Introduction and Summary of the Workshop by Nigel Webb

The 7th European Heathland Workshop was held at Stromness, Orkney from 30th August until 5th September 2001 and was organised by Lynne Farrell and Nadine Perkins of Scottish Natural Heritage. Almost 50 delegates attended representing eight countries (United Kingdom 21, Norway 14, Denmark 2, France 2, Spain 1, Germany 2, Netherlands 3, and Belgium 2).

The first day (Friday 31st August) formed part of the 11th Orkney Science Festival and was held in the St. Magnus Centre in Kirkwall. The session consisted of a series of papers under the collective title The Heathlands of Europe with an Introduction by Prof Nigel Webb (Dorset, UK) and contributions from Prof Peter Emil Kaland (Bergen) on the heathlands of western Norway, Dr Hilary Kirkpatrick (Stirling) on the heaths of Northern Ireland, Dr Johannes Prueter (Niedersachen) on the heaths of Germany, Dr Jacques de Smidt (Utrecht) on the heaths of the Netherlands, Dr Geert de Blust (Brussels) on the heaths of Belgium, and Prof Bernard Clement (Rennes) on the heaths of Brittany, France. This was an open session which was attended by members of the general public as part of the Festival.

On Saturday 1st September there was an all day field visit to heathlands on the island of Hoy. We first visited heathland on the Royal Society for the Protection of Birds reserve at North Hoy before journeying to the south of the island to see coastal heathland on the Scottish Wildlife Trust's reserve at the Keen of White Hamars. The management of this heathland by grazing was described to us by Roy Harris. Unfortunately heavy rain cut short this visit. A further day was spent in the field on Sunday 2nd September when delegates visited heathland on Rousay.

Monday 3rd September was devoted to a session of papers and posters. During the day 16 of the delegates presented papers in three sessions. The day concluded with a business session at which delegates decided that the next (8th) Workshop would be held in 2003 on the Luneburger Heide in Germany and organised by Johannes Prueter. A 9th Workshop would be held in Belgium in 2004 or 2005 and organised by Geert De Blust. During the Workshop Herbert Diemont (Netherlands) lead an evening discussion on rural development and heathlands in Europe.

The Workshop concluded on Tuesday 4th September with a post-conference tour to archaeological and other sites in Orkney including a visit to the Highland Park Distillery at Kirkwall.

Nigel Webb

Convenor of the European Heathland Network

SCIENTIFIC PROGRAMME

SESSION 1 NUTRIENT DYNAMICS

Ib Johansen Nutrient Limitation in the coastal Heath at Anholt, Denmark.

Ruth Mitchell Changes in moorland vegetation following 6 years of fencing and fertiliser treatment.

Arnfin Skogen Recent changes in Norwegian coastal Heath vegetation in relation to long distance transported Nitrogen precipitation.

Torben Riis- Neilsen Danish Heathland: Succession, vegetation dynamics and nitrogen susceptibility.

Sally Power Habitat management as a tool to modify heathland response to nitrogen deposition.

SESSION 2 GRAZING

Jacques de Smidt Sustainable biodiversity in Heathland depending on cattle grazing.

Knut Anders Hovstad Norwegian feral sheep on coastal heathland: production and health status during the year.

Sophie Lake Grazing the lowland Heaths.

Sander Oom Spatial distribution of Heather offtake by sheep across heather/grass mosaics.

SESSION 3 MANAGEMENT AND RESTORATION

Geert de Blust Regeneration of Molina caerulea after heathland fires: the early succession stages.

Dirk Maes A species action plan for Maculinea alcon in Flanders (North Belgium)

I. Alonso, A. Crowle Is the future bright and purple for our Heathlands?

Bo Holst Jorgensen Acceleration of succession from farmland to Heathland - two experiments.

Penny Anderson Restoring dwarf - shrub heath from Molina dominated Moorland.

Sebastien Gallet Atlantic Heathlands: from disturbance ecology to conservatory management. Example of the Megalithic site of Carnac, Brittany.

Liv Nilsen Coastal Heathland in central Norway. Maintaining and restoring botanical diversity.

Loveday Jenkin Regenerated and relict heathland on mining sites - it's importance for invertebrates.

POSTERS

Marcos, E.; Calvo, L.; Fernández, A.J.; Luis-Calabuig, E. Effects of enhanced nitrogen availability on the soil and plant concentration.

Calvo, L.; Alonso I.; Fernández, A.J.; Luis-Calabuig, E. Changes in the structural properties in a heathland community as a response to increased available nitrogen.

European Heathlands - a Common Heritage

Nigel R Webb
NERC Centre for Ecology & Hydrology, Winfrith Technology Centre
Dorchester, Dorset DT2 8ZD, UK
nrw@ceh.ac.uk

The image of heathland is that of a waste, yet nevertheless, beautiful landscape. Heathlands are lands of low fertility and productivity. To botanists heathland is vegetation dominated by evergreen dwarf shrubs especially the heathers (Ericaceae) and where larger shrubs and trees usually absent. To form, heathland requires an oceanic climate and an infertile acid soil (pH <6.7) with small quantities of plant nutrients. Heathland is confined to an area stretching from Portugal and Spain in the south to beyond the Polar Circle in Western Norway and from Ireland in the west to Poland in the east. The present extent of heathland is at least 400,000ha; this is some 15% of that in former times. The open heathland landscape has persisted as a result of the use of the land over the past 4500 years, but until recently it has not been clear how the land was used.

In the Netherlands it has long been known that sheep were grazed by a shepherd on the open heath during the day and kept in a stable at night. Turf was stripped (Plaggen) from the heath and laid in the stable to collect the dung. This manure was then dug into the arable fields to grow crops. In western Norway there was an infield /outfield system involved keeping stock in a stable and covering the floor with turf. The heathland vegetation was cut to provide fodder and the turf and dung were used to fertilize the arable fields. This practice existed within living memory. Plaggen systems were widespread throughout the north European Plain. Sometimes, as in Jutland, shifting cultivation was practised as well. The heath vegetation was burnt and sometimes turves were burnt as well. The ash was rich in nutrients, but the soil soon became exhausted and was abandoned for 40 or 50 years to recover. In Brittany, the practice of ecobuage, where turves were dung in lines and burnt to increase the fertility locally for crops, is similar. In northern Portugal, today, you still find a system in operation very similar to that in Norway. In Britain the position is less clear but early evidence suggests that heathland was managed in the same way.

It is not surprising that throughout the heathlands of Europe similar practices existed because the farmers all faced the same problem. How could they raise the fertility of arable land to enable them to grow crops in a system where the only in put of nutrients was rainfall? The system they operated collected the nutrients falling on the heath and concentrated sufficiently for crops to be grown. This intimate association between the land, the vegetation and the people we now recognise in the concept of the cultural landscape.

Today heathlands are no longer used in these traditional ways and succession to scrub and woodland occurs. At the moment there is money available to remove unwanted scrub, trees and grass, but these funds are unlikely to continue indefinitely. Can we learn a lesson from the cultural landscape? Significantly, people were part of this system whereas in much modern conservation practice this is not the case. The concept of the cultural landscape puts people can be put back into the system and may enable the heaths once again be productive in a way which ensures their persistence.

The heathlands of Northern Ireland

A.H. Kirkpatrick,
Department of Environmental Science, University of Stirling FK9 4LA, UK
a.h.kirkpatrick@stir.ac.uk

Northern Ireland has a range of heathland communities which have developed under an extremely oceanic climate. While there are examples of lowland and coastal heath, most of the communities dominated by *Calluna vulgaris* are found above the upper limits of enclosed farmland, though in the west this may be as low as 120m. The main upland blocks are the Antrim Hills, Sperrin Mountains, Mournes and the upland areas of Co. Fermanagh, where some important heathland sites straddle the border with the Republic of Ireland. Agriculture plays a more important role in the economy of NI than in the rest of the UK and the land tenure pattern is of small, owner occupied farms. Although some heathland has been lost to plantation forestry this pattern of land tenure limited the extent to which large areas could be afforested. From the 1920s there has been a marked decline in breeding red grouse and sheep numbers increased from the 1970s in response to EU policies. Challenges for future management of heathlands include the need to develop sustainable grazing systems and management regimes which are appropriate for maintaining the nature conservation interest of heathlands developed under such extremely oceanic conditions.

Changes in moorland vegetation after 6 years of fencing and fertiliser treatments

Mitchell R.J.[1] and Hartley S.E.[2]
[1]Centre for Ecology and Hydrology – Banchory; [2]Sussex University

The vegetation structure and species composition of many Scottish moorlands has changed over the last 60 years. This is largely due to increased levels of nutrients from pollution and changes in management practices, especially overgrazing by sheep. Both these factors alter the competitive balance between heather (*Calluna vulgaris*) and competing plant species and hence the community composition of the moorland. As the UK has an international obligation to conserve these upland moors the effects of grazing and increased nutrients either singularly or working synergistically needs to be understood. This work aimed to assess changes in moorland community composition under different fertiliser and grazing regimes and answer the following questions:

- Do different moors respond to increase levels of nutrients in different ways?

- Do different grazing levels effect the response of the community to increased nitrogen levels?

- Can key species be identified which respond to nitrogen deposition?

Two upland moors (Glen Clunie and Glen Shee) in the Grampian Mountains in northeast Scotland were selected for the study. At Glen Clunie the soil is wet, acidic and peaty, whereas the soils at Glen Shee are drier and are of the brown earth type. Sheep and red deer graze the two moors. The vegetation consisted of a fine mosaic of *Calluna vulgaris*, other ericoids and graminoid species and was identified as NVC H12: *Calluna vulgaris-Vaccinium myrtillus* heath. In each glen two study sites were established. At each of the four sites there were two blocks of vegetation, one of these was fenced to exclude red deer, domestic sheep and mountain hares the other block was browsed. In each block there were 8 plots (5m x 3m) to which the following treatments were applied: N, P, K, NP, NK, KP, NPK, Control. The fertilisers were added twice yearly at the following rates: N as ammonium nitrate at 75 kg N/ha/yr; P as "superphosphate" at 12.5 kg P/ha/yr; K as potassium sulphate at 25 kg K/ha/yr; the experiment started in March 1993. The percentage cover of the all vascular plants, bryophytes and lichens was estimated by eye in 1996 and 1999, 3 and 6 years after the start of the experiment.

The vegetation data and treatments were analysed by the constrained linear ordination technique Redundancy Analysis (RDA). The environmental variables were the main treatments (fencing/no fencing) and the sub-treatments (the different fertilisers). The 4 sites (blocks) were included as covariables. The model was significant at p=<0.05 when tested using a Monte Carlo permutation test. After six years there were significant differences between plots. The fenced plots having increased levels of dwarf shrub heath species and the grazed plots having more grassland species. Grasses increased with the addition of fertiliser especially N, but which grass increased depended on the grazing level, with *Festuca rubra* and *Deschampsia flexuosa* increasing with N and fencing and *Festuca ovina, Agrostis capillaris,* and *Nardus stricta* increasing with N and grazing. *Agrostis stolonifera, Danthonia decumbens, Festuca rubra* and *Deschampsia flexuosa* increased with fencing and fertiliser; *Agrostis stolonifera, Festuca ovina, Agrostis capillaris, Poa annua, Molinia caerulea, Nardus stricta, Cerastium fontanum*, and *Galium saxatile* increased with fertiliser and grazing; *Calluna vulgaris, Erica tetralix, Eriophorum angustifolium, Vaccinium myrtillus, Vaccinium vitis-idaea* and *Hylocomium splendens* increased with fencing and no fertiliser and *Juncus squarrosus, Luzula spp, Dicranum scoparium* and *Rhytidiadelphus loreus* increased with no fertiliser and no fencing.

An analysis of variance on the species composition was compiled on the basis of 17 different (partial) RDA analyses. There were significant differences between the two moors despite them being only 10km apart. The effect of fencing was significant and there was a significant interaction between moor and fencing. When the sub-treatments were tested, nitrogen and phosphorus were both significant, but effect of potassium was not. Of the interactions between the three fertilisers only the NxPxK interaction was significant and there was no significant interactions between the fertiliser and fencing treatments.

Changes during time (3-6 years after the start of the experiment) were then examined separately for the 2 moors using a Principal Component Analysis (PCA). There were greater change between years in species composition in Glen Clunie (peat soils) than in Glen Shee (brown earth soils). In both glens the grazed fertilised plots showed greatest change between the 3 years and moorland communities changed more slowly with increased nutrients when there was no grazing. However there were differences between the two moors. On Glen Clunie it was the increase in nutrients which seemed to have the greater effect with an increase in plants with high nitrogen scores (Ellenburg values) and nutrient scores (suited species scores). On Glen Shee it was the change in grazing level that had the greater effect with an increase in plants able to tolerate high grazing pressure (high grazing scores (suited species scores)).

Therefore both grazing levels and geographical situation, possibly mediated by differences in soil type, can influence the effect of increased nutrients on moorland vegetation. All three of these factors need to be taken into account when predicting changes likely to occur in moorland communities under different management regimes.

Spatial distribution of heather offtake by sheep across heather-grass mosaics

S.P. Oom, A.J. Hester, and C.J. Legg.

This presentation strongly depends on visual explanations. Therefore please take a look at the original presentation on my publications page at: http:\\www.oomvanlieshout.net\sander.

Heather moorland is an internationally important natural resource. Management is aimed at: maintaining heather cover, protecting insect diversity, protecting bird populations, facilitating tree regeneration, etceteras. Grazing is important part of the heather moorland ecosystem. Different objectives might require different grazing regimes. Current grazing impact is evaluated using the rule of thumb: '40% rule'. Through this the overall grazing intensity is expressed as the stocking density per hectare. But sheep only use part of the landscape intensively, causing high defoliation of heather locally even at low stocking densities. So we where do the animals graze the heather in a landscape?

An experiment was set up to measure the spatial distribution of grazing across heather-grass mosaics. The experiment used 6 plots of 100 x 100 m. The plots were treated with three different year round grazing regimes (Scottish Blackface sheep) for 3 years: 2, 3 and 4 sheep per hectare (groups of six, different frequency). Heather defoliation was measured twice a year in spring and autumn. Transects were laid out perpendicular to the grass/heather edge. Measurements were taken at regular locations along the transect. At each location 10 shoots were selected and for each shoot the biomass removed (<50% , >50%, >100%) was estimated, based on current years growth. The mean defoliation was calculated for each location based on the 10 shoots.

Although observations show that sheep eat a mixed diet of grass and heather, they prefer eating grass over heather. Therefore grass is the 'nutritional attraction' in the heather-grass mosaic. The pattern of heather defoliation is influenced by grass patches and paths. Previous experiments showed that heather defoliation is higher near the edge of grass patches and paths than further away. But what is the defoliation at the edge of a grass patch or a path in a location in the mosaic? We assume that heather defoliation at the edge can be predicted by attraction of nearest grass patch. This was tested against the field observations, and we found a positive correlation between the attraction of a location and the heather defoliation at the edge. This means that heather defoliation is higher at the edge of large grass patches than smaller ones.

If we assume a threshold of defoliation above which heather gets damaged, how big is the zone where defoliation is critical? The field data shows that at low defoliation at the edge, the critical zone is very narrow. When the defoliation at the edge increases, initially the zone stays narrow, but when the defoliation at the edge crosses a threshold the zone quickly increases. This would suggest that the heather-grass mosaic will be resistant to fluctuations in grazing intensity at lower stocking densities, but that heather-grass mosaics are more vulnerable at high stocking densities.

An implications of the spatial distribution of defoliation is that specific management objectives require specific grazing regimes. For instance to maintain overall heather cover, grazing intensity has to be lower than predicted by overall stocking density. On the other hand grazing intensity might have to be higher, to maintain flora and fauna diversity (requiring grazing impact) over larger areas. To determine an appropriate management, an understanding of the spatial impact of grazing is crucial.

A species action plan for the threatened Alcon Blue (*Maculinea alcon*) in Flanders (north Belgium)

Dirk Maes[1], Hans Van Dyck[2] & Wouter Vanreusel[2]
[1] Institute of Nature Conservation, Kliniekstraat 25, B-1070 Brussels, Belgium;
[2] Laboratory of Animal Ecology, Department of Biology (UIA), University of Antwerp, B-2610 Antwerp, Belgium

Butterfly diversity has strongly decreased in Flanders during the 20th century, because suitable butterfly habitats have suffered from major declines in both quality and extent. Especially sedentary species and species from nutrient poor habitats showed the strongest declining trend (Maes & Van Dyck 2001). Heathlands are nutrient poor habitats and almost al typical heathland butterflies (among which the Alcon Blue) are low mobile species; furthermore, this habitat type has shown one of the strongest declines of all habitats present in Flanders.

The Alcon Blue (*Maculinea alcon*) has a complex life cycle: females only lay eggs on the Marsh Gentian (*Gentiana pneumonanthe*) on which the caterpillars live for about 10 days; in the 4th larval stage, they are adopted by *Myrmica* spp. ants and are fed in the ant nest by the ant workers until next spring; pupation takes place in June and butterflies hatch from the pupae in the beginning of July. The Alcon Blue is vulnerable all over Europe and threatened in most NW-European countries (van Swaay & Warren 1999). Three of the 4 components of the "Alcon Blue complex" (butterfly - host plant - host ant - wet heathland) have suffered major declines in Flanders during the 20th century: the butterfly decreased with about 69%, the host plant with 64% and the decline in the extent of wet heathland is estimated at about 92%; the host ants do not seem to be rare in our region but need to be present in high enough densities for the adoption of the Alcon Blue caterpillars (Van Dyck et al. 2000); due to the use of grid cells for the calculation of the trends, most declines are probably understimated.

By order of the Flemish Ministry of Nature Conservation, we compiled a detailed and site-oriented species action plan for this obligate myrmecophilous lycaenid of wet heathlands (Vanreusel et al. 2000). For all actually occupied sites (9) and potentially suitable sites (c. 20), we dealed with the management, the opportunities for improvement of, and hence expansion to, adjacent habitat patches, perspectives of translocation, etc.

In all sites, detailed data on vegetation structure, presence and geographical distribution of host plant (*Gentiana pneumonanthe*) and host ants (*Myrmica* sp.) were collected using standardized field methods. Where the butterfly still occurs, egg counts were included in our field protocol. In addition to these field data, relevant historical information and management (policy) information is also assimilated.

The aim is to create a scientifically based, but practically oriented species recovery plan, with detailed advice towards management and policy.

Using historical information, butterfly and host-plant distribution databases, biological valuation maps and field information, all Flemish sites with wet heathland or bogs, and former or actual presence of *Maculinea alcon* and *Gentiana pneumonanthe* were selected. These areas were ranked in function of their historical, actual and future importance for the Alcon Blue and target study sites were chosen. In these areas we collected data on the following subjects: vegetation structure, vegetation composition (species cover and composition), distribution and species composition of host- and non-host ants, population structure and distribution of host plant, number of stems and buds per individual host-plant, distribution and number of butterfly eggs, information on ownership, actual and former management regime, adjacent land use, legal protection, measurement of extent of potential habitat and distances between habitat patches using GPS systems, …

Analysis of these data and a compilation of recent scientific literature concerning management of wet heathlands and butterfly populations must form the scientific basis of this species oriented recovery program. By keeping in close contact with reserve managers and the Flemish government and by doing repeated field surveys, we assure a practically and site-oriented plan with feasible management measures and advice for the survival of the Alcon blue butterfly in Flanders.

This project is funded by The Flemish Government (Afdeling Natuur).

References

Maes, D. & Van Dyck, H. (2001). Butterfly diversity loss in Flanders (north Belgium): Europe's worst case scenario? Biological Conservation 99: 263-276.

Van Dyck, H., Oostermeijer, J.G.B., Talloen, W., Feenstra, V., van der Hidde, A. & Wynhoff, I. (2000). Does the presence of ant nests matter for oviposition to a specialized myrmecophilous *Maculinea* butterfly? Proceedings of the Royal Society London B. 267: 861-866.

van Swaay, C.A.M. & Warren, M.S. (1999). Red Data Book of European Butterflies (Rhopalocera), Nature and environment No. 99. Council of Europe Publishing, Strasbourg.

Vanreusel, W., Maes, D. & Van Dyck, H. (2000). Soortbeschermingsplan gentiaanblauwtje. Rapport van de Universiteit Antwerpen (UIA-UA) - in opdracht van afdeling Natuur van het Ministerie van de Vlaamse Gemeenschap, Wilrijk [in Dutch].

Is the future bright and purple for our heathlands?

Isabel Alonso & Alistair Crowle
English Nature, Northminster House, Peterborough PE1 1UA, UK
mailto:isabel.alonso@english-nature.org.uk
alistair.crowle@english-nature.org.uk
http://www.english-nature.org.uk/

Lowland and upland heathlands in the UK have decline dramatically during the last 150 or 200 years. The reasons for this decline in the lowlands are well known: increasing intensive farming and cessation of traditional farming practices (and the subsequent lack of management), afforestation, development (houses and roads), mining and possibly atmospheric pollution. The idea of heathlands being a "waste and barren land" has contributed to this loss. All these causes have contributed to the fragmentation and loss of a big proportion of the ecological value of lowland heathlands as habitats for many species.

English Nature is the statutory body that champions the conservation and enhancement of the wildlife and natural features of England. Our work on heathlands is detailed in our Position Statement on Lowland Heathland. One of the main tools to reverse the decline is through leading the "Biodiversity Action Plan", whose main targets are to maintain and restore all existing heathlands (about 58,000 ha in the UK) and to re-create a further 6,000 ha by 2005. This work is done in partnership with other organisations.

The Lowland Heathland BAP is published elsewhere on the web. Just to highlight few points, actions have been classified into those to:

1. Increase and improve the condition of the resource: e.g. agri-environment schemes, re-creation in abandoned mineral workings, production of re-creation plans.
2. Safeguard the resource: notification of sites (SSSI, SAC, SPA) and production of management plans and conservation objectives.
3. Support the delivery of the targets: e.g. contributions to courses, handbooks and other publications.

One of the main founding sources of the Lowland Heathland BAP is "Tomorrow's Heathland Heritage" programme, funded by the Heritage Lottery Fund (£14m) and various partners (a further £11m).

The future of the lowland heathlands is therefore looking much brighter that a few years ago, but there is still much too do…

In general terms, upland heathland has suffered from over-management, particularly since World War II with the emphasis on increasing stock numbers resulting in overgrazing. Much of the remaining heathland occurs on moorland managed for driven grouse shooting. This type of management has maintained heather cover by creating a monoculture, possibly at the expense of the wider biodiversity interest of the habitat, particularly in relation to the plants and invertebrates. This form of land-use has also led to conflict between those concerned with maximising grouse numbers and those who wish to see the end to the illegal persecution of birds of prey. This is most obviously illustrated by the plight of the hen harrier, a bird that is fully protected and which chooses to nest almost exclusively in heather. At the current rate of decline it is likely that this beautiful bird will be extinct as an English breeding bird in the next five years; the second time in 100 years due entirely to the hand of man.

English Nature is seeking to work with landowners and managers to ensure that upland heathland is managed in a sustainable fashion that will deliver the favourable conservation status of the habitat. We are seeking to do this through Habitat Action Plans, demonstration projects and best practice initiatives. Project officers will be appointed to monitor and secure the population of hen harriers in the English Uplands. We will continue to feed comments into the development of agri-environment schemes as well as appropriate farming systems post-Foot and Mouth Disease.

It is our to aim to ensure that the uplands of England are not only bright and purple but are places where the full range of plants and animals are able to thrive in a sustainable environment.

Acceleration from farmland to heathland. Two experiments.

Bo Holst-Joergensen
Chief Forester, Forest and Nature Agency, Denmark.

1) Nørre Tangs Hede.

40 hectares of heathland and 40 hectares of farmland bought in 1984. The farming was stopped in 1985. The last year the farmlands were cultivated with grass, peas and rape.

In summer 1987 we saw some new calluna plants on a former pea field, which we remembered as pretty clean-sprayed. Idea: Is it possible, that clean spraying makes calluna plants germinate easier?

In autumn 1987 we ploughed some of the area and the following years until 1990 4 parcels of 1 ha each were treated with: 1) Nothing 2) Fusilade 3) Round Up 4) Deep Ploughing/Round Up.

In 1991 we saw a beginning growth of calluna on the untreated neighbour areas and then we stopped the treatment. Also because the neighbours told, that the former owner (now dead) only had grown the areas a few years. And, that he had not given the areas the usual amount of fertiliser and lime.

Airphotos from 1999 and 2001 showed very much calluna on the 0- parcel and other areas without treatment. Especially much calluna occurred on the fields, where there had former been rape and peas. After grass for pills there was very little germination of calluna.

Conclusion: a) Calluna will not establish itself easier after spraying.
b) Calluna will establish itself easier and earlier after rape and peas than after grass.

2) Nørholm.

After we had found out that the areas at Nørre Tang were not characteristic for the general amount of farmlands on former heathlands we decided to try again on an area of 25 hectares, that had been cultivated since 1890. The cultivation was stopped in 1991 after harvest of a rye crop. The following methods have been attempted since 1982:

1) Sheep grazing
2) Reference area, untreated
3) 6 harrowings pr year
4) Moving and removal of naturally occurring vegetation
5) Growing of oats and harvesting when green (direct sowing)
6) Growing of winter rye and harvesting when green (direct sowing)
7) Spreading of 650 kg ammonium sulphate/ha/year and moving twice a year plus removal of occurring vegetation

In 1999 we stopped the treatments (money stop!). After 10 years there are still in 2001 no calluna plants.

pH, Kt , Pt and Fi were measured in 1991 and 1998. Results: pH has not moved much from 6. And it looks like it will take very long time to reach the pH on the neighbour-heather, which is about 4. There has been a big reduction of both K and P. Most reduction of K in ”ammonium sulphate”; most reduction of Pt in ”Oats” and ”cut and move” and most reduction of Ft in ”Oats”.

Conclusion: 1) No calluna after 10 years in any plots.
2) pH not moved either.
3) The P and K content is going down even without doing anything. But more slowly.

Restoring dwarf shrub heath from *Molinia* dominated moorland

Penny Anderson
Penny Anderson Associates, Consultant Ecologists.

1. Large-scale trials began in 1994 in Derwentdale in the Peak District National Park, Derbyshire, England, to control *Molinia caerulea* and to restore a dwarf shrub heath community. The moorland was recorded as blanket mire (*Eriophorum* and *Molinia*), and acid grassland or blanket mire with *Calluna* in 1912. Prior to the trials *Molinia* dominated the 200ha.

2. The shooting tenant, Geoff Eyre, has established forty plots. Treatments have not been applied scientifically, but have responded to the vegetation growth and conditions. The trials were monitored in 2000 to identify the most cost effective means of restoring *Calluna* moorland. Environmentally Sensitive Area grant aid supported the work.

3. The trials have included applying 1 to 5 cuts to the tussocky *Molinia*, herbiciding with glyphosate 0 to 2 times, adding *Calluna* seed at 12 to 47kg/ha, and grazed and ungrazed areas can be compared. Each plot received a mixture of the above. Some areas have been burnt after herbicide application to remove the accumulated *Molinia* litter.

4. The herbicide killed the *Molinia* but the cutting, using a heavy-duty topper which smashed the tussocks, provides a suitable seed bed. This machine, used in dry years in summer, also killed much of the *Molinia*. After treatment, *Molinia* and *Deschampsia flexuosa* also re-established, and was re-cut or herbicided in some areas.

5. Using the lowest quantities of *Calluna* seed was as effective as the higher quantities when these were generally applied gradually over several years. G.Eyre has developed methods of collecting, cleaning and drying seed, and pre-treatments for *Calluna* to break dormancy. Using part treated seed and part untreated gives the best results, as treated seed germinates the year of sowing, and can occupy the gaps created in the sward before the grasses re-establish, leaving some seed as an insurance to establish in future years.

6. Excluding grazing proved essential. Sheep were attracted to the treated areas even though they avoided the *Molinia* usually. They were effective in breaking down the *Molinia* litter by trampling to form a seedbed, but prevented *Calluna* establishment (under 1% cover in most grazed plots, compared with 20-35% cover in most fenced plots, and 70% in the best plot).

7. The most promising treatment was to herbicide, then burn the litter and add *Calluna* at 17kg/ha of part treated seed and pods. This treatment only began in 1998, and re-growing grasses may require further treatment later. Burning first to remove the litter, and then herbiciding may be more effective but was not trialed. *Molinia* responds positively to being burnt, and may reappear more strongly after burning.

8. Cutting twice provided similar results to herbiciding plus two cuts. Herbiciding twice plus cutting increased the *Calluna* establishment.

9. The essential requirements for exchanging *Molinia* for *Calluna* are to control grazing, remove accumulated litter, control *Molinia*, and to add *Calluna* seed (where there is none or little in the seed bank).

10. To spray, burn and add seed costs about £225/ha, to spray, cut once and add seed costs about £320/ha, plus fencing costs.

Atlantic heathlands :
from disturbance ecology to conservatory management.

Sébastien Gallet
Université de Rennes 1- UMR 6553- 35042 Rennes Cedex, France
sebastien.gallet@univ-rennes1.fr

The study presented here was conducted during my Ph.D thesis entitled 'Atlantic Heathland : from disturbance ecology to conservatory management. Example of the megalithic site of Carnac.'

1. Study site

The studies were realised in Carnac, on the southern coast of Brittany (Western France). Carnac is worldwide known for its alignments which regroup about 300 standing-stones erected about 6000 years ago. During the 80's, the site suffered of important degradations due to over-frequetation. So, it had been closed in 1991, allowing a rapid come-back of vegetation cover.

The ecosystem of reference of the restoration was defined as heathland or at least as a mosaic of heathlands and grasslands. Two types of heathlands are present in the site : Mesophilous heathland (characterised by *Erica ciliaris*) and dry heathland (*Erica cinerea*).

The management of the site must prevent the degradation of the vegetation, both by trampling and by the dynamic of the vegetation which can lead to the development of thickets.

2. Scientific problematic

The effect of different disturbances and management tools on vegetation have been analysed in order to define the best management plan for the site. This plan must take into account all the site characteristic both ecological, historical and touristical.

3. Effects of grazing on dry and mesophilous heathlands.

The analyses of grazing effects are based on the comparison of different grazing seasons on dry and mesophilous heathlands. The modes of grazing tested ere characterized by a heavy stocking rate during short duration, which seemed to facilitate the management of shrubs. Important differences in the effects of grazing are observed according to the season of application. Heathlands, especially mesophilous, seem to be brittle facing with summer grazing. On the other hand, winter or spring grazing seem to favour the development of heathers in this type of heathland. (Precise results are available in a paper published in Ecological Engineering, ask for reprint to the author.)

4. Effects of trampling on dry and mesophilous heathlands

Experimental approaches and field studies are complementarily used in order to characterize the responses of heathlands and of their characteristic species to this disturbance. In this case again, important variations are recorded according to the season, the vegetation type and to weather conditions at the time of the disturbance. (Precise results are available in a paper published in Biological Conservation ask for reprint to the author.)

5. Conclusion

This study shows the complexity of responses of atlantics dry and mesophilous heathlands to disturbances and the need to adapt management to local conditions and to the defined objectives

Coastal heathland in Central Norway; maintaining and restoring botanical diversity

Liv S. Nilsen
Norwegian University of Science & Technology, Museum of Natural History and Archaeology, Department of Natural History, N-7491 Trondheim

The coastal heathland in Central Norway belong to the southern boreal zone, and compared to nemoral and boreonemoral heathlands it is characterized by:

- Comparatively more *Empetrum nigrum* coll. and less *Calluna vulgaris*
- Comparatively less dry heathland
- Larger proportion of damp heathland. Common species combinations in damp types are
  Calluna vulgaris-Rubus chamaemorus-Carex nigra
  Calluna vulgaris-Eriophorum vaginatum
- Poor distinction between damp heathland and bog vegetation
- More barren rocky landscape without vegetation cover
- Alpine/north boreal species being common at sea-level such as *Arctostaphylos alpinus, Betula nana, Carex bigelowii, Loiseleuria procumbens,* and in rich heath types species such as *Carex capillaris* and *Thalictrum alpinum*
- A number of more southern species such as *Erica cinerea, Luzula congesta, Carex binervis* and *Polygala serpyllifolia* are lacking.

The coastal heathland of Central Norway faces the same threats as the more southern areas through cessation of traditional land use, harvesting of heather, grazing and burning which lead to:

- Invasion of trees and bushes mainly *Betula pubescens,* but also *Sorbus aucuparia, Populus tremula, Picea abies, Salix caprea, Salix aurita* and *Betula nana*. In dryer areas; *Juniperus communis.* Less invasion of *Pinus sylvestris*
- Afforestation, especially the native species *Pinus sylvestris* and the alien species *Picea sitchensis* and *Pinus mugo*. Many plantings now produce seeds and the two alien tree species are establishing in the heathlands.

The aim for my dr.scient. project is to increase the ecological knowledge about the boreal heathlands. Traditional use and the processes taking place after declining or cessation of traditional use will be studied. The studies are based on vegetation ecological methods with permanent plots. Experimental clearing, grazing and burning is included. A historical study of the economical/social importance of the heathland from the 19th century until today is started. Written and oral sources are used.

Artificial burning of heaths in April 2001 led to regeneration from seeds of *Calluna vulgaris,* in August the seedlings were approx. 0.5 cm. *Rubus chamaemorus* and *Carex nigra* are also species that establish after a fire in damp heath in Central Norway together with species such as *Vaccinium myrtillus, V. uliginosum, V. vitis-idaea, Arctostaphylos alpinus* and *Empetrum nigrum*. All these species except *Calluna vulgaris* regenerate vegetatively.

In earlier times heath was burned, mostly for providing summerfodder for sheeps, but also for production of cloudberries (*Rubus chamaemorus*) that is one of the pioneer species after heathburning.

Effects of enhanced nitrogen availability on the soil and plant concentration

Marcos, E.; Calvo, L.; Fernández, A.J.; Luis-Calabuig, E.
Area of Ecology. Faculty of Biology. University of León. 24071 León. Spain.
degemp@unileon.es

In the mountains of Northern Spain, patches dominated by *Calluna vulgaris* are scarce and they may disappear or change significantly as a result of further lack of management and possibly increasing nutrient availability through atmospheric deposition. The objective of this study were to determine the effects of increased nitrogen availability in the soil properties and in the composition of *Calluna vulgaris* and *Erica tetralix* shoots. A second aim is to analyse the influence of the competence of two shrub species: *C. vulgaris* and *E. tetralix*.

The study has been carried out in three mountain "puertos" (passes) in León province (NW Spain): San Isidro, Tarna and Vegarada. The community in each area has been dominated by *Calluna*, intermixed with *Erica*. In each area we established 40 plots using different combinations of cut and fertilisation. Treatments were carried out in April 1998. In each plot one soil sample was taken in the original situation and 5, 13, 16 and 27 months after the treatments. Soil properties as a organic matter, total nitrogen, available phosphorus and pH were determined. In every plot 5 shoots of *Calluna* and *Erica* were also taken to analyse total nitrogen content at 5, 13, 16 and 27 months after the treatments. Likewise 5 *Calluna* and *Erica* shoots were selected to measure the growth and number of flowers. Samplings were carried out at 2, 14, and 27 months after the treatments.

A clear increase in plant nitrogen content in the fertilised plot in relation with no fertilised ones is observed. This increase is most pronounced two years after of treatments. The greatest increase in nitrogen of the shoots appears in both woody species in the control treatment but not in the cut treatments. It is not clear whether the elimination of one specie favours the nitrogen incorporation in the other. The nitrogen addition does not mean an increase of this in the soil, and a clear tendency were not found in the three study sites. A gradual decrease in available phosphorus content was detected in the three sites from the original situation until two years after, being this decrease statistically significant ($p<0.05$). An increase in organic matter content in all cases was observed. The number of flowers is greater in the fertilised plots than in the unfertilised plots for the two species. The same occurs with the annual shoot growth of *C. vulgaris* and *E. tetralix*. *C. vulgaris* shoots produce always the greatest number of flowers independently of the treatments applied, while *Erica tetralix* shoots present in all cases the greatest growth values. The cut of one specie have not influence in the amount of flowers or in the growth of the other specie.

Changes in the structural properties in a heathland community as a response to increased available nitrogen

*Calvo, L.; **Alonso I.; *Fernández, A.J.; *Luis-Calabuig, E.
*Area of Ecology. Faculty of Biology. University of León. 24071 León. Spain.
** English Nature. Northminster House, Peterborough PE1 1UA. UK
* deglcg@unileon.es
** isabel.alonso@english-nature.org.uk

The objective of this study were to know the dynamic vegetation of the heathland dominated by *Calluna vulgaris* and more specifically the regenerative response of two Ericaceous species: *Calluna vulgaris* and *Erica tetralix* after experimental cutting and fertilisation with nitrogen.

The study has been carried out in three mountain “puertos” (passes) in León province (NW Spain): San Isidro, Tarna and Vegarada. The community in each area has been dominated by *Calluna*, intermixed with *Erica*. In each area we used different combinations of cut and fertilisation. In each “puerto” eight 1 m^2 fixed plots were established in April 1998, the treatments being: two control plots, two plots where *Calluna* was cut, two where *Erica* was cut and two where both species were cut. One of each for the two paired plots received an application of nitrogen (5.6 gr m^{-2} yr^{-1}). The other part of plots were unfertilised. Five replicates were established in each “puerto”, giving 40 plots per “puerto” and 120 plots in total. In each plot visual cover percentage of each species present was sampled in the original situation and 1, 2, 3, 12, 15 and 24 months after the treatments.

The values of the global cover (woody species and herbaceous ones) increased through the study period after the experimental treatments. Significant differences appeared between the fertilised and no fertilised plots. Growth was higher in the latter. In all cases the original situation values were reached after two years study. That is due in part, to the increasingly cover values of herbaceous, mainly in the patches were the fertiliser was used.

The cover of *Calluna vulgaris* does not present any variation in the plots where it has not been cut. Nor in the fertilised neither in the unfertilised plots have been found significant differences through the study period, with a clear and very strong diminution in its cover’s values.

Erica tetralix has a lower cover value than *Calluna vulgaris* in the original situation. A significant increase is observed in the cover value of *Erica* in the plots where *Calluna* is cut. Significant differences were observed between the fertilised and non-fertilised plots. After cutting and fertilisation *Erica tetralix* recover better than *Calluna vulgaris*.