Restoring lowland heath through small-scale turf removal at Cooper's Hill Nature Reserve, Bedfordshire

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SUMMARY

At Cooper's Hill Nature Reserve, Bedfordshire, England, areas of mature heather *Calluna vulgaris* have been lost and replaced by dense grassy swards. We hypothesised that any heather seedlings would have difficulty competing with the grasses and tested this by removing the turf to expose the nutrient-poor sandy soil in seven small plots across the reserve. These plots, together with control areas, were monitored annually to determine which vegetation types would re-establish. Five plots also received seed-rich brash (cut heather) on half of each plot to determine whether additional seeding of stripped areas was required. Analysis of the data collected over the first five years indicates that the technique increased the amount of heather seedlings establishing, as measured by percentage heather cover. Adding seed rich brash had no effect, implying a good amount of viable heather seed is present in the soil at this site. Grasses are also establishing in the stripped areas but are not dominating the plots.

BACKGROUND

Lowland heathland is one of Britain's most threatened semi-natural habitats, having declined by 84% over the last century (English Nature 2002). Past drivers of loss have included development expansion, forestry plantations, mining and agricultural intensification. In recent years the main threat to heathland has been the lack of appropriate management, since most of our heathland is a plagioclimax community in which natural succession has been halted due to human intervention. In the case of most lowland heath the climax community would be woodland. Historically heaths were used for rough grazing, preventing the growth of saplings. The vegetation and turf was cut for building, fodder or fuel, which also kept the habitat open. Without some form of intervention, heathlands become covered in scrub and then secondary woodland. Eventually, heathland flora and fauna are lost.

Cooper's Hill nature reserve (National Grid ref: TL028376) is one of the best remaining examples in Bedfordshire of the once more extensive heathland situated on the thin acidic soils of the Lower Greensand ridge. The 12.5 ha reserve is recognised as a Site of Special Scientific Interest (SSSI). The heathland at Cooper's Hill is dominated by heather *Calluna vulgaris* and fine grasses; common bent *Agrostis capillaris*, wavy hair grass *Deschampsia flexuosa* and sheep's fescue *Festuca ovina*. The heath is bordered by trees, with woodland areas to the north, south and east primarily comprised of oak *Quercus robur* and silver birch *Betula pendula*. The open heath is under threat from succession, especially by silver birch, which is kept at bay by regular scrub removal work. The leaf-fall from mature trees enriches the nutrient-poor soils and allows less desirable species to invade and form denser patches of grass, scrub and bramble *Rubus fruticosus* agg.

In some areas heather has been lost to periodic attacks of the heather beetle *Lochmaea suturalis*. This damage is most common at the edges of the heathland near the trees and scrub. In these areas the acid grassland is re-establishing faster than the heather and is forming a dense layer of turf that could be restricting heather seed germination. Management trials at other sites have had success at re-establishing heathland flora, including heather, by removing the turf and/or nutrient rich topsoil (Britton *et al.* 2000, Gardiner & Vaughan 2008, Wilton-Jones & Ausden 2005). Since most of these areas had heather cover in the recent past there should be abundant heather in the seed bank, making additional seeding unnecessary. This study aims to determine whether turf-stripping is an effective method at Cooper's Hill and whether stripped areas require additional seeding.

ACTION

Turf stripping trials took place at seven sites within Cooper's Hill: five were dug in April 2011 using a mini-digger and a further two dug by hand in January 2012. Due to the small size of the reserve, plot size was limited to 5 x 10 m. The grass turves, including roots, were removed taking as little soil below the turf as possible, to avoid removing the heather seed bank. This meant that the depth that plots were dug varied depending on how deep the grass roots were, but were on average between 5 and 10 cm. For each area an adjacent 5 x 10 m control plot was designated where turf was left intact. All treatment and control plots had similar vegetation prior to the trial commencing. Vegetation cover and height was recorded in each before turf removal and annually after removal.

To determine whether additional seeding was required, seed-rich brash (cut heather) was added to the downwind half of each of the five original treatment plots in autumn 2011. This was cut to encourage new growth and collected by hand from an area of mature heather on site.

The plots were monitored annually during late July-August when the plant species are easiest to identify. The initial survey was by necessity conducted in March before the plots were dug. A full plant species list was recorded for each plot and fixed

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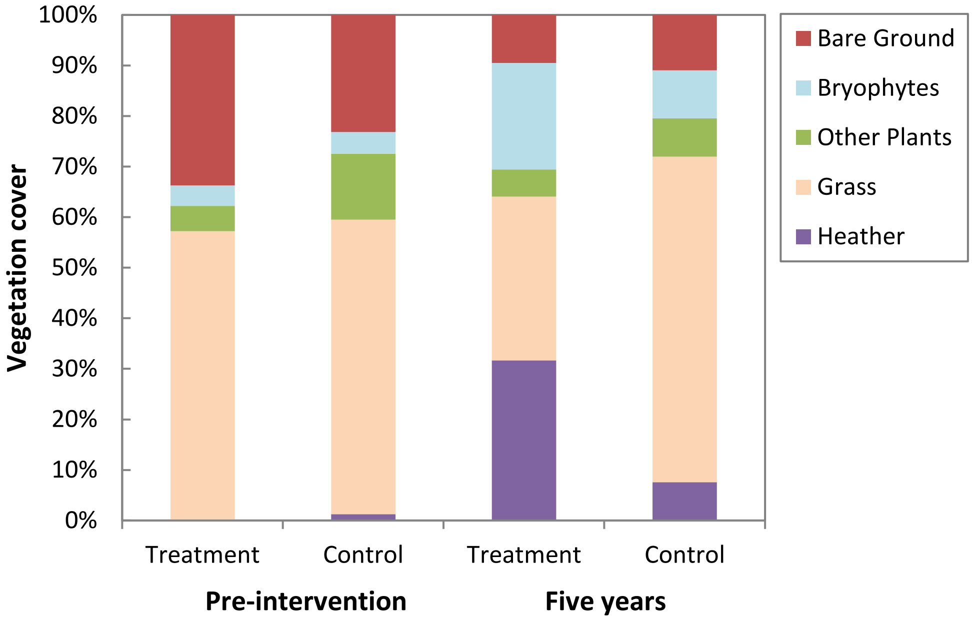

Figure 1. Average percentage vegetation cover in treatment and control plots before intervention and after five years.

point photographs were taken. Vegetation cover was recorded to the nearest percentage using 10 randomly placed 0.25 m^2 quadrats, five of which were placed in the side of the plot seeded with heather brash. To keep monitoring simple, vegetation cover was split into five categories: heather, grass, bare ground, bryophyte or lichen, and other plants.

To prevent pseudo-replication an average of the 10 quadrats was taken for each plot. The difference in vegetation cover between treatment and control plots prior to the experiment was tested using a one-way multivariate analysis of variance (MANOVA) and showed no significant difference ($F_{5,8} = 1.74$, $p = 0.232$; Wilk's $\Lambda = 0.480$). For each vegetation category the difference in cover prior to the experiment and after five years was tested using a repeated measure one-way ANOVA. An outlier was identified in both the heather and bare ground datasets when testing the assumptions of ANOVA. On removal of this one data point, the data satisfied the assumptions of normality and homoscedasticity of residuals; no transformation was required. The effect of adding seed-rich brash was tested using a paired t-test on the arcsine transformed data on heather cover collected in the fifth year and before the trial started.

CONSEQUENCES

Five years after the turf stripping trials, the control plots looked similar to their original state whereas the treatment plots appeared to have a more even spread of different vegetation cover (Figure 1). Analysing the vegetation cover categories separately supports initial observations that the turf-stripping has had a significant effect on vegetation cover.

After five years the cover of heather was significantly higher ($F_{1,11} = 10.28$, $p < 0.01$) in the turf-stripped (treatment) plots (31.5%) compared to the control plots (7.4%) having started the trial at the same level of cover (Figure 2). Seeding the treatment plots using seed-rich brash had no significant effect ($t_4 = 0.60$, $p = 0.583$), with both seeded and unseeded sides of each plot showing similar coverage of heather after five growing seasons.

The cover of grasses showed a significant interaction between time and treatment ($F_{1,12} = 15.48$, $p < 0.01$). After five years the grass cover in the control plots remained similar to original levels (61.5% to 63.5%), whilst in the stripped plots grass cover was below original levels (28.3% from 64.8%, Figure 3).

The cover of bryophytes and lichens (predominantly mosses) showed a significant interaction between time and treatment ($F_{1,12} = 10.70$, $p < 0.01$) with cover decreasing in the control plots (8.5% to 3.9%) and increasing in the stripped plots (6.6% to 17.4%, Figure 4).

There was no difference in the percentage cover of other plants over the five years ($F_{1,12} = 1.80$, $p > 0.2$). The amount of bare ground decreased over time ($F_{1,11} = 5.62$, $p < 0.05$) but with no significant difference between treatment and control plots after five years ($F_{1,11} = 0.15$, $p > 0.2$).

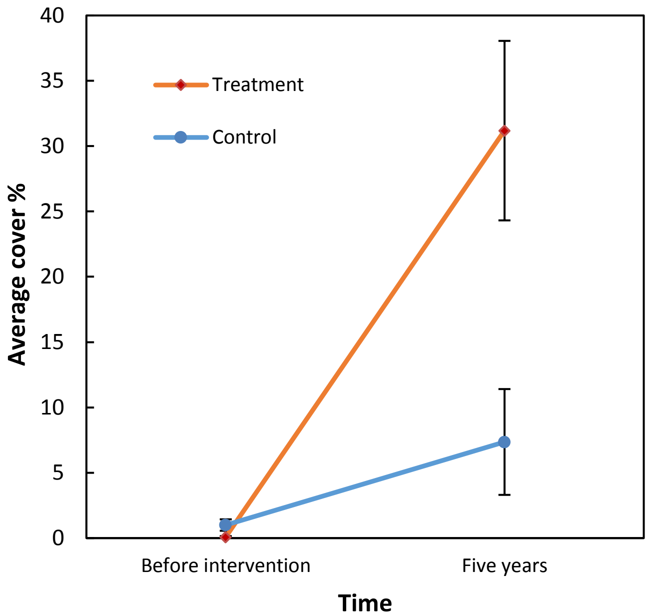

Figure 2. Interaction plot showing the percentage cover of heather over time in the treatment and control plots with standard error bars.

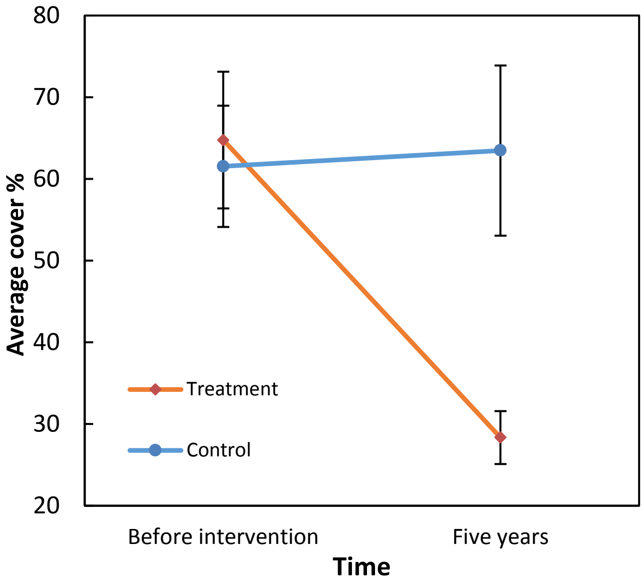

Figure 3. Interaction plot showing the percentage cover of grass over time in the treatment and control plots with standard error bars.

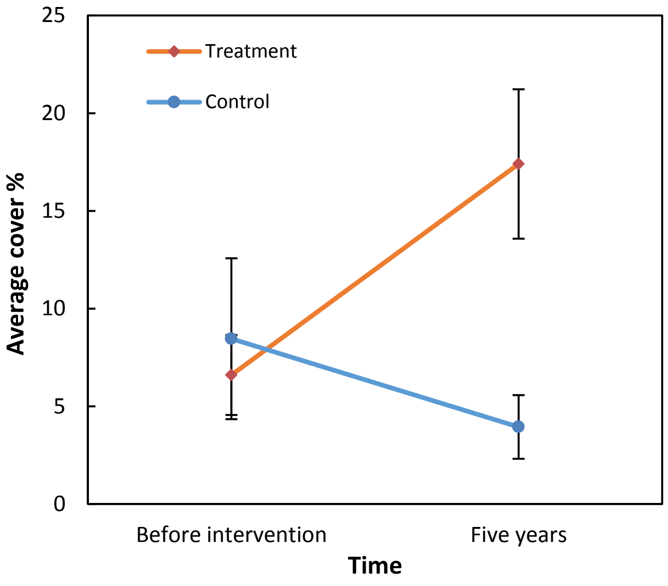

Figure 4. Interaction plot showing the percentage cover of bryophytes and lichens over time in the treatment and control plots with standard error bars.

DISCUSSION

These results show that at Cooper's Hill this method of turf-stripping increased heather establishment without the need for additional heather seed. The regeneration of grasses and other plants indicates that the method produced a heterogeneous habitat after five years which is more desirable than a monoculture of heather or grass. In the control areas where the turf was not removed grasses remain dominant, though the existing heather plants have grown larger.

Many mosses are pioneer species (Royal Botanic Garden Edinburgh 2017) and the bare ground created following turf removal provides suitable habitat for these pioneers to establish.

By reducing competition for heather seedlings the heathland should be able to regenerate in areas where the thick turf has been removed. A few larger areas of turf-stripping have subsequently been carried out in areas where the heather beetle has killed off the heather. In order to cause minimal disturbance to other wildlife these operations were timed to avoid both peak breeding season and hibernation for reptiles, insects and ground-nesting birds. Heather is a slow growing and relatively long lived species (taking over 40 years to complete its life cycle) so ongoing monitoring is required to determine the technique's impact long-term.

ACKNOWLEDGEMENTS

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