Review of studies which assess the effectiveness of non-chemical bracken treatments

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10th March 2025

Summary

Previous research in the UK, including on lowland heaths, suggests that two cuts per year is effective at controlling bracken, and there is some evidence that one cut per year may be sufficient. The timing of these cuts varies between studies, but tends to be in June-August. There is limited evidence from a single study that sheep in combination with a single cut may be as effective as two cuts per year, but no evidence that sheep alone are effective. The efficacy of other livestock has not been assessed, and bracken bashing and hand pulling do not seem to be effective. Most previous studies have used bracken stem density and frond length to assess the effect on bracken, and used species % cover to assess the impact of treatments on other species.

To compare different bracken treatments on Surrey Wildlife Trust sites, I would suggest an experimental design which assesses:

- **A minimum of three repeated plots for each experimental condition, and three 1m^2 quadrats sampled from each plot seems to be standard.**
- **Plot size should depend on what the team would normally expect to minimally cover in a work party.** However, this should be at least 3 x 3m^2 to allow placement of three separated 1m^2 quadrats – see below.
- **Within each quadrat assess % cover of a limited number of desirable species.** Desirable species TBD by the team. Ideally this would be done using a gridded quadrat, but 'by eye' estimation is also used in previous studies.
- **Within each quadrat, conduct a full bracken stem count and calculate mean stem length.** Mean stem length may not need to be of each frond in the quadrat, and could be of a subsample of stems in the centre of the quadrat (some use a 0.25m^2 subplot for this).

Review of interventions to control bracken

A systematic review of methods to control bracken compared herbicides, mowing or cutting, handpulling, rolling, use of livestock (cattle, sheep, ponies) or burning, and combinations of techniques (Stewart et al., 2005). **Only evidence for cutting and herbicide use were found**. The authors provide a summary of all studies in a table. Their review suggests cutting may be as effective as asulam (herbicide) application. **The studies they review looked at cutting various times May-September.** They also do not seem to have included some of the studies listed on the Conservation Evidence website which are reviewed below (e.g. Lowday & Marrs, 1992).

Summary of individual studies from Conservation Evidence

On the Conservation Evidence website, there are no studies which evaluate the effects of controlling bracken by increasing livestock numbers. However, one study which is not on the Conservation Evidence website (detailed below) found that sheep grazing is not effective at control bracken on its own, but can improve the efficacy of a single annual cut (Milligan et al., 2018).

Bracken was 14-99% lower in areas where bracken was annually cut, and heather biomass was higher some years at two lowland heaths, Cavenham and Weeton in East Anglia (Lowday & Marrs, 1992). They monitored twelve 18m^2 plots; 4 with annual bracken cutting (July), 4 with biannual cutting (June-and July) and 4 with no cutting. Three random 1m^2 plots were monitored each year in each plot. They used three measurements of 'bracken performance': the number of bracken fronds, the height of bracken fronds, and the dried biomass of 25% of the fronds in a 1m^2 plot. They note that all three were correlated. As dried biomass is correlated with the other two measures and requires drying facilities etc., there doesn't appear to be an additional benefit to sampling this.

Snow & Marrs (1997) found cutting reduced the cover of bracken but did not increase the number of common heather *Calluna vulgaris* seedlings, relative to spraying with herbicide on Thurstaston Common, Merseyside. They use the same method to assess bracken cover as Lowday and Marrs (1992) and used the same cutting times. They counted the number of emergent *Calluna* seedlings in plots 7 and 15 months after seeding the plots, and assess cover of individual species in 0.5 x 0.5m^2 quadrats. They also monitor soils, but this requires laboratory sampling.

After 10 years, annual bracken cutting was associated with a 38% increase in heather cover, but by 18 years there was no heather cover in the plots on Cavenham Heath (Marrs et al., 1998). After 18 years though, half of the plots had 30% more wavy-hair grass and 17% more sheep's fescue. They monitored twelve 70m^2 plots, 4 with annual bracken cutting (July), 4 with biannual cutting (June-July) and 4 with no cutting. Three random 1m^2 plots were monitored each year in each plot. 25 points within a 1m^2 grid were sampled and the cover (from 26 species, bare ground or bracken litter) recorded. Their analysis focuses on 9 species, including heather and bracken.

Paterson et al. (2000) also worked on Cavenham Heath and found that cutting to control bracken had mixed effects on bracken cover and wavy-hair grass *Deschampsia flexuosa*, but no significant effect on the cover of six other plant species, including heather. They sampled from 18 8m^2 plots split into six conditions: a control, 2 cutting frequencies (late July only or late July

and mid-June), 2 herbicide frequencies, and a cutting / herbicide combination. 2 1m^2 quadrats were assessed for individual species cover 'by eye' in each plot.

Milligan et al. (2016) found that cutting decreased bracken cover whereas bracken bruising (bashing) increased bracken cover on Bamford Edge in Derbyshire. Neither effected the number of plant species, and but cutting increased plant diversity measured using the Shannon-Weiner index, whereas bruising had no effect. They sampled from 18 20m^2 plots using six conditions: 2 cutting conditions, 2 bruising conditions, 1 herbicide condition and a no treatment control. Cutting was conducted 2 in late June and late July, with the 3 times cutting treatment also including a cut in late August. Plant cover was assessed by eye in five 1 m^2 quadrats which were randomly located in each plot. Bracken fronds were cut from a 0.25m2 area then counted and their length measured.

Alday et al. (2013) did a 10 year study on four sites , and found that all repeated treatments were effective treatments were effective at reducing bracken and increasing desired species diversity, though one-off treatments were not. The sites were Cannock in the Midlands, Hordron Edge in the Peak District, Carneddau in Wales and Sourhope in the Scottish Borders. Six experiments were run with six conditions: a control, two cutting conditions (June only, or June and August), two cutting and herbicide conditions, and a herbicide only condition. A seventh experiment compared no treatment to cutting twice per year. In total there were 352 plots, and these are of variable sizes, from 50m^2 to 180m^2. 1m^2 quadrats were monitored and the cover of vascular plants, bryophytes and lichen species recorded.

Brook et al. (2007) assessed the effect of bracken bashing and herbicides on plants which support Heath fritillaries on Cavenham Heath. They discontinued bracken bashing due to its negative effects on desirable vegetation, and lack of effect on bracken. 18 40 m x 20 m plots were used: six were applied with herbicide, six experienced bracken bashing in May and six had no treatment. Thirty 1 m^2 quadrats were monitored in each plot and 'vegetation composition and structure was recorded' (no further details given, though 5 plants are named, and bracken 'density and vigour' mentioned). The results suggest that in addition to recording species present they measured with height and stem density, at least for some species.

There is a study in Norway listed by Conservation Evidence which is not included due to the geographical distance (Måren et al., 2008).

More recent studies not included on the Conservation Evidence website

Alday et al. (2023) provided a more recent update on the study at Bamford Edge Derbyshire, and concluded that cutting 2 or 3 times a year is effective.

Milligan et al. (2018) compared cutting and herbicide application in Hordron Edge in Derbyshire, but also looked at the effect of sheep grazing. In the absence of other treatments, they found little effect of sheep grazing on bracken or species richness and cover of desired species. However, when grazing was combined with cutting, species richness was higher. Two cuts a year (month of cutting not given) were more effective than one cut at reducing bracken frond length and density, but one cut a year was just as effective as two cuts if the plot was also grazed by sheep. They measure two 1m^2 plots in each sub-sub-plot each year, measuring % cover of vascular plants, bryophytes, lichen and bracken litter. Bracken height and frond density per m^2 were measured.

Two studies compared once (June) and twice (June and August) yearly cutting with hand pulling and no treatment at a site in Gloucestershire, measuring frond density and frond height (Grange, 2013; Grange & Swallow, 2018). They found that cutting twice was marginally more effective than cutting once, and hand-pulling was more time consuming and little different from control plots.

Akpınar et al. (2023) looked at how long treatments remain effective once they stop at two sites in the Scottish borders. They found that if bracken is cut twice yearly (June and August) for 10 years, then it takes up to a further 5-15 years for those plots to return to the same level of bracken cover as control plots. They measure % cover of vascular plants, bryophytes, lichen and bracken litter. Bracken height and frond density per m^2 were measured

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