

## Manipulating ungulate herbivory: Effects on forest biodiversity

*What are the possibilities for conserving or restoring the biodiversity of forest ecosystems by manipulating the populations of deer, livestock or other ungulates? MISTRA EviEM has assessed how changes in grazing and browsing pressure by such animals affect plants and invertebrates in temperate and boreal forests.*

### Too much herbivory? Or too little?

In many parts of the world, human activities have greatly influenced the abundance and species composition of large herbivores. In some cases, this has resulted in either very high or very low herbivory pressure.

'Overabundance' of native wild herbivores has frequently been identified as a major challenge for forest regeneration and biodiversity conservation. On the other hand, a lack of mammalian herbivores can also have negative effects on biodiversity. Consequently, management of herbivory can be a critical tool for forest conservation.



Moose (*Alces alces*) are among the most important herbivores in Swedish forests. Photo: Anna Fuster / Creative Commons.

However, there has been a shortage of quantitative assessments of the effects of grazing and browsing on forest biodiversity. To synthesise the available evidence, therefore, we have undertaken a *systematic review* of studies of how manipulation of ungulate herbivory affects plants and invertebrates. Ungulates include all species of deer and other cervids, and also livestock such as cattle, sheep, goats, horses and their relatives in the wild.

The ultimate purpose of the review was to investigate whether manipulation of herbivory is useful for conserving or restoring biodiversity in forest set-asides.

### Results from 144 studies synthesised

Most of the 144 studies included in the review had been conducted in North America, Europe or Australia/New Zealand. The intervention most commonly studied was experimental exclusion of wild and/or domestic ungulates by fencing. We also included studies of enclosure or culling of game, and of long-term forest grazing by livestock.

We found negative effects of herbivory on the abundance of understorey vegetation as a whole, woody understorey and bryophytes (mosses and liverworts), and also on the species richness of woody understorey vegetation, whereas the richness of forbs and bryophytes was favoured.

Among invertebrates we found negative effects of herbivory on the abundance of lepidopterans (butterflies and moths) and spiders, but no significant effects on species richness.

A major finding of our review was that the impacts of ungulate herbivory on biodiversity are profoundly affected by the context (e.g. climate, forest type, management history and herbivore identity). Several effects on vegetation depended on whether the ungulates were native, introduced or domesticated, but the duration and intensity of herbivory manipulation had limited influence.

We also identified important knowledge gaps – we found few studies of boreal areas, long-term herbivory effects, impacts on bryophytes, lichens and invertebrates, and effects of manipulation less radical than total exclusion of ungulates.

Our review confirmed that manipulation of ungulate herbivory is often highly influential on tree regeneration and understorey vegetation. The fact that grazing/browsing reduces the abundance and species richness of woody understorey, and of saplings in particular, has clear implications for the future density and composition of overstorey trees.

Further, our results demonstrate that ungulate herbivory does not generally pose a risk for eradication of herbaceous plant species. They also suggest that understorey vegetation is more likely to be affected by exposure to abundant introduced deer or livestock as compared to native ungulates. There was some evidence that livestock grazing can increase understorey species richness, but such effects may take many years to develop.

Overall, the findings suggest that manipulations designed to reduce high levels of ungulate herbivory could be used to encourage regeneration of certain tree species without concerns about reducing the diversity of herbaceous understorey or invertebrate communities. However, plans to (re-)introduce ungulates or increase their abundance need to carefully consider potential undesirable effects on biodiversity and tree regeneration, especially if the manipulations will involve non-native ungulates or livestock.

Our results suggest that conservation management based on livestock in forests should seek to optimise the positive impacts of grazing on herbaceous plant richness while at least occasionally allowing tree saplings to reach maturity. The context-dependence demonstrated by our review indicates that the balance between these two targets should be specified on a site-by-site basis.

### What is a systematic review?

In this review we used a systematic approach to synthesise available evidence on the impacts of grazing and browsing by ungulates. A systematic review is characterised by meticulous planning, thorough searches for literature, objective assessments of studies, and a complete documentation of the whole review process. This approach is designed to avoid bias and increase reliability and repeatability.

### How this review was conducted

This review was initiated and financed by the Mistra Council for Evidence-Based Environmental Management (EviEM). It was conducted by a team of researchers chaired by Bengt Gunnar Jonsson, professor of ecology at Mid Sweden University in Sundsvall. The main part of the work was carried out by Claes Bernes, Askö Löhmus, Ellen Macdonald and Biljana Macura.

### EviEM

The Mistra Council for Evidence-Based Environmental Management (EviEM) strives to ensure that environmental management in Sweden is informed by the best possible scientific evidence. Through systematic reviews of relevant research, we aim to improve the basis for decisions in environmental policy. EviEM is funded by the Swedish Foundation for Strategic Environmental Research (Mistra). It is financially and politically independent.

### Free access to full report

A more detailed summary of this review is available at the EviEM website ([www.eviem.se/en/](http://www.eviem.se/en/)). The full report on the review can also be downloaded there. The report has been published in the journal *Environmental Evidence* ([www.environmentalevidencejournal.org](http://www.environmentalevidencejournal.org)).



The red dots on the map show the locations of studies included in the review. The green colour indicates the extent of the boreal and temperate climate zones, which were the focus of this review.