

Effectiveness of Sheep Grazing of the Invasive Giant Hogweed (*Heracleum mantegazzianum*) at Kirkside Farm, Macduff, Aberdeenshire

2021 Progress Report

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1. Introduction

This trial project is a practical experiment to investigate if and how land managers could best use sheep to control substantial giant hogweed (*Heracleum mantegazzianum*) infestations – in this case in a woodland site – with a view to preparing practical advice for land managers. Where giant hogweed has taken over in an area it can be a difficult, time consuming and expensive problem to tackle and requires the use of herbicides. This study has been assessing the opportunity of using sheep to control giant hogweed in a trial site at Kirkside Farm near Macduff at the bottom of the River Deveron catchment.

This trial is part of the Scottish Invasive Species Initiative and where the Deveron Bogie and Isla Rivers Charitable Trust, Aberdeen University and Kirkside Farm have been working together to assess:

- The impact of sheep grazing on the volume of giant hogweed throughout the site, and
- The impact of sheep grazing on the rest of the vegetation community

By monitoring and recording our work we will issue a good practice guide for land managers who may wish to control invasive plant problems through sheep grazing.

2. The site at Kirkside Farm, Macduff

The site in Macduff is part of Kirkside Farm on the right bank of the Deveron near Macduff Distillery. It is a strip of mature woodland with an access road between it and the River Deveron (Grid reference: NJ688626). The site is well known for having large amounts of giant hogweed, is popular with dog walkers and opposite the local golf course.

Due to the scale of giant hogweed infestation and the difficult terrain of the site, previous chemical control actions were ineffective, time consuming and expensive. Therefore, we wanted to find a more effective approach to giant hogweed control here. After success in using sheep to control giant hogweed elsewhere in the Deveron catchment at Auldtown Farm, the landowners at Kirkside were keen to try using sheep to control the plant at this site where the extent of giant hogweed was increasing and there was concern about public health implications given the area's recreational popularity.

The site allows an assessment of the effectiveness of sheep grazing in a radically different setting (mature woodland) compared to a previous study site at Auldtown.

3. Sheep and grazing regime

In 2019 the sheep were initially reluctant to tackle the giant hogweed and so were contained in an area by the farmhouse to allow familiarisation with the site and available grazing before being released onto the

wider site. In 2020 and 2021 the same sheep were utilised, did not need this familiarisation period and so were released straight onto the whole site. Due to overgrazing observed and reported in 2019, the number of sheep grazing days was halved in 2020. However, variable numbers of sheep were on site during the grazing period and the sheep were removed for a period of three weeks for shearing. Sheep numbers were further reduced in 2021 and the sheep were added at the start of May instead of April.

The grazing periods for 2019, 2020 and 2021 are summarised in **Table 1**.

Table 1: The number of sheep and duration they spent within the trial site (2019 – 2021)

Year	Start	End	Sheep put on	Sheep taken off	Sheep days	Annual Total Sheep days
2019	12/04	01/11	26	25	^a 5075	^a 5075
2020	06/04	26/04	24	12	^b 480	
2020	26/04	24/06	12	12	^c 708	
2020	12/07	06/09	23	23	^c 1288	2476
2021	02/05	23/06	12	12	^d 624	
2021	30/06	20/07	12	12	^d 240	
2021	04/08	15/09	11	11	^d 462	1326

^a 5075 days estimated based on 25 sheep

^b 2020 - Twenty-four sheep were initially added by the farmer due to his concern about the amount of Giant hogweed emerging. However, on advice sheep numbers were reduced from 24 to 12 due to concerns in 2019 about overgrazing.

^c 2020 dates split as sheep were off the site for shearing from the 24th June until the 12th July.

^d 2021 sheep were taken off for shearing 20-23rd June and for fly strike treatment 20th July until the 4th of August.

In 2019, through speaking with the farmer and members of public who use the site, it was reported that the sheep developed something of a daily routine whereby in the morning they would spend their time at the northern end of the site and then in the evening spent more time by the road and farm. The sheep seemed to have adopted a slightly different routine in 2020, spending less time in the paddock and northern end of the site and much more time in the upper middle section. This pattern of sheep usage appeared to continue in 2021 with little or no time spent in the paddock area and more time spent in the middle section of the woods. As the season progressed the sheep spent more time at either end of the site.

4. Monitoring

a) Giant hogweed

The density and spatial distribution of giant hogweed was monitored to assess whether and the extent to which sheep grazing was affecting numbers of plants present. Monitoring plots were stratified along the top of the site at approximate 15m intervals. Forty-two plots were established in total as shown in **Figure 1** (blue circles). Each 1m² plot was permanently marked using metal stakes and their position recorded using GPS, to allow repeat surveys to be undertaken at each location and thus the accurate assessing of possible change.

At each plot:

- Photos of the plot and surrounding area were taken to enable relocation and monitoring change in giant hogweed and vegetation cover.

- Vegetation height was recorded at 3 points within the plot as well as recording the main vegetation types to allow detection of change in the vegetation composition.
- The number of giant hogweed plants/seedlings were recorded in the 1m² plot.
- In addition, to investigate further the density and spatial distribution of giant hogweed plants, additional counts were made in adjacent 1 m² quadrats (to the right and below, creating 4 x 1 m²).

The plots were surveyed in June and September/October in 2019 and 2020 and in April, June and September in 2021. The timing of surveying in 2020 was impacted by Covid-19 restrictions.

b) Habitat / vegetation monitoring

Habitat recording undertaken is based on the methodology used as part of the Repeat Woodland Bird Survey (RWBS) (Amar *et al.*, 2006). Habitat recording was undertaken at seven points as shown in **Figure 1** (orange circles), spaced approximately 150m apart. Four (1-4) points were distributed along the south of the site with two (5&6) along the lower half above the track and one (7) in the paddock area at the entrance of the site.

Each habitat survey point is the centre of a 25m radius area within which habitat recording took place. Some measurements were recorded from the centre of the 25m plot, whilst others were recorded in four 5m radius sub-plots centred 12.5m north, east, south and west of the centre of the plot. The centre point and the four 5m radius sub-plots were marked with a metal stake to allow easy relocation. Presence of sheep paths, streams and the dominant tree and herb species were recorded, as well as browsing pressure at the plot level. The recording took place on 23rd June and 17th September 2021.



Figure 1: Giant hogweed monitoring plots (blue markers) and vegetation monitoring plots (orange markers) at the Macduff trial site

c) Subplot level information

At each of the four subplots the following were recorded:

Horizontal Visibility (assessed to gauge openness of the site).	A 2.4m pole marked with alternate black and white 10cm sections was placed in the centre of the plot and viewed from the centre of each subplot. The number of black bands that were at least 50% visible through the vegetation (maximum 12) was recorded. This method is described in detail in Wilson et al. (2005).
Canopy cover	% canopy cover overall over the plot
% vegetation cover in height classes (0.5-2m, 2-4m, 4-10m)	Total cover by vegetation of the 5m subplot as if viewed from above, considering only the vegetation in each height band in turn
Field layer cover	% cover of each of the following - bracken, herb, grass, moss, leaf litter/wood, rock, bare ground, salmonberry, wood rush, hogweed, dead hogweed stems, nettle, other. Note % herb excludes nettle
Presence of shrub species	Shrubs under 5m high only
% shrub species grazed - Elder, Salmonberry, Ash, Sycamore	For woody stems <2m high: no browsing, light browsing, moderate browsing, heavy browsing
Level of Hogweed grazing	light browsing, moderate browsing, heavy browsing

5. Results

Giant hogweed monitoring plots

a) Giant hogweed

Giant hogweed was extensive, especially across the top of the site, prior to the sheep being added in 2019. The dense tall giant hogweed stands were all grazed in the first 6 months with only small, scattered seedlings remaining in most areas, shown in **Figure 2** and as can clearly be seen in many of the plot photos (especially those of plots 20-28, **Appendix 1**).

There has been a steady decrease in the number of plots with giant hogweed over the years in both the June recording visits (41 plots in 2019, 37 in 2020 and 34 in 2021) and September visits (34 plots in 2019, 22 in 2020 and 21 in 2021) as detailed in **Table 2**. Likewise, there has been a significant decrease in the number of giant hogweed seedling/plants counted across all the plots in the June and September visits (**Table 2**). In 2021 an additional site visit was made prior to sheep being introduced to the site. At the end of April 2021 the number of giant hogweed seedling/plants counted across all the plots was 2999 - but this was already two-thirds lower by the end of June and by the end of September only 149 plants were counted on all the plots. The plots with the highest number of giant hogweed seedlings recorded in the April 2021 monitoring visit had dense stands of giant hogweed at the start of the study e.g., plots 20, 25, 30-31 (**Appendix 1**).

Table 2: Number of plots with giant hogweed seedling/plants and total number across all plots

Year and date of survey	Number of plots with giant hogweed seedling/plants			Total number of giant hogweed seedling/plants recorded in the plots across the whole site		
	April	June	Sept/Oct	April	June	Sept/Oct
2019 (11/06 & 01/10)		41	34		1371	501
2020 (24/06 & 16/09)		37	22		907	340
2021 (29/04, 25/06 & 20/09)	42	34	21	2999	842	149

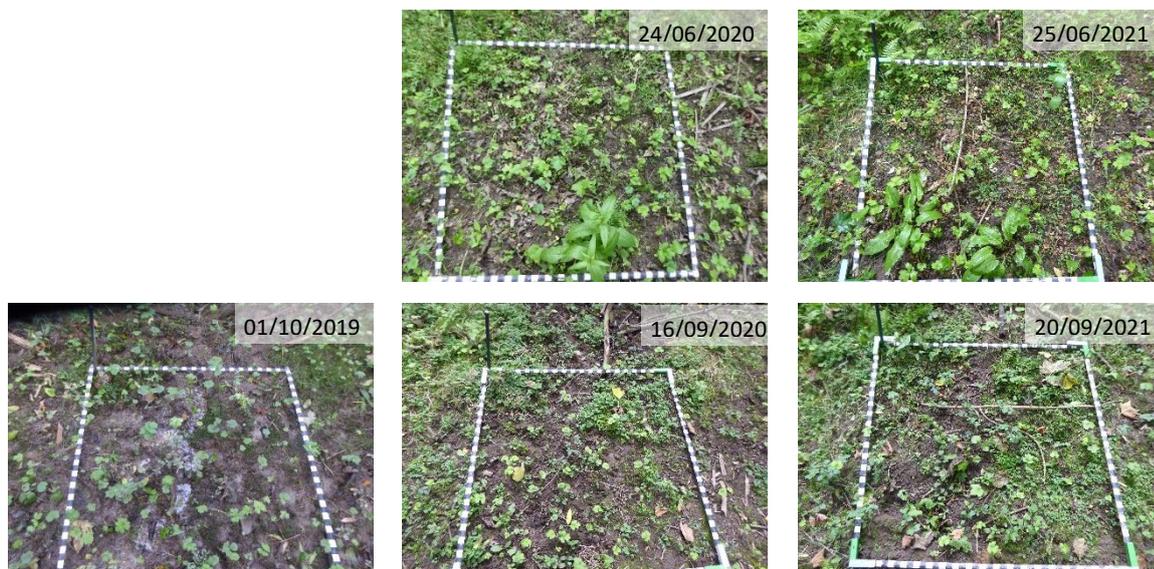
Figure 2: Dramatic changes in giant hogweed cover occurred after 6 months of grazing by sheep in 2019 as shown in Plot 24. There were 39 and 30 giant hogweed seedlings recorded in June and Sept 2020 respectively and a distinct sheep path in 2020. In 2021 there were less giant hogweed seedlings (22 and 2 recorded in June and Sept 2021) and some mixed herb species growing. Sheep path still very distinct.



The number of giant hogweed plants in the following height categories <10cm, 10- 30cm and >30cm were recorded. By 24th June 2020, 96% of giant hogweed seedlings/plants on the plots were <10cm. In contrast, by 25th June 2021 only 55% of giant hogweed seedlings/plants on the plots were <10cm, with 40% 10-30cm and 3% >30cm. This can be explained by the fact that in 2021 the sheep were introduced later, and smaller numbers were on site (624 sheep days prior to the monitoring visit in 2021 compared to 1188 sheep days in 2020). However, even with the significantly lower grazing pressure in 2021 - 1326 sheep days vs 2476 sheep days in 2020 - by the September visits similar proportions of giant hogweed seedlings/plants on the plots were <10cm (96% in 2020 and 90% in 2021). In addition the overall number of plants was also less than half – 149 plants - in September 2021 compared to 340 plants recorded in 2020.

Areas that showed heavy sheep usage and poaching of the ground in autumn 2019, featured numerous small giant hogweed seedlings in 2020 which also appeared in 2021 **Figure 3**.

Figure 3: In areas where there was heavy sheep usage and poaching of the ground observed in autumn 2019 there were lots of small giant hogweed seedlings in 2020 and 2021 such as in plot 26 (above). There was a decline in % bare ground (85%, 55% and 40% in the autumn visits in 2019, 2020 and 2021 respectively) and a corresponding increase in vascular plant cover.



Giant hogweed plants that were going to flower were cut to prevent new seeds being dispersed into the site. In 2020 246 plants were cut - these were concentrated in the ravine east of plot 8, near plot 28, just below and to the side of plot 42 in the vicinity of the farm buildings. In 2021, 62 flowering plants were cut in similar areas to those tackled in 2020. The number of flowering plants requiring to be cut annually is expected to decrease in time as the cutting effort combined with the sheep grazing will prevent giant hogweed plants from reaching flowering maturity and issuing seeds to replenish the seed bank.

Giant hogweed plants that grow in harder or out of reach places and escape sheep grazing e.g. in the ravine will continue to act as a seed source and should be removed by cutting where possible (**Figure 4**).



Figure 4: Giant hogweed growing 4m up a tree out of reach from sheep

b) Vegetation change observed in the giant hogweed monitoring plots

The average vegetation height in the 1m² giant hogweed monitoring plot increased over the surveyed years but was either the same or lower at the September visit than the June visit (**Table 3**). These increases in vegetation height reflect the changes in vegetation composition.

In 2019 and 2020, there was heavy grazing of hedge woundwort (*Stachys sylvatica*) and other herbs (**Figure 5**). However, lower levels of grazing occurred in 2021. The reduction in cover of herbs due to overgrazing in 2019 was accompanied by an increase in the cover of stinging nettles (*Urtica dioica*), on many plots in 2020 and 2021 (**Figure 6** and see plot 9 photos in **Appendix 1** and **2**). To a lesser extent, and in more open areas, there was an increase in the amount of thistles (see plots 29 and 32 photos in **Appendix 1** and **2**). In a few plots in the east of the site giant Hogweed bare ground has been replaced by dense stands of bracken (see photos of plots 5-7 in **Appendix 1** and **2**). This increased dominance of highly defended plant species such as stinging nettles, thistles and bracken which are less palatable to sheep occurs where grazing levels are too high. In some plots there was an increase in tufted hair-grass (*Deschampsia cespitosa*). The coarse leaves of *D. cespitosa* have a high silica content, and mature leaves are usually avoided by herbivores and therefore it can thrive where alternative forage is available (see photos of P12 in **Appendix 1**).

The extent of bare ground in the plots was higher in September than in June in each year but reduced significantly across years as grazing pressure was reduced. However, many plots where giant hogweed was dominant pre sheep grazing remained largely unvegetated as shown in **Figure 2** (also see photos of plots 18, 20-22, 24- 28 in **Appendix 1**).

Table 3: Average vegetation height and % bare ground cover in giant hogweed monitoring plots

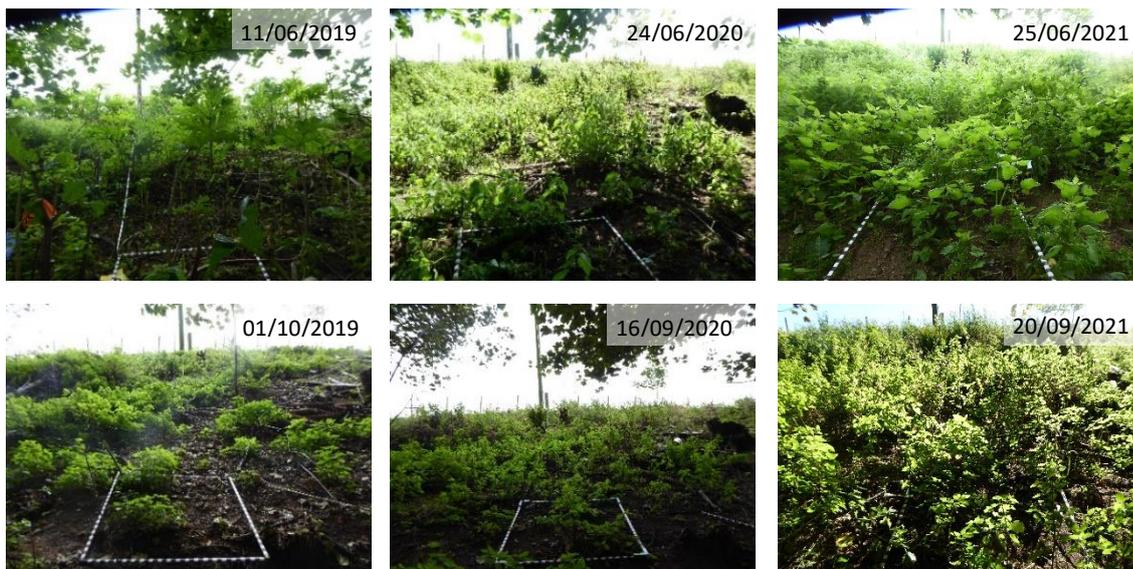
Year	Average vegetation height (cm)		Average % cover of bare ground	
	June	Sept/Oct	June	Sept/Oct
2019	7	7	47	59
2020	22	14	41	42
2021	38	28	29	32

Figure 5: Heavy grazing of herb species in particular hedge woundwort as seen in plot 34



In some areas there were encouraging signs of re-vegetation and a transition from giant hogweed to bare ground to a mixed grass sward and herbs as grazing pressure was progressively reduced year by year - as shown in the photos of plots 4, 8, 10, 12, 13 in **Appendix 1**. Likewise, in the south-west of the site in some areas the ground flora was re-vegetating (plots 38-42).

Figure 6: Plot 16 showing giant hogweed has been replaced with stinging nettle; see also close-up photos of plot 16 in Appendix 1



c) Grazing of shrub and tree species

In 2020 ash seedlings and saplings were regenerating well in the June visit but by September these were heavily grazed (see plot 23 photos in **Appendix 1**). This was less so in 2021 and in some plots ash seedlings were not grazed and were growing well even by the September visit (see plots 11, 20 and 37 photos in **Appendix 1**).

In 2019 and 2020 salmonberry (*Rubus spectabilis*) was heavily grazed with the majority of lower branches within reach of sheep being grazed. In addition there was evidence of the shrub layer dying off more generally (see plot 21 photos in **Appendix 1**) due to overgrazing. However, in 2021 there were signs of new salmonberry plants and lower levels of grazing (compare plot 21 photos in **Appendix 1** to previous years).

Vegetation Monitoring plots

a) Giant hogweed

At the summer recording visits, 19 of the 28 sub-plots had giant hogweed in 2019, 15 in 2020 and 17 in 2021. In 2019, 9 of these sub-plots had 10% or more giant hogweed cover compared to 4 sub-plots in 2020 and 2021. In the autumn visits in 2019, 2020 and 2021, 9 of the 28 sub-plots had giant hogweed. There was therefore a decrease in both occurrence and abundance of giant hogweed over the three years.

b) Bare ground

The amount of bare ground decreased between 2019 and 2021 (**Table 4**). In 2019 the amount of bare ground was considerably higher in the autumn visit than the summer visit due to over-grazing, whereas in 2020 and 2021 the amount of bare ground was similar in the summer and autumn visits. The monitoring visit was also later in 2019 which may also account for some of the difference between the first and second visits.

There were very distinct sheep paths in the upper half of the site as evidenced in vegetation plots 1, 2 and 3 (**Appendix 3**), although in 2021 sheep usage was far less evident around plot 1. In 2020 and 2021, sheep were spending more time around the middle of the site (vegetation plot 2). In the lower half of the site sheep usage of the site was also different in 2020 and 2021 than in 2019. In 2019 grazing pressure was limited just above the access track whereas in 2020 and 2021 there was an increase in sheep usage in the lower half of the site nearer the track as indicated by new sheep paths, dung and grazing just above vegetation plots 5 and 6 (**Appendix 3**).

Table 4: Vegetation monitoring plots

Measured element	Date of Survey					
	26/06/19	02/10/19	03/07/20	18/09/20	23/06/21	17/09/21
Horizontal visibility	9	10	7	7	6	7
% Bracken	1	2	4	3	7	5
% Herb cover	20	12	22	17	24	14
% Grass cover	10	19	23	24	29	25
% Bare ground	24	38	22	21	14	15
% Salmonberry	12	8	12	5	5	4
% Stinging Nettle	4	6	5	8	8	8

c) Vegetation composition

The changes in vegetation composition varied across the site. The plot nearest the farmhouse (vegetation plot 4), which had been sprayed with herbicide in spring 2019, showed an increase in both grass and herb cover, and in 2020 and 2021 there was a mixed sward of grasses and mixed herbs (**Appendix 3**). In contrast, at vegetation plot 1, herb cover (excluding stinging nettles) was on average 36% in summer 2019 yet by summer 2020 this had dropped to 25% and by summer 2021 was 11% (**Figure 7**). This was largely due to the dramatic decline of the highly palatable hedge woundwort.

Alongside the reduction in mixed herbs at some of the plots there was an increase in grazing tolerant species. The cover of stinging nettles and bracken increased over the years as shown in **Table 4**. This was particularly evident at some plots, at vegetation plot 1 for example, the percentage cover of stinging nettles was on average 18% in summer 2019; this had increased to 26% by summer 2021 with stinging nettles accounting for 60% cover at one sub-plot (**Figure 7**). The spread of stinging nettles normally occurs on bare ground or “gappy” swards created through overgrazing or poaching and where nitrogen enrichment of the soil occurs, in this case because of sheep dung. There was also a large increase in bracken, another highly defended plant species at vegetation plot 1 (**Appendix 3**).

Horizontal visibility was lower at both visits in 2021 and 2020 than in 2019. This can partly be explained by the increases in stinging nettles and other taller grazing tolerant plants.

Figure 7: Vegetation plot 1 - Hedge woundwort was heavily grazed and there was a significant decrease in cover and a corresponding increase in the amount of stinging nettles



In 2021, a more luxuriant ground flora was evident at some of the plots and there was an increase in cover of herb and grass species (**Table 4**). For example, at vegetation plot 3 there was lots of ash seedling and grass regeneration, although this was partially impacted by grazing by the autumn visit (**Figure 8**).

Figure 8: Vegetation plot 3. Regeneration of the ground flora following overgrazing in 2019



d) Grazing of shrub and tree species

Salmonberry bushes were mostly lightly grazed in summer 2019 but by the autumn were showing moderate to heavy levels of grazing. This trend continued in 2020 and by the autumn two-thirds were categorized as being heavily grazed (**Figure 9**). In 2021, salmonberry was still moderately to heavily grazed especially where it was growing proximate to sheep paths but there were signs of new salmonberry plants. Salmonberry is an invasive plant in Scotland. On several of the plots lots of new ash seedlings were observed (**Figure 8** and **Figure 10** and see plots 2 and 4 in **Appendix 3**). New ash seedlings were only lightly grazed in 2021 although you could still see that older saplings were moderately or heavily grazed in previous years.



Figure 9: Heavy grazing of salmonberry in 2019



Figure 10: Ash seedling regeneration

The high grazing pressure in 2019 was evidenced by the fact that even stinging nettles and bracken had also been grazed (**Figure 11**). There were still signs of grazing of these plants in 2020 but to a lesser extent and there was little evidence of it in 2021.



Figure 11: Even bracken and stinging nettles had been grazed showing very high grazing pressure in 2019 and 2020

6. Summary and Recommendations

In 2019, the introduction of twenty-five sheep over a period of seven months at Kirkside Farm resulted in a massive reduction in giant hogweed present - but also in the site becoming heavily overgrazed to the detriment of other parts of the plant community. There were extensive areas of bare ground, grazing of shrubs and saplings and quite large changes in ground flora apparent and recorded.

As a result of this smaller numbers of sheep were introduced in 2020 and the grazing period reduced. Overall, the total number of sheep days in 2020 was reduced to 2476 days – 49% of the grazing pressure recorded in 2019.

The plant community monitoring undertaken in 2020 still, however, confirmed overgrazing at the site (grazing of herbs, shrubs and tree seedlings), though at levels less severe than that found in 2019. In response the number of sheep days was further reduced in 2021 by 46% of 2020 levels and the sheep were added at the start of May instead of April. This represented a reduction in grazing days of 74% from the 2019 levels.

In 2021, the sheep continued to successfully graze giant hogweed plants and seedlings. As predicted in 2020, apart from isolated small patches or relatively inaccessible giant hogweed plants, the sheep dealt with the majority of these plants on the site. Monitoring in April 2021 showed that very large numbers of small giant hogweed seedlings had emerged in early spring – however, the number of seedlings present had reduced by two-thirds lower by the end of June. We know, from video footage and field observation, that sheep will tackle large giant hogweed plants by rubbing and knocking them over before grazing. Therefore, grazing does not need to be started in early Spring – the animals will happily tackle larger plants later in the season.

Sheep usage of the site varied between the years, and this must be borne in mind in future recommendations both for this and other sites where sheep grazing is to be used as a control strategy for giant hogweed. It is very hard to predict how sheep will behave and distribute - especially when there are additional factors which may influence this, such as disturbance (dog walkers), flock size or the suite of other vegetation available for grazing – but the acknowledgement of this variability is required.

Monitoring of plant communities, both in the giant hogweed monitoring plots and the larger vegetation monitoring plots, detected less evidence of over-grazing in 2021. Regeneration of tree seedlings and shrubs was observed and an increase in grass and herb species noted in several areas.

The initial overgrazing at the site, particularly in 2019, has resulted in changes in vegetation composition and led to an increased dominance of highly defended and less palatable plant species, such as nettles, thistles and bracken. These species spread on bare ground or 'gappy' swards created through overgrazing or poaching and flourish where nitrogen enrichment of the soil occurs, in this case because of sheep dung deposition.

Grazing as a management tool cannot simply be assessed by its effectiveness in controlling the target invasive species. The secondary impacts it has on other species and the site as a whole must also be considered.

Once overgrazing has led to bare ground - subsequently colonised by unpalatable and well-defended species - sheep are unlikely to tackle or remove these species and so they will persist. Where and when unpalatable species are abundant then sheep may graze preferentially in other parts of the site and cause further overgrazing and vegetation change.

To avoid such impacts, the grazing pressure must be carefully considered initially and adjusted as required to both deliver control of giant hogweed and retain diversity in the ground flora. In order to reduce the potential for undesired change in vegetation structure grazing should start with a low overall intensity as opposed to introducing high levels of grazing which may quickly change vegetation structure and diversity for the long-term.

At this study site there will be an extensive bank of giant hogweed seeds in the soil – particularly where there were very dense hogweed stands prior to sheep grazing being introduced. Controlling giant hogweed by grazing should be a long-term strategy as the seed bank formed by the species can remain viable for ten years or more. As each flowering plant can contain 50,000 seeds per flowering head it is important that such ungrazed plants are cut before they seed to prevent the addition of fresh seeds to the seed bank.

In 2021, from monitoring and observations the grazing pressure appears to be sufficient for effective control of giant hogweed, while limiting detrimental grazing effects on the rest of the ground flora. In 2022, we therefore suggest that a similar number of sheep are introduced for a similar length of time, that progress is observed and future grazing pressure adjusted as necessary. Beyond 2022, sheep grazing should continue to control of giant hogweed but grazing pressure may be further and progressively reduced until the number of giant hogweed plants is at a level that control by cutting is achievable on an annual basis.

Therefore, our overall recommendations to any land manager looking to control an area of giant hogweed by grazing are that;

- Before starting there should be a sound understanding of initial distribution and abundance of giant hogweed on the site or area where sheep are to be deployed
- Small numbers of sheep should be used at the outset to prevent the creation of bare and/or poached ground and reduce the likelihood of overgrazing in the first instance
- Grazing pressure should be monitored annually and revised in response to the findings of this monitoring
- Annual sheep grazing should be maintained – alongside the cutting of any emerging or flowering seed heads - until the number of plants are so small that other control methods might be considered.

Acknowledgements

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