, therefore, that grazing can benefit butterflies, although the benefits will differ by species. There are of course red list butterfly species as well which benefit from other management instruments such as mowing, peat extraction, or coppicing. But the richest variety of butterfly species is found in park landscapes, most of which are extensively grazed.

In practice, grazing does not always bring about the intended variation in vegetation structure, so that the practice ultimately has a negative result, or only benefits a few species. Like reptiles, a variable influence from grazing over space and time is important for butterflies. Most grazed areas are smaller than 1000 ha, which necessitates the nature manager carefully gearing the frequency, duration and intensity of the grazing periods to the fauna. The vegetation structure can be maintained as an indicator of an optimum condition. Although the principles of successful grazing policy for both flora and fauna are gradually becoming clear, knowledge of the best approach for concrete situations is still limited. More monitoring of vegetation and fauna needs to be done, in addition to more in-depth research on the relations between grazing, structural variation and prevalence of species.

Grazing has a great influence on red list species, and many of these are butterflies. The national butterfly counting network keeps an eye on the red list butterfly species.

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mals graze in a fenced-in area (and especially given the Dutch situation of relatively small parcels), the system of clear variation in influence barely exists any longer.

Type of grazers

The mineral cycle of lean soils with few nutrients is easily affected. Large herbivores such as cows and horses are high-energy colossuses, bringing the precarious mineral cycle much more out of balance than smaller animals, such as sheep, which are adapted to more Spartan conditions. Horses and cattle originally kept closer to rivers, principally in the deltas, where rich soils prevailed. Grazing these animals on truly poor soils is thus not the right choice, although the enormously increased nitrogen supply in large parts of the country may give the appearance of a richer soil.

Grass overgrowth and reptiles

Reptiles certainly occur in other places besides shrub and bog-heather vegetations. They can thrive in situations dominated by moor grass or wavy hair grass. These vegetation types can also be rich in structure, with a great variation between sunny and sheltered, closed spots. The food supply, especially invertebrates, can be lower than in the heath, so the local population density of lizards can be lower in grassy heaths. On the other hand, these heaths can contain more mice, which is favourable for mice-eaters such as adders and smooth snakes.

Conclusions

Grazing is in the long term always beneficial for reptiles, as long as it is spread out over space. This necessitates large areas and proportionally smaller numbers of grazing animals. In the Netherlands, where grazing is employed predominantly in relatively small areas, it is thus risky as a management tool, and has already caused the extinction of more than a few populations. For reptiles, the Dutch landscape has become greatly fragmented, which nearly always means certain extinction for local populations. On small sites grazing quickly becomes a negative factor due to habitat destruction (since it sets back the vegetation to a too-early stage of succession.). This can be mitigated by spreading out grazing of small areas over time. If done carefully, grazing is in theory good for sustaining reptile populations, but the following points are of great importance:

- Current and potential reptile biotopes must be re-connected; if these areas are grazed, the area must be as large as possible and the number of grazing animals must be limited. The grazed are must be built up gradually to give the fauna present a chance to adapt.
- At a later stage it can be useful to vary more intensive grazing with more extensive (i.e. spread out) grazing.
- If there is too much forest growth, mechanical removal (cutting) is by far preferable to long-term high-intensity grazing.
- Grazing of small areas is only acceptable for reptiles if the grazing periods are brief, and always followed by long periods with no grazing. Even during the brief grazing period, the number of grazing animals must never be so high that all parts of the terrain are grazed.
- In fine-tuning details of grazing policy (number and type of herbivores, placement of a boundary fence, etc.) and any additional measures, it is necessary in all cases to take reptile populations into account.

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