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PRACTICE INSIGHTS

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No-mow amenity grassland case study: Phenology of floral abundance and nectar resource

Kelly Hemmings | **Rebecca Elton** | **Ian Grange**

School of Agriculture, Food, and Environment, Royal Agricultural University, Cirencester, UK

Correspondence
Kelly Hemmings, School of Agriculture, Food, and Environment, Royal Agricultural University, Tetbury Road, Cirencester GL7 6JS, UK.
Email: kelly.hemmings@rau.ac.uk

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Abstract

1. Popular campaigns such as No Mow May seek to encourage early-season forage resource for pollinators in urban green spaces. Land managers need to balance ecological benefits with extent of accessible amenity grassland.
2. To pilot the identification of a 'tipping point' when the nectar resource of unmown grassland exceeds that mown, we surveyed floral abundance in 30 plots on an amenity grassland site at 11 time points between late April and July. Each species' floral abundance per 1 m^2 was multiplied by published nectar sugar values to obtain an overall nectar sugar value per plot.
3. The nectar sugar value of no-mow plots was overall significantly higher than for mown plots. However, week-by-week analysis revealed that the first significant difference did not occur until mid-late May when no-mow plots yielded three times the nectar sugar value of the mown plots. In early-mid June, there was a significant eightfold divergence followed by a late June to early July decline. Common Ragwort (*Senecio jacobaea*) provided the greatest nectar sugar value, driving significant differences again in mid-July. No-mow plots contained twice as many (22 vs. 11) open flower broadleaf species compared to the mown plots.
4. Land managers could consider extending No Mow May management into June and beyond to maximize nectar sugar resource for pollinators. To comply with *S. jacobaea* legislation, a management plan and financial resource should be allocated to no-mow projects.

KEYWORDS
biodiversity, diversity, no mow, pollinators, ragwort, urban green space, wildflower

1 | INTRODUCTION

Public and organizational interest in establishing areas of unmown grassland in urban and peri-urban settings has increased (Garbuzov et al., 2015; Hoyle et al., 2017), due, in part, to initiatives such as No Mow May. The practice of leaving grass unmown throughout the spring and early summer is hereafter referred to as 'no-mow'. Amenity grassland has been defined as frequently mown short-sward grassland that is managed for recreation (Norton et al., 2019). Such grassland, including lawns, parks, and sports grounds, has been shown to cover 25% of U.K. urban land area (Evans et al., 2009). A frequently mown short sward has been the norm for amenity grassland management, resulting in a substantial opportunity for no-mow habitat in suitable locations.

The decline in pollinator abundance has been attributed, in part, to reduced pollen and nectar resource (Powney et al., 2019). No-mow has been proven to very effectively increase early season floral abundance and richness in domestic lawns, which in turn support a greater abundance and/or richness of bees (Del Toro & Ribbons, 2020; Lerman et al., 2018; Wastian et al., 2016). Floral abundance has been used as a proxy measure for pollinator resource, but the availability of U.K. wildflower nectar values has since enabled more precise quantification (e.g. Baude et al., 2016; Hicks et al., 2016; Timberlake et al., 2019). Using such values, Plantlife's Every Flower Counts citizen science website reported that lawn mowing once every four weeks yielded the maximum nectar sugar value for pollinators, but taller sward areas exhibited the greatest diversity of plant species. The physical structural diversity of no-mow habitat is also important: compared to mown lawns, no-mow lawns have been shown to provide greater pollinator habitat structural diversity due to increased sward height and flower cover (Garbuzov et al., 2015).

A further motive for no-mow is the natural regeneration of the existing flora, which contributes to the conservation of wildflowers in their own right. Of the few studies that have specifically investigated the impact of no-mow on native or existing plant communities in amenity grassland, there is evidence that reduced mowing increases floral resource either through diversity (Chollet et al., 2018) or number of flowering units (Garbuzov et al., 2015).

The phenology of nectar resource provision using known values is a relatively new discipline and existing studies are few (e.g. Tew et al., 2022; Timberlake et al., 2019). To date, no study has investigated the sequential early season floristic and nectar resource dynamics of no-mow versus mown amenity grassland. To address this gap, this study compares the early season nectar sugar value of both habitats by monitoring the phenology of species floral abundance and their contribution to the nectar sugar resource. We aimed to (i) monitor each species' floral abundance at weekly intervals from late April until mid-July; (ii) combine floral abundance data with published nectar sugar values to quantify any differences between the no-mow versus mown plots; and (iii) record changes in sward height and biomass.

2 | MATERIALS AND METHODS

Ethical approval number is RAU20210726-Hemmings. No permits or licences were required.

2.1 | Study area

The intensive study site was a 1.6-ha area of peri-urban campus amenity grassland surrounded by buildings, pasture and arable land in Cirencester, UK, centred on 51°42′35.29 N, 1°59′40.39 W (Figures 1 and 2). Altitude was 143 m above sea level and topography was flat. The annual mean diurnal temperature was 5.96–14.35°C and annual rainfall 822.6 mm (Met Office, 2022). The prevalent substrate was shallow

FIGURE 1 Location of Cirencester, South-West United Kingdom

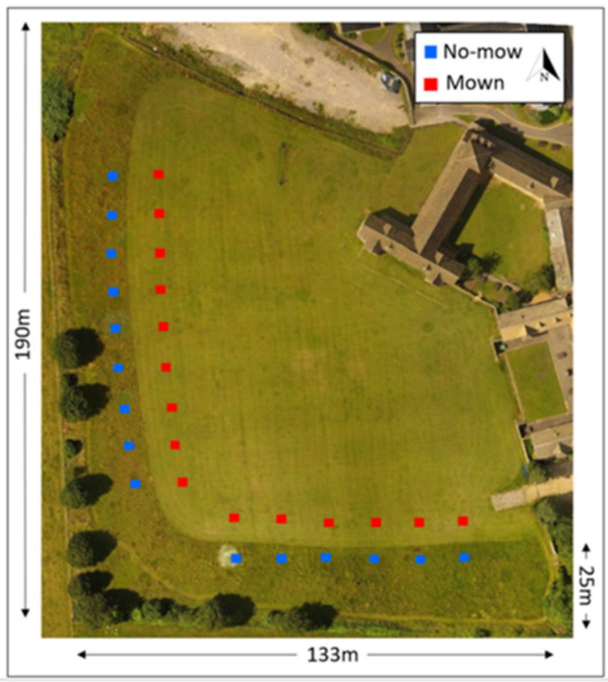


FIGURE 2 Drone image 14 July and site dimensions: No-mow section around field perimeter with plots indicated in blue and mown section centre with plots indicated in red. Plots 1m^2, not to scale

lime-rich soils over limestone with soil pH 7.0–7.5. The National Vegetation Classification of the site was typical of recreational grassland (Rodwell, 1991): OV23d *Lolium perenne*–*Dactylis glomerata* community, *Arrhenatherum elatius*–*Medicago lupulina* sub-community.

In previous years and up to 23 April 2021, the whole site was mown at 23 mm and rolled twice weekly during the growing season. Cuttings were left in situ. The grassland did not receive any chemical applications or aeration. In time for No Mow May, a 20–25m wide no-mow area was established around two edges of the amenity grassland area by first omitting mowing on 29 April (Figure 2). This was the first year of no-mow on this site. The no-mow area was not mown again until a hay cut in September. Mowing and rolling continued at the existing height and frequency over the rest of the site.

2.2 | Data collection

Prior to the introduction of no-mow, we located transects of 15 permanent plots in the no-mow area and 15 in the mown area (Figure 2). Plots were $1m^2$ and systematically spaced 10 m apart within each treatment, except to avoid anomalous areas of recreationally damaged sward when the minimum was 8 m. To avoid effectively comparing edge with interior, we placed the no-mow transect 10 m parallel to the mown transect.

Plantlife's Every Flower Counts survey method was adapted to monitor the sequence of floral abundance and nectar sugar value at weekly intervals (cf. Garbuzov et al., 2015) through late spring and into summer. We counted the number of open floral units of all broadleaf species (Supporting Information S1), in all plots over 11 time points. A floral unit comprised, for example, a single flower for creeping buttercup *Ranunculus repens*, a capitulum for dandelion *Taraxacum* agg., or a raceme for black medic *Medicago lupulina* (Supporting Information S1). Counts were first carried out as a baseline survey on 27 April, then at weekly intervals until 15 July. Hereafter, open floral units are referred to as 'open flowers'. Nomenclature follows www.theplantlist.org.

To quantify the total nectar sugar value for each plot, we multiplied the number of open flowers of each species by published nectar sugar values in micrograms per flower per day (Supporting Information S1). Asteraceae composite values were obtained from Hicks et al. (2016), with one exception, and all other species from Baude et al. (2016). As published nectar sugar values were not available for some species, we substituted closely related species with similar flower sizes (Hardman, 2016).

For non-nectar producing species, we also recorded the number of open flowers. Vegetative presence of broadleaf species not in flower was also recorded. At the same time as each open flower survey, a digital rising-plate meter (F200 Farmworks Ltd) was used to measure sward height and biomass per plot.

2.3 | Statistical methods

A two-way repeated-measures ANOVA was applied to natural logarithm transformed data to test for overall difference in nectar sugar values for no-mow plots (n = 15) and mown plots (n = 15) over 10 time points, excluding the baseline. As the assumption of sphericity was violated, we reported the Greenhouse–Geisser-corrected main effects value. To test for significance of difference at each survey time point and between these and the baseline, natural logarithm transformation was applied to all 11 time points, including the baseline. The interaction between mowing treatment and time was tested using simple main effects post hoc testing with Bonferroni correction. Although this was a single-site study, there was merit in testing in line with Hurlbert (2004) but caution should be applied if generalizing to other sites. Raw data were used to describe results.

3 | RESULTS

The mean nectar sugar value of the no-mow amenity grassland section was overall statistically significantly higher than the mown (F (1, 14) = 12.396, p = 0.003). Across all survey time points, the nectar value of the no-mow plots was on average 5.35 times higher than the mown plots.

However, individual time points revealed more detail. The mean nectar sugar value of the no-mow plots was first significantly higher than the mown plots on 20 May (three times higher) after omission of four mows and 3 weeks into the no-mow regime (p = 0.03) (Figure 3). At 4–6 weeks, no-mow plots showed a strongly and significantly higher mean nectar value compared to the mown plots ($p < 0.0001$) (Figure 3), with the no-mow value eight times higher than the mown on 11 June (Figure 3). There was no significant difference at 12 (p = 0.313), 14 (p = 0.058), or 16 mows (p = 0.083) between 17 June and 2 July (Figure 3). No-mow was again significantly higher than mown after 18 ($p = 0.036$) and 20 mows omitted ($p = 0.008$) on 9 and 15 July (Figure 3). At the final survey point 11 weeks into the no-mow regime, the no-mow mean nectar value was significantly higher and 47 times that of the mown (Figure 3).

The mean nectar sugar value of the no-mow plots was never statistically significantly higher than the baseline, which was attributable to variation among plots, and was significantly lower (p = 0.001) on 20 May. The mean of the mown plots was statistically significantly lower than the baseline on all but two occasions on 3 June and 9 July.

Twenty-two broadleaf species in flower were recorded in the no-mow plots and 11 in the mown plots (Figure 4a,b). No species in flower were unique to mown plots. However, considering vegetative presence only, the plant communities of both treatments were similar: 23 species were present in the no-mow plots and 21 in the mown plots (Figure 4a,b). Perennial sow-thistle *Sonchus arvensis* was the only species unique to the mown plots (vegetative only). White campion *Silene latifolia*, ox-eye daisy *Leucanthemum vulgare* and field bindweed *Convolvulus arvensis* were unique to the no-mow plots (all in flower).

The no-mow plots exhibited a clear temporal change in species floral abundance (Figure 4a) with *Taraxacum* agg. and daisy *Bellis perennis* as the early season highest nectar contributors. These were superseded by *M. lupulina* and beaked hawksbeard *Crepis vesicaria* into June.

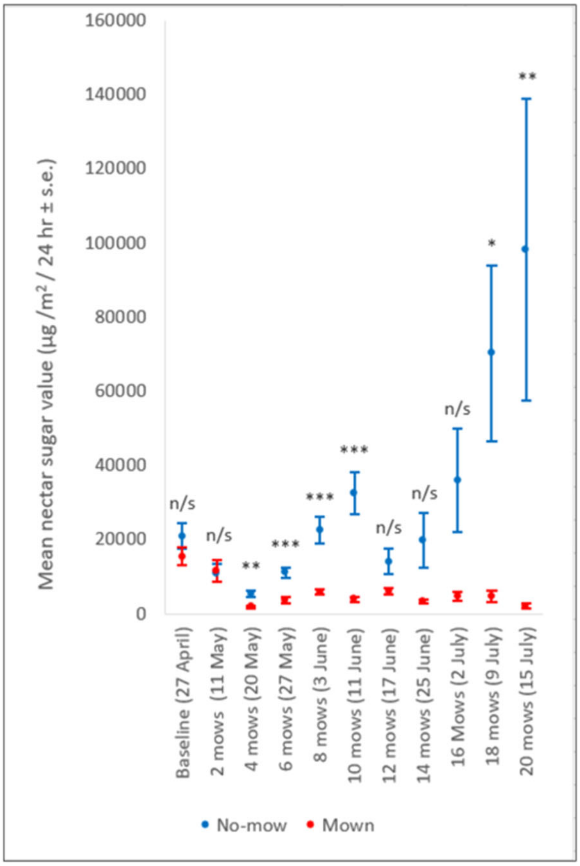


FIGURE 3 Average nectar sugar value (μg/m^2/24 h $\pm$ standard error) in no-mow ($n = 15$) and mown ($n = 15$) 1 × 1 m^2 quadrats. Number of mows omitted (no-mow) or carried out (mown) and date of survey. Significant differences between mean nectar sugar value of no-mow and mown plots at each time point indicated by n/s = not significant; * $\leq p = 0.05$; ** $\leq p = 0.01$; *** $\leq p = 0.001$.

In July, yarrow *Achillea millefolium* and common ragwort *Senecio jacobaea* contributed the most nectar. For the no-mow plots, common ragwort *S. jacobaea* was the overall highest contributor of nectar sugar over the survey period, followed by *C. vesicaria* and *Taraxacum* agg. Excepting *Taraxacum* agg., the sequence of seasonal change for the mown plots was less perceptible compared to the no-mow. For the mown plots, *Taraxacum* agg. was the overall highest contributor, followed by *M. lupulina* and *B. perennis* (Figure 4b).

The mean sward height and biomass of the no-mow plots showed a general pattern of increase over the survey period, while twice-weekly mowing suppressed growth in the mown plots. As the grassland was relatively herb rich, no-mow sward heights and biomass were lower and more variable than might be expected in a more uniform grass-rich sward.

4 | DISCUSSION

The primary aim of the no-mow approach was to provide early season forage resource for pollinators. Similar to prior studies, no-mow was found to yield greater nectar sugar resource and gamma richness of open flower species compared to standard mowing (cf. Del Toro & Ribbons, 2020; Lerman et al., 2018).

However, had the no-mow approach been implemented only for the duration of May, there would have been limited benefit. The nectar sugar value of no-mow plots was only first significantly higher than the mown in mid-late May. May 2021 was particularly cool and wet with temperatures 1.3°C below average (Met Office, 2021). It may be appropriate to extend the No Mow May approach beyond the end of that month when needed to align with climate for that particular year. Compared to this study conducted in southern United Kingdom, the later flowering phenology in northerly or upland locations may require a later or longer no-mow period to become at all effective, even in warmer years. Extending urban no-mow into June may also address the May–June drop in garden nectar resource evidenced by Tew et al. (2022).

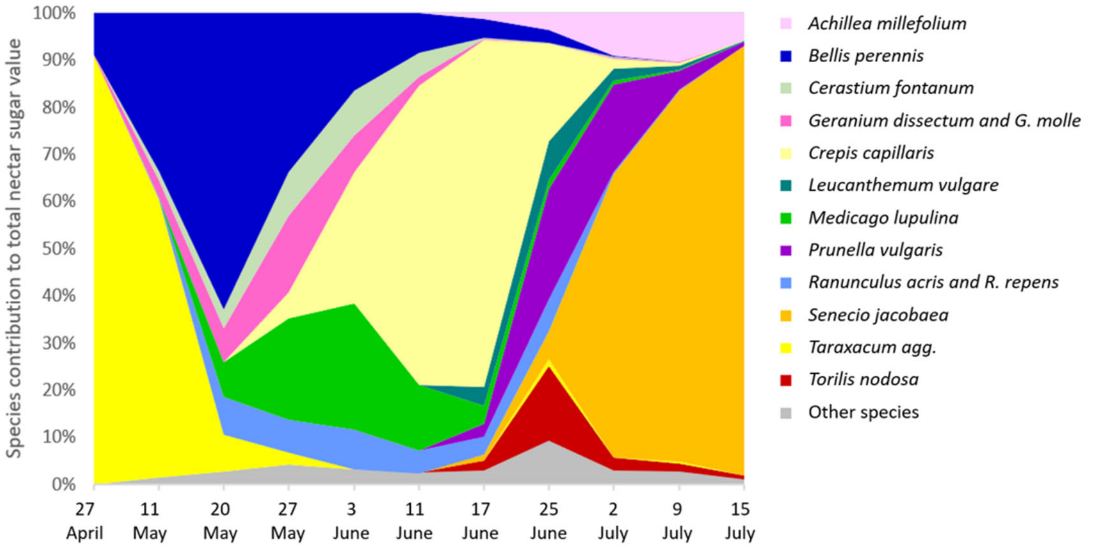
Species phenology, life traits and changes in sward structure combined to explain patterns in floral diversity and associated nectar values through May, June and July. Nectar-rich Asteraceae strongly determined patterns in nectar availability. The low no-mow nectar sugar values in early May coincided with a decline in *Taraxacum* agg., which is early-season flowering, nectar rich and moderately short-sward demanding. The widening gap in nectar resource between the no-mow and mown plots in June aligned with greater abundance of nectar-rich tall sward species such as *C. vesicaria* and *R. repens*. In mid-July, the difference in nectar resource was increased by emergence of later-season flowering and mowing-averse species such as *A. millefolium*, *L. vulgare* and *S. jacobaea*. For the mown section, short-sward species such as *B. perennis*, common mouse-ear *Cerastium fontanum* and *M. lupulina* contributed nectar resource fairly consistently over the season.

The range of nectar-providing species in the no-mow section may support a greater diversity of bee species (Woodard & Jha, 2017) and non-bee pollinators such as Lepidoptera, Coleoptera and Diptera (Phillips et al., 2020). No-mow also generated a numerically greater sward height and biomass, providing more habitat for invertebrates (Garbuzov et al., 2015). Vegetative surveys clarified that the greater number of open flower species in the no-mow section was due to perennial species being able to attain growth and flowering in the absence of mowing. The difference was not driven by colonization of annual or ruderal species, as was the case in Norton et al. (2019).

A consequence of no-mow was emergence of *S. jacobaea*, which contributed the highest nectar sugar total of all the species. Despite being recognized for its extensive wildlife benefits and nectar value (Balfour & Ratnieks, 2022), current U.K. legislation requires its control to prevent seed dispersal to pasture or land used for feed or forage production. As the site was adjacent to pasture, plants were pulled after the final survey in mid-July before seed set. Land managers should make financial provision for a *S. jacobaea* management plan and control in similar sites.

This pilot study revealed that it was possible to identify when the nectar sugar value of no-mow exceeded that of mown. Scaling up this

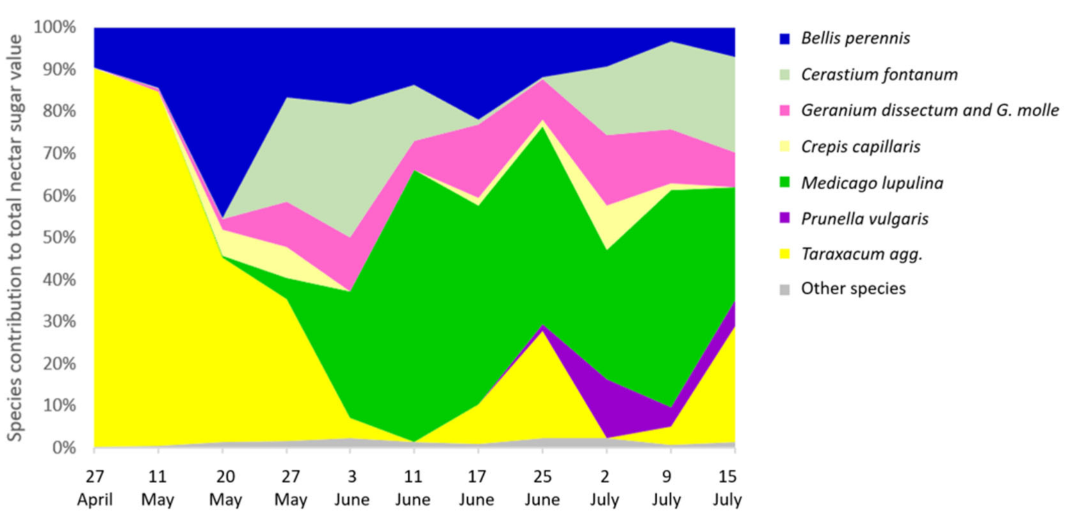
(a) No-mow



Mows omitted	0	2	4	6	8	10	12	14	16	18	20
Sward height (cm)	4.2	5.2	5.8	6.9	9.2	10.4	10.7	12.1	10.6	12.7	11.7
Sward biomass (kg/ha)	1060	1239	1318	1500	1743	1962	1957	2153	1970	2222	2071

Species with vegetative presence only: *Plantago major*

(b) Mown



Mows since baseline	0	2	4	6	8	10	12	14	16	18	20
Sward height (cm)	4.1	4.1	3.0	2.6	3.3	4.0	3.3	3.8	4.2	3.6	3.4
Sward biomass (kg/ha)	1067	1067	926	965	1408	1137	1036	1117	1163	1079	1056

Species with vegetative presence only: *A. millefolium; C. vulgare; O. apifera; P. major; S. jacobaea; R. acris; Sonchus arvensis.; T. nodosa; T. repens; V. persica.*

FIGURE 4 Percentage species contribution to nectar sugar value at the baseline (27 April) and subsequent survey points for (a) no-mow and (b) mown recreational grassland plots. For (a) other = *Cirsium vulgare*, *Convolvulus arvensis*, *Ophrys apifera* (non-nectar producing), *Sherardia arvensis*, *Silene latifolia*, *Trifolium repens*, *Veronica arvensis*, and *Veronica persica*. For (b) other = *Ranunculus repens*, *Sherardia arvensis*, and *Veronica persica*. Mows omitted/carried out, mean sward height (cm) ($n = 15$), and mean sward biomass (kg/ha) ($n = 15$). Species with only vegetative presence also listed.

study to a number of sites would consolidate the findings for wider application. The suitability for pollinators is limited by factors other than nectar: phenology of pollen value would also be a valuable avenue of research. To maximize early season nectar sugar resource in amenity grassland, citizen science campaigns should continue to encourage public engagement beyond No Mow May into mid-June, particularly when the phenological response of floral abundance may be delayed due to climatic or geographical conditions.

AUTHOR CONTRIBUTIONS

Kelly Hemmings and Ian Grange conceived the project. Kelly Hemmings, Ian Grange and Rebecca Elton collected the data. Kelly Hemmings and Ian Grange implemented the analyses and wrote the manuscript. Rebecca Elton (practitioner) advised on and was involved in the practical management of the study site. All authors gave feedback and approved the final version.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data available from Royal Agricultural University CREST repository: https://rau.repository.guildhe.ac.uk/id/eprint/16545/ (Hemmings et al., 2022).

ORCID

Kelly Hemmings https://orcid.org/0000-0001-7658-7803

PEER REVIEW

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Supporting Information 1. Open floral unit definition and source of nectar sugar value. Hemmings, Elton, Grange. (2022). No-mow amenity grassland case study: phenology of floral abundance and nectar resource. Ecological Solutions and Evidence.

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