Glen Finglas – A synthesis for policy

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 policy makers as we connect the study to current policy areas.

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 policy related findings are:

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

- 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.

- Biodiversity impacts are complex, with winners and losers in every treatment. Management decisions need to be taken with a clear understanding of the consequences.

- 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 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.

Climate Change

Scotland has ambitious targets to transform to net-zero set out in the Climate Change Plan. These include woodland creation and peatland restoration at scale. The experiment is not on peatland, but as mentioned in the section on Woodland Expansion, there has been limited tree expansion.

Whilst there hasn't been soil sampling across the experiment, there has been some modelling of soil carbon dynamics. This revealed that soil organic carbon is predicted to decline in the High treatment but increase under the Continued and None treatments. However, these increases in soil carbon under reduced grazing are likely only to occur where there has been significant atmospheric nitrogen pollution, so such a change may not occur in the cleaner north and west of Scotland.

Recent research elsewhere has instead highlighted the potential loss of sol carbon after tree invasion as tree litter can boost microbial activity and decomposition and the importance of large herbivores in transferring above-ground carbon into persistent soil carbon.

Woodland Expansion

Scotland's Forestry Strategy has a priority of expanding the area of forests and woodlands with a specific target of increasing the woodland cover in Scotland from 18 % to 21 % of land by 2032.

Our monitoring of the plots indicates that tree regeneration where livestock grazing has been removed has been very slow. Five out of the six ungrazed plots look like Figure 1, left, where the vegetation is taller, a few species have expanded but there has been almost no tree invasion. The exception is the plot in Figure 1, right, where willow and birch trees have started to invade. This latter plot is very close to a good seed source, a heavily wooded gorge, so it may have a substantially higher seed rain than the other ungrazed plots. This may be exacerbated by the low background levels of deer browsing are preventing tree regeneration across the experiment and the higher densities of voles in the ungrazed plots.

The evidence from Glen Finglas suggests that it would be unreasonable to rely on passive regeneration of trees in many situations to expand woodland cover. Arguably Glen Finglas has more seed sources than many upland glens as it still has extensive woodland cover, areas of parkland with scattered mature trees, wooded gorges and areas of recent planting. Woodland expansion may need to be driven by sensitive planting.

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

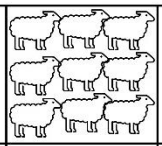
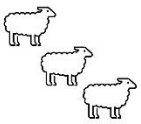
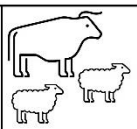
Biodiversity

The initial focus of the experiment was t understand the consequences of changing agricultural support payments to upland farmers and how this might affect upland birds. We can say with confidence that the commonest bird across the experiment, the meadow pipit, benefits from either increased grazing (High) or from introducing cattle (Mixed) as this breaks up the vegetation allowing them easier access to forage. However, bird diversity increases in the ungrazed plots.

Meadow pipits are a relatively common upland bird but have been rated as Amber in the Birds of Conservation Concern. They are also a common prey species for raptors such as merlin and hen harrier, both of which are classified as Red. The High treatment also has Snipe nesting (Amber) However, the developing scrub in the plot shown in Figure 1 right has species such as whinchat (Red) and willow warbler (Amber) nesting in it. Clearly, land use change has an impact on the bird community, but the experiment shows that decisions about grazing can have benefits for some species of conservation concern but have negative impacts on others.

This trade-off between different bird species of conservation concern depending on how a site is managed is replicated across other groups. Table 1 clearly shows that no single treatment has benefitted all the groups studied, though there are more overall benefits with grazing removal. Within the multi-species groups, like the birds, there will be species that benefit from more grazing and ones that benefit from less. Consequently, the ramifications of changing grazing management if considered at the species level are complex and difficult to predict.

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

Conclusions

What is remarkable in the experiment is how quickly some impacts were observed, with the birds and the invertebrates reacting relatively quickly, whilst the vegetation has changed much more slowly. This suggests that in the medium term, at least, reversing management decisions could be feasible if outcomes were unwanted.

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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