Glen Finglas – A synthesis for stakeholders

The purpose of this document

We have put together this document to draw together the many outputs from the Glen Finglas upland grazing experiment into a summary that is relevant to land managers and others interested in the management of the uplands. We hope the findings are useful for those continuing high nature value farming in the uplands or those contemplating rewilding.

Summary

The Glen Finglas experiment is a large-scale, long-term grazing experiment on a mosaic of upland habitats where we have studied the cascading impacts of changes in grazing on. Our main findings are:

- Vegetation changes are slow, so it may be possible, in the medium-term at least, to reverse management decisions if unwanted outcomes are apparent.

- The diversity of some organisms is higher when grazing is removed, but for some it is higher in the more open conditions provided by higher grazing.

- Tree invasion has been very slow and largely confined to one ungrazed plot. Glen Finglas is more wooded than many glens, so woodland expansion in less wooded areas may be likely very slow and planting will be necessary.

- Modelling suggests that removing grazing will slowly increase soil carbon stocks, whilst increased grazing will slowly reduce them to a new equilibrium.

- Biodiversity impacts are complex, with winners and losers in every treatment, and more complex if other ecosystem services are added to the mix. Management decisions need to be taken with a clear understanding of the consequences.

The Experiment

The Glen Finglas experiment was set up in 2002 to look at how decisions about grazing management in the uplands could have cascading impacts on biodiversity. Initially it focussed on the linkage between vegetation, invertebrates and insectivorous birds, but it has become a platform for other studies that have extended its focus.

The experimental design is simple; four treatments, each replicated six times in a randomised block design. The treatments are (1) “Continued” – a continuation of the management prior to the experiment with a sheep density of 0.9 sheep ha^{-1} from spring to autumn, (2) “High” - a tripling of sheep numbers to 2.7 sheep ha^{-1}, (3) “Mixed” - a partial replacement of sheep by cattle so that total offtake is the same as the Continued treatments and (4) “None” – no livestock present.

What is unusual about the Glen Finglas experiment is the large size of the plots – 3.3 ha. The large size was needed so that we could look at the density of breeding birds, particularly meadow pipits, in the plots, but it has meant that our analysis has to cope with substantial heterogeneity in the vegetation of the plots. Where possible we have turned that heterogeneity to our advantage.

The Findings

Vegetation changes have been slow, but increasing grazing (High treatment) leads to higher local diversity and stability, but leads to homogenisation as grazing sensitive species are lost from the less preferred vegetation types they have previously hung on in. Reduced grazing (None) increases that heterogeneity as grazing sensitive species spread in previously less preferred vegetation but leads to the loss of low-growing species in previously heavily grazed areas.

The removal of grazing has not generally ended up with increased tree regeneration. In five of the six ungrazed plots (Figure 1, left), the vegetation is taller but very few seedlings/saplings are visible. The exception to this is one ungrazed plot (Figure 1, right) adjacent to a steep sided gully which is densely wooded where there is regeneration of willow and birch. Glen Finglas is relatively well wooded at a landscape scale suggesting less wooded glens might see even slower tree invasion.

Figure 1. Vegetation in a typical ungrazed plot (left) and the ungrazed plot by the wooded gorge (right).

Invertebrate herbivore abundance and diversity are higher without grazing (None), reflecting a higher availability of resources. However, invertebrate predator responses differ between groups. Spider abundance and diversity is higher in ungrazed plots as they take advantage of greater vertical space to build webs in, whilst carabid beetle abundance and diversity is higher in the more heavily grazed plots (High) as they often prefer more open ground.

Vertebrates similarly showed complex patterns with voles, and foxes, more abundant in plots without grazing (None) but meadow pipits more abundant in the High and Mixed grazed treatments. The voles prefer dense cover, and the foxes follow them, but the meadow pipits prefer foraging in vegetation that has been broken up by grazing or trampling as their prey is more accessible.

Bird diversity follows a different pattern to meadow pipit abundance as it is highest in the ungrazed plots. This is mainly driven by the appearance of birds associated with scrub and woodland in the ungrazed plot near the wooded gully. These include black grouse, whinchat and willow warbler, though snipe are more common in the open areas.

Changes in soil carbon haven't been measured, but modelling work suggests the ungrazed plots will see a low climb to an equilibrium slightly higher than pre-experiment levels whilst the High plots will decline to a new equilibrium below these levels.

Trade-offs

Management decisions will always result in winners and losers. The bird results offer a clear example of this, should the site be managed for snipe (Amber on the list of Birds of Conservation Concern) and meadow pipit (Amber), the latter of which is a common prey item of hen harrier (Red) and merlin (Red), or should the site be managed for black grouse (Red), whinchat (Red) and willow warbler (Amber).

These trade-offs are magnified in complexity if different groups are considered (Table 1). At the level of the groups measured there is a preponderance of "High" in the ungrazed treatment, but within each group there will be trade-offs similar to that of the birds with some species preferring more open conditions and others denser vegetation. Complexity will only increase when ecosystem services (benefits) like carbon sequestration are added to the mix.

The main take home message is that whatever decisions are made about management in the uplands there will always be winners and losers. Decision making should acknowledge this and perhaps mitigate the full impact of decisions.

Further resources

More on the Glen Finglas experiment can be found here and a full bibliography here. It is part of the Ecological Continuity Trust's network of long-term study sites.

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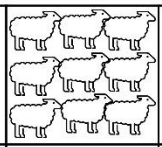
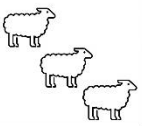
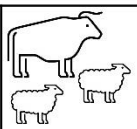
Table 1. A summary of how the different grazing treatments benefit different aspects of biodiversity by trophic level. Treatments from left to right are High, Continued, Mixed and

				No grazing
Plants				
Diversity	High	Low	Mod	Low
Stability	High	Mod	High	Low
Heterogeneity	Low	Mod	Low	High
Herbivores				
Plant bug abundance	Low	Mod	Mod	High
Plant bug diversity	High	Low	Mod	High
Moth abundance	Low	High	Mod	High
Moth diversity	Low	Mod	Mod	High
Vole abundance	Low	Mod	Mod	High
Predators				
Spider abundance	Low	Mod	Mod	High
Spider diversity	Low	Mod	Mod	High
Carabid beetle abundance	High	High	Mod	Low
Carabid beetle diversity	High	High	Mod	Low
Fox activity	Low	Mod	Mod	High
Meadow pipit numbers	High	Mod	High	Low
Bird diversity	Low	Low	Low	High