# CENTRE FOR EVIDENCE-BASED CONSERVATION

## SYSTEMATIC REVIEW NO. 14

# TITLE: HOW DOES THE IMPACT OF GRAZING ON HEATHLAND COMPARE WITH OTHER MANAGEMENT METHODS?


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## REVIEW PROTOCOL

### 1. BACKGROUND

*Introduction*

Lowland heath is a priority habitat for nature conservation because it is a rare and threatened habitat supporting a characteristic flora and fauna. Only about 70,000 ha of lowland heath now remains in the UK, representing approximately 16% of its extent in the 19th century. Many heaths have been lost due to afforestation, agricultural conversion and development (JNCC 2004). The main threat today is percieved to be encroachment of trees and scrub and changes in vegetation structure resulting from lack of appropriate management such as selective grazing, controlled burning and cutting (UK BAP 2005). Nutrient enrichment, particularly deposition of nitrogen compounds emitted from intensive livestock farming, or from other sources, fragmentation and disturbance from developments such as housing and road constructions and agricultural improvement including reclamation and overgrazing, (especially in Northern Ireland) are also considered as current threats (UK BAP 2005).

The disappearance of grazing from lowland heath in the 20$^{th}$ century is often cited as the major cause of loss of heath vegetation in Europe (Harrison 1976, Bunce 1989,

Webb 1990, Marrs 1993, Bullock & Pakeman 1996). Cessation of grazing allows succession towards woodland to proceed in the absence of alternative management (Bullock & Pakeman 1996, Manning, Putwain & Webb 2004). Conversely, grazing with livestock prevents succession, controlling scrub and maintaining open short dwarf shrub stands with a high diversity of low growing species thus achieving conservation management objectives (Gimingham 1972, 1992, Webb 1986, Bullock & Pakeman 1996, Lake, Bullock & Hartley 2001). However, the need for introducing or re-instating grazing of lowland heaths has been challenged in England and Wales, particularly (but not exclusively) where fencing of heathland on common land is required for control of grazing stock and also when other forms of management are undertaken (UK BAP 2005). There is therefore a requirement to determine how the impact of grazing compares with other management methods in delivery of conservation objectives.

*Management Options*

There are three primary alternatives to grazing namely no management, burning and cutting. Other forms of management e.g. turf stripping are practiced but are not generally used extensively. As already stated lack of management results in succession towards woodland and is generally thought to result in a reduction in conservation value (Bullock & Pakeman 1996, Lake, Bullock & Hartley 2001, Manning, Putwain & Webb 2004).

Burning has agricultural benefit and is usually used to increase the quality of forage available to stock (Lake, Bullock & Hartley 2001). Frequent burning especially in combination with grazing may have a deleterious impact on conservation value particularly to bryophyte and lichen-rich heathland (JNCC 2004). Controlled burning removes most above-ground living biomass, but leaves the litter layer largely intact. Thus it creates areas bare of vegetation which are re-colonised mostly by species that can resprout from underground organs. It also can cause net loss of nutrients in smoke and in run-off (Lake, Bullock & Hartley 2001). The aim of burning is to remove degenerate heather growth and to create a mosaic of different aged heather stands (Lake, Bullock & Hartley 2001).

Cutting simply removes all vegetation to a uniform height. It is a less severe management than burning, but again removes degenerate shrub growth, opens up the vegetation, and can be used to create a patchwork of stands of different heights (Lake, Bullock & Hartley 2001). The impacts of grazing management have rarely been compared within the same heath system to those of other management practices, but Pywell *et al.* (1995) found large vegetation differences among different areas managed in different ways (Lake, Bullock & Hartley 2001). In particular grazed areas had greater botanical species richness than areas mown or recovering from burns. The former had a higher incidence of low-growing and small forbs and grasses (Lake, Bullock & Hartley 2001). This is consistent with the current consensus on lowland heath management which suggests that burning and mowing cannot provide the diversity created by grazing (Gimingham 1972, 1992, Webb 1986, Lake, Bullock & Hartley 2001). Conversely, grazing alone is unlikely to maintain a lowland heath habitat in favourable condition. The precise impacts of grazing are variable partly because of the large number of effect modifiers that operate in grazing systems.

*Reasons for heterogeneity: Potential effect modifiers*
Grazing intensity, grazing period, grazing duration, stock type (including breed, gender, age, origin and husbandry), initial floristic composition, follow up period and the amount and proximity of palatable grassland within the heathland mosaic have been identified as important potential effect modifiers in upland (Gimingham 1972, Armstrong & Milne 1995, Milne *et al.* 1998) and lowland (Gimingham 1972, 1992, Webb 1986, Lake, Bullock & Hartley 2001) heath grazing systems.

Grazing intensity has a large impact on biomass offtake and selectivity which are both important determinants of floristic composition (Armstrong & Milne 1995, Milne *et al.* 1998, Lake, Bullock & Hartley 2001). The nutritional characteristics of swards vary seasonally thus grazing period also effects selectivity, whilst the duration of grazing relates to the magnitude of changes due to grazing intensity and period (Lake, Bullock & Hartley 2001). Selectivity, biomass offtake, and flock behaviour vary with stock type and breed influencing the outcome of grazing interventions (Armstrong & Milne 1995, Milne *et al.* 1998, Lake, Bullock & Hartley 2001). The initial floristic composition represents the baseline from which changes occur, and can have a strong influence on any subsequent successional modification. Likewise, floristic responses to grazing are dependent upon time. Short-term studies can miss potentially important vegetation responses. The amount and proximity of palatable grassland within the heathland mosaic will also affect selectivity (Armstrong & Milne 1995, Milne *et al.* 1998). These grazing related effect modifiers operate on a range of scales creating potential variation within as well as between different grazing regimes.

Burning impacts also vary depending on the timing, extent, frequency and severity of the burn. Likewise, the timing, extent and frequency of cutting will modify the impact of cutting. Whether cut material is left on site or removed can also influence the outcome of management. The relative impact of different management regimes on lowland heath cannot be ascertained without concurrent investigation of the impact of these factors.

*Current evidence and the need for systematic review*
Despite the number of high quality reviews on lowland heath management (Gimingham 1972, 1992, Webb 1986, Lake, Bullock & Hartley 2001), there is little scientific literature to provide an evidence-base to support decision-making. Much of the data on the impacts of grazing on lowland heath are not easily interpretable, having been collected from sites with no baseline monitoring, from studies which were insufficiently replicated and/or with insufficient monitoring (Lake, Bullock & Hartley 2001). Likewise, there is little robust information on burning or cutting and there are very few direct head to head comparisons of different management types. A large quantity of anecdotal and observational information from site managers and unpublished reports exist, and reviews notably Lake, Bullock & Hartley (2001) provide a qualitative synthesis of this data. A rigorous quantitative synthesis designed to minimize the potential for bias would build on this work, improving the evidence base by providing best available evidence regarding the relative impacts of grazing burning and cutting on the conservation value of lowland heath.

Systematic review methodology will be used to retrieve data pertaining to the impact of grazing, burning and cutting on the floristic composition of lowland heath and associated fauna of conservation concern. The review will limit bias through the use

of comprehensive searching, specific inclusion criteria and formal assessment of the quality and reliability of the studies retrieved. Subsequent data synthesis will summarise evidence guiding the formulation of appropriate evidence-based management guidelines and highlighting gaps in research evidence. The review should be of use to staff carrying out or advising on lowland heathland site management for conservation organisations (statutory and non-statutory) and local authorities, as well as agri-environment scheme advisors. It will have value across local and national scales informing local management or policy decisions but also influencing regional policy on lowland heathland management, and national options within management frameworks such as agri-environment schemes.

## 2. OBJECTIVE OF THE REVIEW

### 2.1 Primary question

How does the impact of grazing on heathland compare with the impact of burning, cutting or no management?

**Table 1:** Definition of components of the primary systematic review question.

| Subject (Population) | Intervention | Outcomes** |
|---|---|---|
| Lowland heath in Great Britain (dry heath types H1-4, H6-12; wet heath types H3-5, M14-16, M21; grass heath of Suffolk Sandlings and Breck lichen heaths U1, CG7; other communities occurring in a heathland mosaic M13, M25, M33). Communities >300m are not considered lowland irrespective of floristic composition | Grazing<br>Vs<br>burning<br>cutting<br>no management<br>* | Amount of bare ground not including rock or stone (Wet/dry, vertical/sloping/horizontal, undisturbed or heavily disturbed e.g. poached)<br><br>Individual and combined cover of ericoid dwarf shrubs and *Empetrum, Genista* or *Ulex* species.<br><br>Cover of pioneer (10-15cm height), building (40cm height), mature (60-100cm height), degenerate and dead *Calluna/Erica* spp.<br><br>Cover of carpet, topiary and drumstick *Calluna* growth forms.<br><br>Cover of graminoids: *Agrostis* spp., *Carex* spp., *Danthonia decumbens, Deschampsia flexuosa, Festuca* spp., *Molinia caerulea, Nardus stricta, Scirpus cespitosus;* ***For dune heath only:*** *Aira praecox, Ammophila arenaria, Phleum arenarium.*<br><br>Cover of forbs: *Galium saxatile, Hypochaeris radicata, Lotus corniculatus, Plantago lanceolata, Potentilla erecta, Rumex acetosella, Scilla verna, Serratula tinctoria, Thymus praecox, Viola riviniana;* ***For limestone heath only****: Filipendula vulgaris, Galium verum, Helianthemum nummularium, Sanguisorba minor;* ***For dune and maritime heath only:*** *Armeria maritime, Corynephorus canescens, Erodium cicutarium, Filago minima, Plantago maritima, Sedum acre,* ***For wet heath only:*** *Anagallis tenella, Drosera spp., Genista anglica, Myrica gale, Narthecium ossifragum, Pinguicula spp., Potentilla erecta, Succisa pratensis.*<br><br>Cover of bryophytes and lichens: *Cladonia* spp., *Dicranum scoparium,Hylocomium splendens, Hypnum cupressiforme,*<br>*Pleurozium schreberi, Polytrichum* spp.*,Racomitrium lanuginosum;* ***For dune heath only:*** *Peltigera spp.;* ***For wet heath only:*** *Sphagnum spp.*<br><br>Cover of miscellaneous species which have negative conservation value if present above target thresholds: *Rhododendron ponticum, Gaultheria shallon, Fallopia japonica, Cirsium arvense, Digitalis purpurea, Epilobium spp. (excl. E. palustre), Chameriun angustifolium, Juncus effusus, J. squarrosus, Ranunculus* spp.*, Senecio* spp.*, Rumex obtusifolius, Urtica dioica,* "coarse grasses" (e.g. *Holcus lanatus, Dactylis glomerata), Betula* spp.*, Prunus spinosa, Pinus* spp.*, Rubus* spp.*, Sarothamnus scoparius, Quercus* spp.*,Hippophae rhamnoides*, *Pteridium aquilinum* Dense mats of acrocarpous mosses (*Campylopus introflexus*).<br><br>Amount of scrub (mainly trees or tree saplings) above 1 m in height and in clumps, not as isolated trees (sparse or dense stands; structurally complex edge or simple edge; heathland vegetation as ground cover or modified ground cover) |

*Burning and cutting Vs no management are also relevant as they may allow indirect comparison of cutting, burning and grazing impacts, but other management is beyond the scope of the review.
**All outcomes except the amount of scrub should be assessed at the quadrat scale with mean and variance values derived for the whole site or management parcel.

The focus of the review outcomes is on Common Standards Monitoring (CSM) and habitat features linking CSM and the habitat requirements of BAP species (amount and type of bare ground and scrub). Individual species-level impacts might be addressed at some future date.

### 2.2 Secondary questions

What influence does grazing intensity, grazing period, grazing duration, stock type, initial floristic composition, follow up period, the amount and proximity of palatable grassland within the heathland mosaic and other concurrent management activity (e.g. burning) have on the impact of grazing?

What impact does the timing, extent, frequency and severity of burning have on the impact of burning?

What impact do the timing, extent and frequency of cutting and disposal of cut material have on the impact of cutting?

## 3. METHODS

### 3.1 Search strategy

The following electronic databases will be searched:

1. ISI Web of Knowledge
2. Science Direct
3. Scopus
4. Index to Theses Online (1970-present)
5. Digital Dissertations Online
6. Agricola
7. Europa
8. English Nature's "Wildlink"
9. JSTOR

The following English language search terms will be used:

1. heath* and graz*
2. heath* and sheep
3. heath* and cattle
4. heath* and ponies
5. heath* and horse
6. heath* and manage*
7. heath* and conservation
8. heath* and cut*
9. heath* and burn*

ISI Web of knowledge will be searched using the additional terms heath and mow, dwarf and shrub and diversity, dwarf and shrub and structure, heath and goat, heath and pig, heath and restoration, heath and condition. Further searching of other

electronic databases may be undertaken if new material is retrieved but a sensible balance between specificity and sensitivity must be maintained. Foreign language searches are not considered cost effective in view of the UK focus of this review, but attempts to capture relevant foreign material will be made via expert contacts and organisations.

Publication searches will be undertaken on conservation, research and statutory organisation websites (Agricultural Development and Advisory Service, Countryside Council for Wales, Centre for Ecology and Hydrology, Department of Environment Food and Rural Affairs, English Nature (with additional searches of the GAP and FACT websites), Environment Heritage Service NI, Joint Nature Conservation Committee (JNCC), National Trust, Royal Society for the Protection of Birds, Rural Development Service, Scottish Executive (SERAD), Scottish Natural Heritage, English/Welsh and Scottish Wildlife Trusts) and using the meta-search engines Dogpile, Alltheweb and Google Scholar. The first 100 word document or PDF hits from each data source will be examined for appropriate data. In addition bibliographies of articles viewed at full text will be searched. Authors, recognised experts and practioners will also be contacted for further recommendations and for provision of any unpublished material or missing data that may be relevant. Questionnaires will be circulated to practioners in order to collate experience. Specialists (e.g. botanists, entomologists) will be questioned about impacts as well as heathland managers.

### 3.2 Study inclusion criteria

- **Relevant subjects:** lowland heath (dry heath types H1-4, H6-12; wet heath types H3-5, M14-16, M21; other communities occurring in a heathland mosaic M13, M25, M33). Communities >300m are not considered lowland irrespective of floristic composition.
- **Type of Intervention:** grazing, burning, cutting or no management
- **Types of Outcome:** Relevant outcomes are amount and type of bare ground; cover of ericoid dwarf shrubs and *Empetrum* or *Ulex* species; cover of pioneer, building, mature, degenerate and dead *Calluna/Erica* spp. and growth form of *Calluna*; cover of graminoids; cover of forbs; cover of bryophytes and lichens; cover of miscellaneous species which have negative conservation value if present above target thresholds; amount and type of scrub. Details of the species are provided in Table 1 above.
- **Types of Study:** All information is considered relevant irrespective of study type.

Where there is insufficient information to make a decision regarding study inclusion when viewing titles or titles and abstracts, then relevance to the next stage of the review process will be assumed. One reviewer will assess study relevance but a second reviewer will examine a random subset of 25% of the reference list (up to a maximum of 2000 references) to assess repeatability of the inclusion criteria. Kappa analysis will be performed, with a rating of ‘substantial’ (0.6 or above) indicating sufficient repeatability. Disagreement regarding inclusion or exclusion of studies will be resolved by consensus following further definition of the inclusion criteria if necessary.

### 3.3 Study quality assessment

Reviewers will consider articles viewed at full text excluding or admitting them to different categories of information quality. The primary data quality distinction will be between data with comparators suitable for meta-analysis and data without comparators. A further distinction will be made between empirical evidence (data) and experience or opinion.

### 3.4 Data extraction strategy

Data regarding study characteristics, quality and results will be recorded on a specially designed data extraction form. These forms may be amended after consultation with statisticians and piloting of the data extraction process.

### 3.5 Data synthesis

All information will be collated within a Bayesian framework. This will incorporate meta-analysis where appropriate data exists. Reasons for heterogeneity in results including grazing intensity, period, duration, stock type initial floristic composition, follow up period and the amount and proximity of palatable grassland within the heathland mosaic, the timing, extent, frequency and severity of cutting and burning and the disposal of cut material will be investigated by meta-regression where appropriate data exists.

### 3.6 Reasons for heterogeneity

The following potential reasons for heterogeneity have been formally identified *a priori* in order of importance by JNCC and the Lowland Heathland Lead Agency Group. Additional reasons for heterogeneity (e.g. further site characteristics and animal husbandry practices such as supplementary feeding) may be analysed in exploratory analyses.

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*Grazing effect modifiers*
1. Grazing intensity
2. Grazing period (i.e. season)
3. Grazing duration
4. Stock type (including breed, gender, age, origin and husbandry)
5. Initial floristic composition
6. Follow up period (monitoring)
7. Proximity and quantity of palatable grassland within the heathland mosaic
8. Other concurrent management activity (e.g. burning)

*Burning effect modifiers*
1. Timing
2. Extent
3. Frequency
4. Severity
5. Follow up period (monitoring)

*Cutting effect modifiers*
1. Timing
2. Extent
3. Frequency
4. Severity
5. Disposal of cut material
6. Follow up period (monitoring)

## 4. Potential Conflicts of Interest

No conflicts of interest to be declared.

This protocol should be cited as: Stewart, G.B., Newton, A., Bullock, J.M. & Pullin, A.S. (2005) How does the impact of grazing on heathland compare with other management methods? *Systematic Review Protocol* No. **14**.
http://www.cebc.bham.ac.uk

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## 5. References

Armstrong, H.M. and Milne, J.A. (1995) *The effects of grazing on vegetation species composition.* In Heaths and Moorlands: Cultural Landscapes. D.B.A. Thompson, A.J. Hester and M.B. Usher (eds.). SNH/HMSO. Edinburgh. 162-173.

Bullock, J.M. & Pakeman, R.J. (1996) Grazing of lowland heath in England: Management methods and their effects on heathland vegetation. *Biological conservation* **79**, 1-13.

Bunce, R.G.H. (ed.) (1989) *Heather in England and Wales.* Institute of Terrestrial Ecology, Grange over Sands, UK.

Gimingham, C.H. (1972). *Ecology of Heathlands.* Chapman & Hall, London.

Gimingham, C.H. (1992). The lowland heathland management book. *English Nature Science Reports*, No. **8**. English Nature, Peterborough.

Harrison, C.M. (1976) Heathland management in Surrey, England. *Biological Conservation* **10**, 211-220.

JNCC, (2004), Common Standards Monitoring Guidance for Lowland heath, Version August 2004, ISSN 1743-8160

Lake, S., Bullock, J.M. & Hartley, S (2001) Impacts of livestock grazing on lowland heathland in the UK. *English Nature Research Reports* **422**. English Nature, Peterborough.

Manning, P, Putwain, PD, Webb, N (2004) Identifying and modelling the determinants of woody plant invasion of lowland heath *Journal of Ecology* **92**, 868-881.

Marrs, R.H. (1993) An assessment of change in Calluna heathlands in Breckland, eastern England, between 1983 and 1991. *Biological Conservation* **65**, 133-139.

Milne, J.A., Birch, C.P.D., Hester, A.J., Armstrong, H.M. and Robertson, A. (1998) *The impacts of vertebrate herbivores on the natural heritage of the Scottish uplands-A review.* Scottish Natural Heritage Review **95**. SNH. Edinburgh.

Pywell, R.F., Bullock, J.M., Pakeman, R.J., Mountford, J.O., Warman, E.A., Wells, T.C.E & Walker, K. (1995) *Review of calcareous grassland and heathland management*. MAFF. London.

UK BAP (2005) http://www.ukbap.org.uk.

Webb, N.R. (1990) Changes on the heathlands of Dorset, England, between 1978 and 1987. *biological conservation* **51**, 273-286.

Webb, N.R. (1986). *Heathlands*. Collins, London.