

Supporting Information. Norton, Briony A., Gary D. Bending, Rachel Clark, Ron Corstanje, Nigel Dunnett, Karl L. Evans, Darren R. Grafius, Emily Gravestock, Samuel M. Grice, Jim A. Harris, Sally Hilton, Helen Hoyle, Edward Lim, Theresa G. Mercer, Mark Pawlett, Oliver L. Pescott, J. Paul Richards, Georgina E. Southon, and Philip H. Warren. 2019. Urban meadows as an alternative to short mown grassland: effects of composition and height on biodiversity. *Ecological Applications*.

Appendix S1

Figure S1: Maps showing the location of the experimental sites and their surrounding landscape. (A – Luton site; B – Bedford sites; C – Cranfield University site).





Table S1: Site details and invertebrate sampling dates in treatment year 2. For details of treatments, refer to Figure 1 in the main manuscript.

| Site details | | | | | Invertebrate sampling dates treatment year 2 | | |
|--------------|----------------------|-----------------------------|--|------------------|--|---------------------|--|
| Town | Site | Location | Treatment set | Plot size | Summer | Autumn | Winter |
| Bedford | Chiltern Ave | 52°08'53.2"N 0°26'48.0"W | Full | 12.5 m x 20 m | 17 June 2014 | 2 September 2014 | 11th and 13th February 2015 |
| Bedford | Goldington Green | 52°08'38.9"N 0°25'42.0"W | Excludes: H1.D2 H2.D2 H3.D2 | 12.5 m x 20 m | 18 June 2014 | 3 September 2014 | 9 February 2015 (only unmanipulated control + H3.D1 + H3.D3 available, others rotovated) |
| Bedford | Jubilee Park | 52°07'18.0"N 0°26'50.3"W | Full | 12.5 m x 20 m | 23 July 2015 | 7 September 2015 | NA |
| Bedford | Brickhill Heights | 52°09'10.2"N 0°28'15.3"W | Excludes H1.D2 H2.D1 H2.D2 H2.D3 | 12.5 m x 20 m | 18 June 2014 | 2 September 2014 | 10 February 2015 |
| Luton | Bramingham Road | 51°54'53.6"N 0°26'16.2"W | Full | 12.5 m x 20 m | 17 June 2014 | 3 September 2014 | 12 February 2015 |
| Cranfield | Cranfield University | 52°04'40.1"N 0°37'36.0"W | Full (small plots) | 5 m x 10 m | NA | NA | NA |

Table S2: Composition of seed mix per treatment. Treatments are designated by H.D. H = height and D = diversity. H: 1 = short; 2 = intermediate; 3 = tall. D: 1 = low; 2 = medium; 3 = high. Treatments D2 and D3 (grass/forb mixes) plots were initially sown at 4g/m², and bare patches were over-sown at the end (autumn) of the first growing season at the same density. Treatment D1 (grass only) plots were initially sown at 4g/m² and most (two plots were excluded as they established adequately: H3 at Goldington Green and Bramingham) were sprayed and re-sown at 20 g/m² at the end (autumn) of the first growing season.

| Treatment | H1.D1 | H1.D2 | H1.D3 | H2.D1 | H2.D2 | H2.D3 | H3.D1 | H3.D2 | H3.D3 |
|-------------------------------|--|-------|-------|-----------|-------|-------|-----------|-------|-------|
| Total Richness | 4 | 9 | 16 | 3 | 10 | 17 | 5 | 13 | 21 |
| Forb Richness | 0 | 5 | 12 | 0 | 7 | 14 | 0 | 8 | 16 |
| Grass Richness | 4 | 4 | 4 | 3 | 3 | 3 | 5 | 5 | 5 |
| Forb: grass seed ratio | All grass | 1:3 | 1:1 | All grass | 1:3 | 1:1 | All grass | 1:3 | 1:1 |
| Forb species | % of forb community per species (by seed weight) | | | | | | | | |
| <i>Achillea millefolium</i> | | 10 | 5 | | 5 | 1 | | 10 | 4 |
| <i>Anthriscus sylvestris</i> | | | | | | | | 10 | 4 |
| <i>Arctium minus</i> | | | | | | | | 4 | 2 |
| <i>Centaurea nigra</i> | | | | | 30 | 10 | | 40 | 15 |
| <i>Centaurea scabiosa</i> | | | | | | 15 | | | |
| <i>Daucus carota</i> | | | | | | 3 | | | |
| <i>Dipsacus fullonum</i> | | | | | | | | 6 | 4 |
| <i>Echium vulgare</i> | | | | | | | | | 10 |
| <i>Galium album (mollugo)</i> | | | | | | | | | 7 |
| <i>Galium verum</i> | | | 5 | | 5 | 2 | | | |
| <i>Geranium pratense</i> | | | | | | 7 | | | |
| <i>Hypericum perforatum</i> | | | | | | 1 | | | |
| <i>Knautia arvensis</i> | | | | | 25 | 15 | | | 10 |
| <i>Leontodon hispidus</i> | | | 10 | | 15 | 10 | | | |
| <i>Leucanthemum vulgare</i> | | | 5 | | | 5 | | 7 | 3 |
| <i>Linaria vulgaris</i> | | | | | | | | | 3 |
| <i>Lotus corniculatus</i> | | 40 | 20 | | | | | | |
| <i>Malva moschata</i> | | | | | | 20 | | | 7 |
| <i>Medicago lupulina</i> | | 20 | 12 | | | | | | |
| <i>Ononis spinosa</i> | | | | | | | | | 10 |
| <i>Plantago lanceolata</i> | | | | | | | | 8 | 3 |
| <i>Plantago media</i> | | | 3 | | 5 | 2 | | | |
| <i>Primula veris</i> | | | 5 | | | | | | |
| <i>Prunella vulgaris</i> | | 15 | 7 | | | | | | |
| <i>Ranunculus acris</i> | | | 15 | | | | | | |
| <i>Rumex acetosa</i> | | 15 | 8 | | | | | 15 | 5 |
| <i>Tanacetum vulgare</i> | | | | | | | | | 5 |
| <i>Trifolium pratense</i> | | | 5 | | 15 | 4 | | | |

Vicia cracca

5

8

| Grass species | % of grass community per species (by seed weight) | | | | | | | | |
|----------------------------|--|----|----|----|----|----|----|----|----|
| <i>Agrostis capillaris</i> | | | | 10 | 10 | 10 | | | |
| <i>Agrostis castellana</i> | 10 | 10 | 10 | 10 | 10 | 10 | | | |
| <i>Dactylis glomerata</i> | | | | | | | 30 | 30 | 30 |
| <i>Festuca arundinacea</i> | | | | | | | 15 | 15 | 15 |
| <i>Festuca pratensis</i> | | | | | | | 25 | 25 | 25 |
| <i>Festuca rubra</i> | 50 | 50 | 50 | 80 | 80 | 80 | 20 | 20 | 20 |
| <i>Lolium perenne</i> | 20 | 20 | 20 | | | | | | |
| <i>Phleum pratense</i> | | | | | | | 10 | 10 | 10 |
| <i>Poa pratensis</i> | 20 | 20 | 20 | | | | | | |

Table S3: Invertebrate biomass calculations

Biomass estimates for invertebrates sampled in the meadow experiment were obtained using data from invertebrate samples taken across Bedford, Luton and Milton Keynes in the summer (July and August) of 2013. Invertebrates were sampled in 243 plots (each 25 m² in area) across 78 urban green spaces using a sweep net and vacuum sampler, identified to order level primarily (see table for details) and stored in separate vials for each taxon. Of this collection, samples from 18 sites that reflected a range of vegetation types and site sizes were selected to estimate biomass. From this subsample, up to 48 individuals (based on availability of specimens) were selected from each taxon, excepting Acari, which had not been separated from the samples. Length of each individual was measured under the microscope with a graticule to the nearest 1/10th mm. Specimens were then oven-dried overnight (16 hours) at 60° C. Each individual organism was weighed on a microbalance (in mg to 4 dp). Collembola were too light to measure individually, and were instead weighed in groups of 24 and an average weight derived. Where there were too few specimens (< 5) to derive an average weight for a particular taxon, an average weight was derived as a surrogate, using the weights of taxa with similar physical properties.

Dry weight per individual organism in a taxon used to estimate biomass across the treatment plots. The number of specimens is the number used to derive the dry weight. Where this is blank, a surrogate was used, indicated in the final column.

| Phylum | Class | Order | lower taxon.1 | lower taxon.2 | Dry weight (mg) | No. specimens | Weight surrogate |
|------------|--------------|------------------|---------------|---------------|-----------------|---------------|--|
| Mollusca | Gastropoda | | | | 0.746 | | Average of all 'large' (> 0.1 mg) taxa |
| Arthropoda | Arachnida | Acari | | | 0.054 | | Average of all 'small' (< 0.1 mg) taxa |
| Arthropoda | Arachnida | Araneae | | | 0.815 | 36 | |
| Arthropoda | Arachnida | Opiliones | | | 0.815 | | Araneae |
| Arthropoda | Arachnida | Pseudoscorpiones | | | 0.746 | | Average of all 'large' (> 0.1 mg) taxa |
| Arthropoda | Malacostraca | Isopoda | | | 0.746 | | Average of all 'large' (> 0.1 mg) taxa |
| Arthropoda | Chilopoda | | | | 0.746 | | Average of all 'large' (> 0.1 mg) taxa |
| Arthropoda | Diplopoda | | | | 0.746 | | Average of all 'large' (> 0.1 mg) taxa |
| Arthropoda | Symphyla | | | | 0.009 | | Thrips |
| Arthropoda | | Collembola | | | 0.061 | 138 | |
| Arthropoda | | Diplura | | | 0.009 | | Thrips |

| | | | | | | | |
|------------|---------|---------------|-----------------|---------|-------|----|-------------------------------|
| Arthropoda | Insecta | Coleoptera | adult | | 1.015 | 71 | |
| Arthropoda | Insecta | Coleoptera | larvae | | 0.082 | 22 | |
| Arthropoda | Insecta | Dermaptera | | | 2.329 | 8 | |
| Arthropoda | Insecta | Diptera | adult | | 0.227 | 56 | |
| Arthropoda | Insecta | Diptera | larvae | | 0.404 | 24 | |
| Arthropoda | Insecta | Ephemeroptera | | | 0.515 | | Average of all adult insects |
| Arthropoda | Insecta | Hemiptera | Heteroptera | | 1.128 | 35 | |
| Arthropoda | Insecta | Hemiptera | Auchenorrhyncha | Hoppers | 1.075 | 35 | |
| Arthropoda | Insecta | Hemiptera | Sternorrhyncha | Aphids | 0.064 | 36 | |
| Arthropoda | Insecta | Hemiptera | Sternorrhyncha | Other | 0.064 | | Aphids |
| Arthropoda | Insecta | Hymenoptera | Formicidae | | 0.313 | 24 | |
| Arthropoda | Insecta | Hymenoptera | Other | | 0.059 | 48 | |
| Arthropoda | Insecta | Lepidoptera | adult | | 1.026 | 3 | |
| Arthropoda | Insecta | Lepidoptera | larvae | | 0.137 | 16 | |
| Arthropoda | Insecta | Mecoptera | | | 0.515 | | Average of all adult insects |
| Arthropoda | Insecta | Neuroptera | adult | | 0.515 | | Average of all adult insects |
| Arthropoda | Insecta | Neuroptera | larvae | | 0.221 | | Average of all larval insects |
| Arthropoda | Insecta | Odonata | | | 0.515 | | Average of all adult insects |
| Arthropoda | Insecta | Orthoptera | | | 0.515 | | Average of all adult insects |
| Arthropoda | Insecta | Plecoptera | larvae | | 0.221 | | Average of all larval insects |
| Arthropoda | Insecta | Psocodea | | | 0.057 | 21 | |
| Arthropoda | Insecta | Thysanoptera | | | 0.009 | 47 | |
| Arthropoda | Insecta | Trichoptera | | | 0.515 | | Average of all adult insects |
| Arthropoda | Insecta | Zygentoma | | | 0.009 | | Thrips |

Section S1: Extended method details: supplement to main manuscript Methods: Invertebrates

Aboveground invertebrates were sampled twice in all plots: first in the summer (June/July) and then the autumn (early September) of the second year post-sowing. Sampling was scheduled to occur at least a week after mowing, but unplanned changes in the council maintenance schedule meant that a subset of plots ($n = 4$, September) had been recently mown prior to sampling. Sweep netting (primarily targeting taxa that can fly) was undertaken along a 20 m transect through the middle of the plot, using a white net (60 cm diameter). Vacuum sampling (for invertebrates on the ground and vegetation) was undertaken at two points in each plot using a cordless leaf blower/vac (airspeed = 320 km/h; 11 cm diameter nozzle). Sampling locations were away from the sweep net transect and at least 2 m apart. Sampling was conducted at all vegetation heights in a sampling container (0.5 m in diameter and 1.5 m high) that prevented the escape of aerial insects.

The potential of meadows to support overwintering invertebrates was assessed through sampling conducted in February 2016 at sites at the end of their second-year post-establishment (Brickhill Heights, Chiltern Avenue, Bramingham Road and Goldington Green). At Goldington Green only three plots were available for sampling as four plots had experienced unscheduled rotovation by greenspace management teams. Sweep netting was conducted as in summer but vegetation was too compacted and damp for effective use of the blower/vac. Hand-searching was thus conducted in two, 1 m² quadrats in each plot, off the sweep net transect and at least 2 m apart. Searches involved a sequence of beating, cutting, collecting and sieving vegetation. A pooter/aspirator was used to extract invertebrates from the ground surface and collected vegetation, by orally sucking them into collecting tubes. Each quadrat was surveyed for a maximum of 50 minutes, with equal time allocated to each quarter of the quadrat and a stopping rule used for each survey method.

All invertebrate specimens were stored in 80% industrial methylated spirits prior to identification to order (class for Chilopoda, Diplopoda and Gastropoda) using a binocular microscope. Order is a coarse resolution, but sorting to this level allowed an assessment of all collected taxa simultaneously at a level directly comparable between sites and studies. The numbers of each taxon were counted precisely except where one taxonomic group (usually Acari or Collembola) exceeded approximately 200 individuals, when they were estimated by precisely counting two or three groups of 10 or 100 individuals (depending on abundance) and then estimating the number of such groups in the entire sample. Adults and larvae from each taxon were combined to order level for analysis. Coleoptera are a taxonomically and functionally diverse order of insects, and were ubiquitous across plots. Coleoptera adults from the summer and autumn samples and from the three sites with a full set of treatments (Chiltern Avenue, Bramingham Road, Jubilee Park) were identified to family to provide a taxonomically and functionally more finely resolved assessment of differences in diversity and composition across the plots. Finally, invertebrate biomass was estimated based on an average oven-dry weight of approximately 30 individuals for each order, or the closest taxonomic grouping if too few specimens were available, using samples collected from greenspace in the surrounding urban landscape (Table S3).

Section S2: Extended method details: supplement to main manuscript Methods: Soils, Soil biological community

Microbial biomass-C was determined using the fumigation-extraction procedure (Jenkinson and Powlson 1976) using the KEC of 0.45 (Vance et al. 1987). Microbial community phenotypic characteristics were determined by analysing cellular phospholipids using an adaptation of Frostegård's et al. (1993) method. Phospholipid Fatty Acids (PLFA) were extracted from approximately 7 g freeze dried soil. Fatty acids were derivatised by mild alkaline methanolysis prior to analysis by gas chromatography (Agilents, USA) using a HP-5 (Agilent Technologies) capillary column (30 m length, 0.32 mm ID, 0.25 µm film). The GC conditions were reported in Pawlett et al. (2013). Fatty acids were identified by comparison of sample retention time to a standard qualitative bacterial acid methyl ester mix (Supelco) and by using gas chromatography coupled with mass spectroscopy (Agilents, USA). Resultant fatty acids were integrated using G2070 ChemStation for G.C, and calculated as relative abundance (mol %). The mol% of indicator fatty acids was used as an indicator of the presence of group of organisms. Indicator fatty acids included: 18:2ω6, 9 (ectomycorrhizal fungi) and the sum of i15:0, ai15:0, 15:0, 16:1, i16:0, 16:1ω9, 16:1ω7 t, i17:0, ai17:0, cyc-17:0, 17:0 and cyc-19:0 (total bacteria).

Total DNA was extracted from 250 mg soil using the PowerSoil DNA Isolation kit (MoBio, USA) according to the manufacturer's instructions. For each sample, 10 ng of DNA was used to amplify either the ITS region using the ITS fungal primer pair ITS3 and ITS4 (White et al. 1990), or the 16S rRNA gene using the 16S bacterial primer pair 515f and 806r (Caporaso et al. 2011). The two primer sets were modified at the 5' end with Illumina Nextera Index Kit v2 adapters. PCR reactions were performed in a reaction volume of 25 µl, containing Q5® Hot Start High-Fidelity 2X Master Mix (New England Biolabs) and 0.5 µM of each primer. Thermocycling consisted of an initial denaturation at 98°C for 30 s followed by 30 cycles of 98°C for 10 s, 50/57°C (16S/ITS) for 15 s and 72°C for 20 s with a final extension at 72°C for 5 min. The libraries were sequenced using the Illumina MiSeq Reagent Kit v3 (600-cycle). Following sequencing, Trimmomatic v0.35 was used to remove low-quality bases from the sequence ends (Bolger et al. 2014). The following steps were then performed using USEARCH and UPARSE software (Edgar 2010, 2013). Paired-ends reads were assembled by aligning the forward and reverse reads, trimming primers and quality filtering (-fastq_maxee 0.5). Unique sequences were sorted by abundance and singletons were discarded from the dataset. Sequences were clustered to Operational Taxonomic Units (OTUs) at 97% minimum identity threshold. Taxonomy was assigned using Quantitative Insights into Microbial Ecology (QIIME 1.8) (Caporaso et al. 2010) and the Greengenes reference database for 16S (McDonald et al. 2011), or the UNITE database for ITS (Kõljalg et al. 2013).

Table S4: Total abundance of each aboveground invertebrate taxon collected in summer, autumn and winter in the second growing season of the meadow treatments. Collection methods in winter were different, from those in summer and autumn (see main manuscript Methods: Invertebrates and Appendix S1: Sect. S1) and sampling was undertaken on a subset of sites (Table S1).

| Taxon | Summer | Autumn | Winter |
|---------------|---------------|---------------|---------------|
| Chilopoda | 4 | 16 | 2 |
| Diplopoda | 7 | 21 | 8 |
| Gastropoda | 138 | 533 | 455 |
| Acari | 5298 | 19204 | 173 |
| Araneae | 1523 | 3612 | 397 |
| Coleoptera | 8095 | 2953 | 253 |
| Collembola | 19424 | 25727 | 1,724 |
| Dermaptera | 91 | 53 | 2 |
| Diplura | 2 | 5 | 0 |
| Diptera | 8055 | 5607 | 705 |
| Ephemeroptera | 0 | 2 | 0 |
| Hemiptera | 10283 | 9970 | 283 |
| Hymenoptera | 2803 | 3421 | 28 |
| Isopoda | 38 | 34 | 0 |
| Lepidoptera | 112 | 185 | 74 |
| Neuroptera | 32 | 14 | 0 |
| Odonata | 31 | 1 | 0 |
| Opiliones | 0 | 5 | 0 |
| Orthoptera | 1 | 2 | 0 |
| Psocodea | 172 | 2322 | 154 |
| Thysanoptera | 3232 | 5277 | 149 |
| Zygentoma | 0 | 1 | 0 |

Table S5: Output from adonis and betadisper models (vegan, Oksanen et al. 2017) for plants and invertebrates (summer and autumn order-level community and Coleoptera families). Model terms are added sequentially and treatment effects are reported for the model where the other treatment is accounted for (for details refer to main manuscript Methods: Data Analysis, Plants and invertebrates – ordinations). Site was included as a blocking factor. The betadisper p-values indicate whether there is significant differences in homogeneity of group variances. Where these are < 0.05, the adonis outputs should be treated cautiously as they are sensitive to variation in homogeneity of group variances.

| | | adonis | | | | | betadisper |
|---------------------------------|-----------------|--------|-----------|---------|---------|--------------|--------------|
| Taxon | | Df | SumsOfSqs | F.Model | R2 | Pr(>F) | Pr(>F) |
| Plants All | Site: Diversity | 9 | 3.5744 | 1.7705 | 0.27741 | 0.001 | 0.173 |
| | Site: Height | 9 | 4.0785 | 2.0202 | 0.31653 | 0.001 | 0.362 |
| | Site | 4 | 1.8038 | 2.0103 | 0.13999 | 0.001 | |
| | Residuals | 15 | 3.3649 | | 0.26114 | | |
| | Total | 37 | 12.8851 | | 1 | | |
| Plants Non-sown | Site: Diversity | 9 | 3.3999 | 1.2431 | 0.22999 | 0.045 | 0.709 |
| | Site: Height | 9 | 3.6194 | 1.3234 | 0.24484 | 0.018 | 0.010 |
| | Site | 4 | 3.1108 | 2.5592 | 0.21043 | 0.01 | |
| | Residuals | 15 | 4.5583 | | 0.30835 | | |
| | Total | 37 | 14.783 | | 1 | | |
| Order-level community Summer | Site: Diversity | 9 | 0.9272 | 1.3903 | 0.20385 | 0.094 | 0.313 |
| | Site: Height | 9 | 1.1345 | 1.7012 | 0.24943 | 0.026 | 0.104 |
| | Site | 4 | 1.3421 | 4.5281 | 0.29507 | 0.018 | |
| | Residuals | 15 | 1.1115 | | 0.24437 | | |
| | Total | 37 | 4.5484 | | 1 | | |
| Order-level community Autumn | Site: Diversity | 9 | 1.0181 | 1.5411 | 0.22545 | 0.060 | 0.608 |
| | Site: Height | 9 | 1.1641 | 1.7622 | 0.25778 | 0.023 | 0.609 |
| | Site | 4 | 1.1953 | 4.0713 | 0.2647 | 0.007 | |
| | Residuals | 15 | 1.101 | | 0.24381 | | |
| | Total | 37 | 4.5159 | | 1 | | |
| Coleoptera Families Summer | Site: Diversity | 6 | 1.8413 | 1.8719 | 0.28478 | 0.067 | 0.010 |
| | Site: Height | 6 | 1.6155 | 1.6424 | 0.24986 | 0.102 | 0.727 |
| | Site | 2 | 1.0415 | 3.1765 | 0.16108 | 0.051 | |
| | Residuals | 12 | 1.9673 | | 0.30427 | | |
| | Total | 26 | 6.4657 | | 1 | | |
| Coleoptera Families Autumn | Site: Diversity | 6 | 1.1714 | 1.5197 | 0.24517 | 0.073 | 0.776 |
| | Site: Height | 6 | 1.5559 | 2.0186 | 0.32566 | 0.007 | 0.278 |
| | Site | 2 | 0.5089 | 1.9805 | 0.1065 | 0.008 | |
| | Residuals | 12 | 1.5416 | | 0.32266 | | |
| | Total | 26 | 4.7778 | | 1 | | |

Figure S2: Boxplot of total abundance per plot by height treatment (H1 = short, H2 = medium, H3 = tall) of invertebrates collected during winter surveys (February 2015).

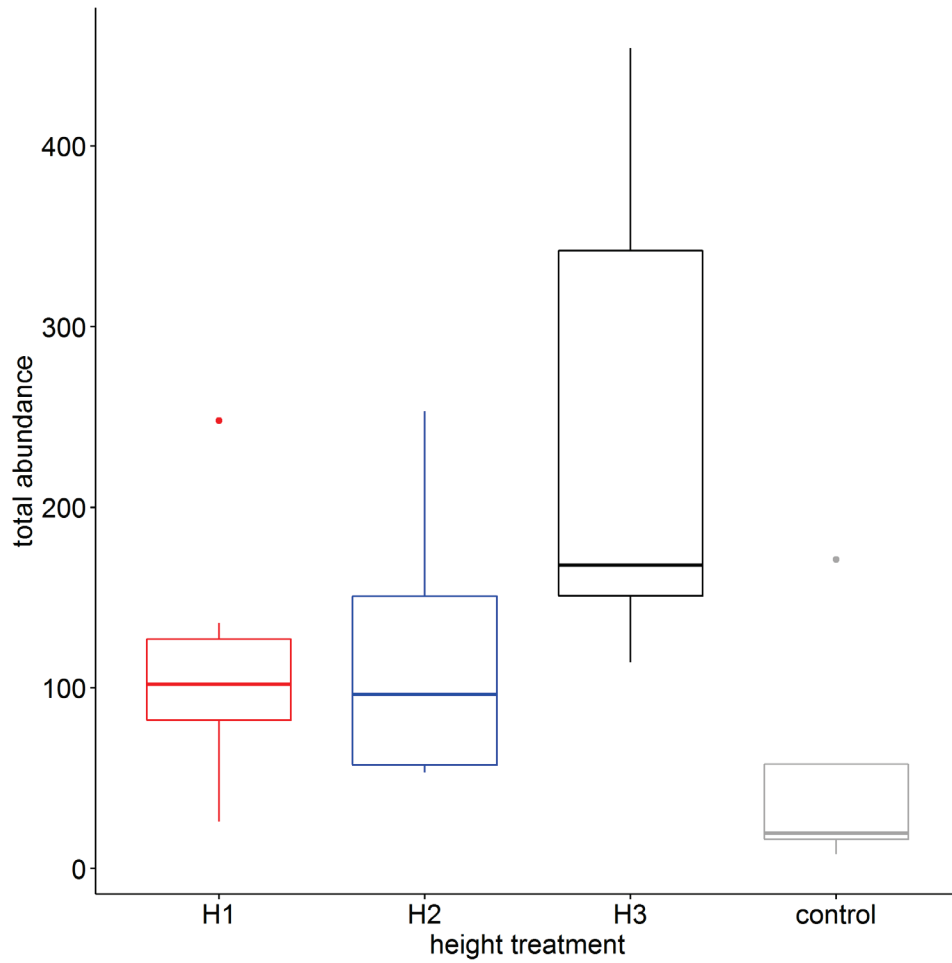


Figure S3: (a) Total nitrogen, and (b) total carbon (both measured as percent dry weight), by treatment and by depth. Bars are organised from short (left) to tall (right) treatments, with small gaps between the height groups, and diversity treatment is indicated by grey shading; light grey = low diversity, medium grey = medium, black = high diversity. White bars represent the unmanipulated control. Bars are the mean per treatment combination with standard deviation bars.

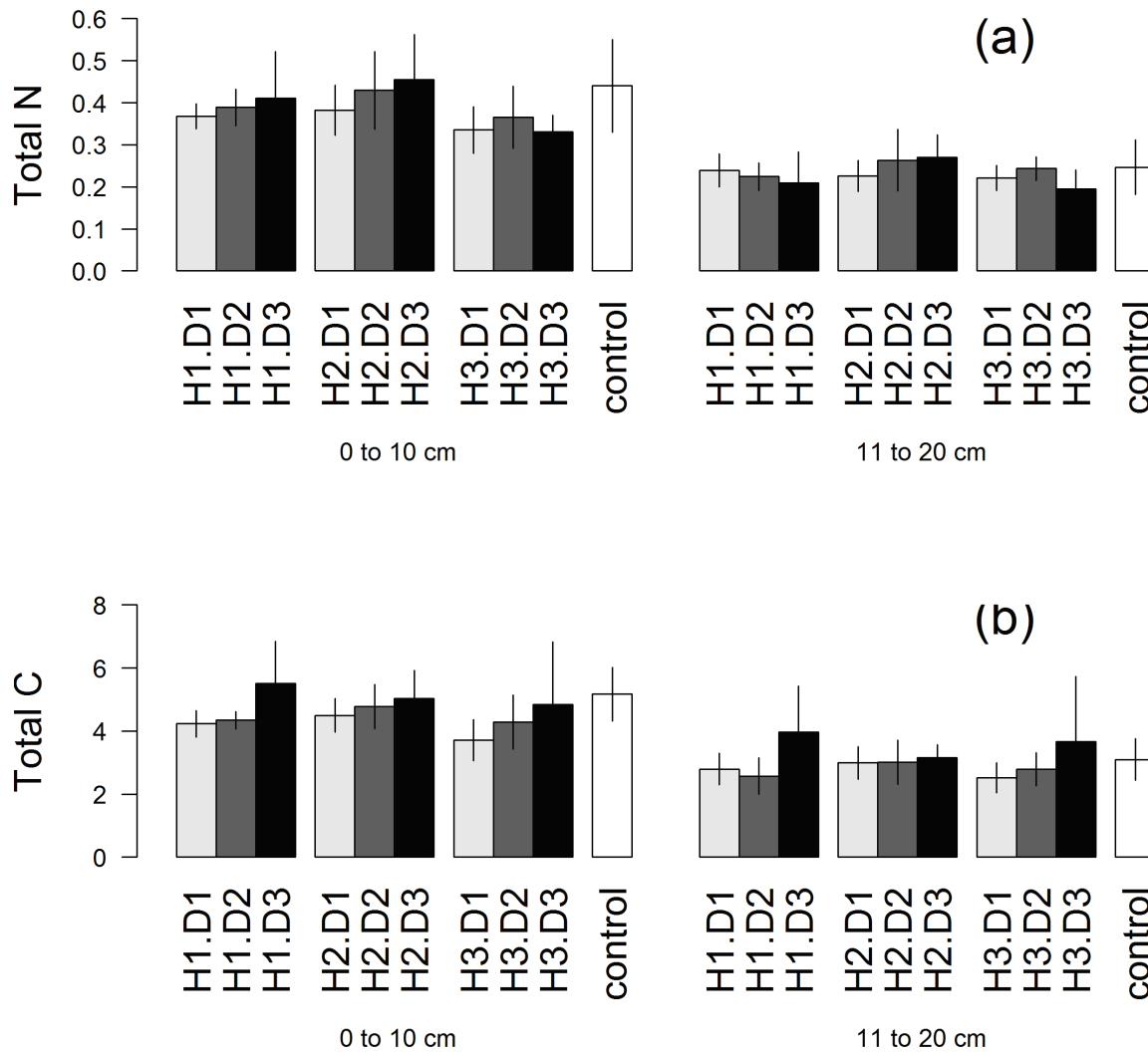


Table S6: Non-sown plant species detected in treatment year 2 and their lifecycle and strategy according to Grime’s CSR theory (Grime 1979, Grime et al. 1995). Each species is denoted as C = competitor, S = stress tolerator, R = ruderal, or some combination of these. ND indicates no data are available. Life cycles are denoted as per = perennial, ann = annual, biann = biannual.

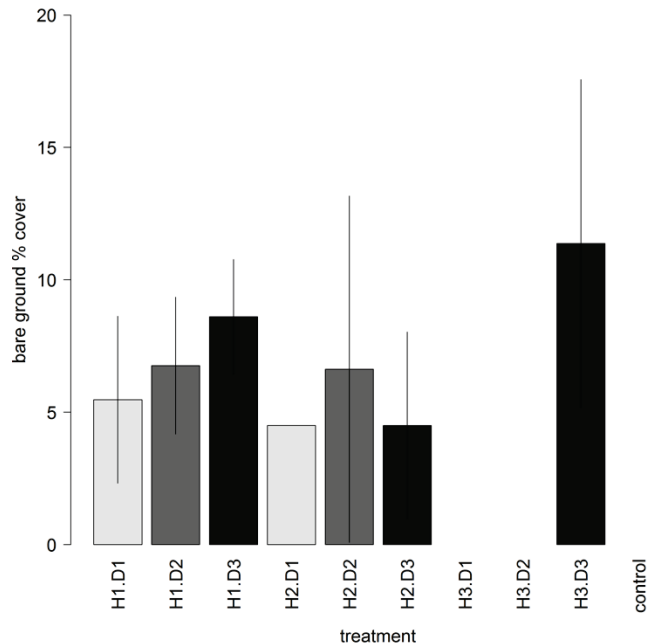
| Species | Strategy | Lifecycle |
|---|-----------------|------------------|
| <i>Achillea millefolium</i> | CR | per |
| <i>Agrostis capillaris</i> | CR | per |
| <i>Agrostis castellana</i> | ND | per |
| <i>Agrostis gigantea</i> | CR | per |
| <i>Agrostis stolonifera</i> | CR | per |
| <i>Alopecurus myosuroides</i> | ND | ann |
| <i>Anagallis arvensis</i> | R | ann |
| <i>Anisantha sterilis</i> | R | ann |
| <i>Arrhenatherum elatius</i> | C | per |
| <i>Ballota nigra</i> | ND | per |
| <i>Bellis perennis</i> | R | per |
| <i>Capsella bursa pastoris</i> | R | ann |
| <i>Centaurea nigra</i> | CSR | per |
| <i>Centaurea scabiosa</i> | S | per |
| <i>Cerastium fontanum</i> | R | ann |
| <i>Chenopodium album</i> | R | ann |
| <i>Chenopodium polyspermum</i> | ND | ann |
| <i>Cirsium arvense</i> | C | per |
| <i>Cirsium vulgare</i> | CR | biann |
| <i>Convolvulus arvensis</i> | CR | per |
| <i>Conyza canadensis</i> | ND | ann |
| <i>Crepis capillaris</i> | R | ann |
| <i>Cynosurus cristatus</i> | CSR | per |
| <i>Dactylis glomerata</i> | C | per |
| <i>Daucus carota</i> | ND | biann |
| <i>Echium vulgare</i> | ND | biann |
| <i>Elytrigia repens</i> | C | per |
| <i>Epilobium</i> sp. | ND | ND |
| <i>Epilobium ciliatum</i> x cf. <i>tetragonum</i> | ND | per |
| <i>Epilobium obscurum</i> | CSR | per |
| <i>Epilobium tetragonum</i> | ND | per |
| <i>Fallopia convolvulus</i> | ND | ann |
| <i>Festuca arundinacea</i> | CSR | per |
| <i>Festuca pratensis</i> | CSR | per |
| X <i>Festulolium loliaceum</i> | ND | per |
| <i>Galium aparine</i> | CR | ann |

| <i>Galium mollugo</i> | ND | ann |
|--------------------------------|-----------------|------------------|
| Species | Strategy | Lifecycle |
| <i>Galium sp.</i> | ND | ND |
| <i>Galium verum</i> | CS | per |
| <i>Geranium dissectum</i> | R | ann |
| <i>Geranium molle</i> | R | ann |
| <i>Geranium pratense</i> | ND | per |
| <i>Geum urbanum</i> | S | per |
| <i>Helictotrichum pratense</i> | S | per |
| <i>Holcus lanatus</i> | CSR | per |
| <i>Hordeum murinum</i> | ND | ann |
| <i>Knautia arvensis</i> | CSR | per |
| <i>Lactuca serriola</i> | R | ann |
| <i>Lactuca virosa</i> | R | ann |
| <i>Lamium album</i> | CR | per |
| <i>Lapsana communis</i> | R | ann |
| <i>Leucanthemum vulgare</i> | C | per |
| <i>Lolium perenne</i> | CR | per |
| <i>Lotus corniculatus</i> | S | per |
| <i>Malva moschata</i> | CSR | per |
| <i>Medicago lupulina</i> | R | per |
| <i>Myosotis arvensis</i> | R | ann |
| <i>Papaver rhoeas</i> | R | ann |
| <i>Phleum pratense</i> | ND | per |
| <i>Picris echioides</i> | ND | ann |
| <i>Plantago lanceolata</i> | CSR | per |
| <i>Plantago major</i> | R | per |
| <i>Poa annua</i> | R | ann |
| <i>Poa pratensis</i> | CSR | per |
| <i>Poa trivialis</i> | CR | per |
| <i>Polygonum aviculare</i> | R | ann |
| <i>Potentilla reptans</i> | CR | per |
| <i>Prunella vulgaris</i> | CSR | per |
| <i>Quercus cerris</i> | ND | per |
| <i>Ranunculus repens</i> | CR | per |
| <i>Rumex acetosa</i> | CSR | per |
| <i>Rumex acetosella</i> | SR | per |
| <i>Rumex crispus</i> | R | per |
| <i>Rumex obtusifolius</i> | CR | per |
| <i>Senecio vulgaris</i> | R | ann |
| <i>Sherardia arvensis</i> | R | ann |

| | | |
|--|-----------------|------------------|
| <i>Silene alba</i> | ND | ann |
| <i>Silene dioica</i> | CSR | per |
| <i>Silene latifolia</i> ssp. <i>alba</i> | R | ann |
| Species | Strategy | Lifecycle |
| <i>Sisymbrium officinale</i> | R | ann |
| <i>Sonchus arvensis</i> | CR | per |
| <i>Sonchus asper</i> | R | ann |
| <i>Sonchus oleraceus</i> | R | ann |
| <i>Stellaria media</i> | R | ann |
| <i>Taraxacum</i> agg. | R | per |
| <i>Torilis nodosa</i> | ND | ann |
| <i>Trifolium dubium</i> | R | ann |
| <i>Trifolium pratense</i> | CSR | per |
| <i>Trifolium repens</i> | CR | per |
| <i>Tussilago farfara</i> | CR | per |
| <i>Urtica dioica</i> | C | per |
| <i>Veronica arvensis</i> | R | ann |
| <i>Veronica chamaedrys</i> | CSR | per |
| <i>Veronica filiformis</i> | R | per |
| <i>Veronica persica</i> | R | ann |
| <i>Vicia cracca</i> | C | per |
| <i>Viola arvensis</i> | R | ann |
| <i>Viola tricolor</i> | R | ann |
| <i>Vulpia bromoides</i> | SR | ann |

Section S3: Bare ground cover extended results details: supplement to main manuscript
Discussion: Plants

Figure S4: Percent of bare ground cover (mean and standard deviation) in the experimental treatments and unmanipulated control. Bare ground cover was recorded as part of the plant surveys, using Domin cover estimates (for details see main manuscript Methods: Botanical surveys).



Linear mixed effects models were constructed in lme4 (Bates et al. 2015) with height (three levels) and diversity (three levels) treatments included as fixed effects and site as a random intercept, using maximum likelihood parameter estimation. P-values for the main fixed effects were extracted using the package lmerTest (Kuznetsova et al. 2017), with degrees of freedom based on Satterthwaite's approximation. Within-treatment pairwise comparisons were determined with post-hoc tests using least-squares means in package lsmeans (Lenth 2016).

No significant effect of treatment on bare ground cover was detected (Diversity: $F_{2,19.0} = 0.91$, $P = 0.421$; Height: $F_{2,19.0} = 2.10$, $P = 0.150$).

Section S4: Vegetation clippings biomass extended results details: supplement to main manuscript Discussion: Plants

Method

We estimated biomass of vegetation clippings (arising) from a complete cut of the medium and tall plots prior to termination of the experiment (3 November 2015). Samples were taken from Chiltern Avenue (year 3 post-sowing) and Jubilee Park (year 2 post-sowing). These sites were selected as they retained a full set of un-mown treatments at this point of sampling.

In each medium and tall treatment plot at each site, all vegetation within two 0.5 m x 1 m quadrats was cut off at the base and collected in to large, plastic bags. Quadrats were placed to capture remaining areas of non-trampled vegetation. Samples were stored in freezers for two days prior to processing.

All samples were weighed wet, cut into pieces and thoroughly mixed up. A subsample of each was oven-dried at 60°C for 60 hours. Subsamples were weighed before and after drying to measure moisture content of the sample. The moisture loss from the subsample combined with the final dry weight was used to back-calculate the total estimated dry weight of each sample. The two plot replicates were combined to estimate dry weight per 1 m² per plot.

Results

Table S7: Estimated dry weight in kilograms per 1 m² of vegetation clippings from medium (H2) and tall (H3) experimental meadow plots. D1 to D3 represent the low to high diversity treatments (Figure 1).

| Site | H2.D1 | H2.D2 | H2.D3 | mean H2 | H3.D1 | H3.D2 | H3.D3 | mean H3 |
|--------------|-------|-------|-------|-------------|-------|-------|-------|-------------|
| Chiltern Ave | 0.29 | 0.26 | 0.22 | 0.26 | 0.66 | 0.71 | 0.80 | 0.72 |
| Jubilee Park | 0.55 | 0.26 | 0.52 | 0.44 | 0.61 | 0.66 | 0.59 | 0.62 |
| Mean (kg) | | | | 0.35 | | | | 0.67 |

References: Appendices

- Bates, D., M. Maechler, B. Bolker, and S. Walker. 2015. Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software* **67**:1-48.
- Bolger, A. M., M. Lohse, and B. Usadel. 2014. Trimmomatic: a flexible trimmer for Illumina sequence data. *Bioinformatics* **30**:2114-2120.
- Caporaso, J. G., J. Kuczynski, J. Stombaugh, K. Bittinger, F. D. Bushman, E. K. Costello, N. Fierer, A. G. Peña, J. K. Goodrich, J. I. Gordon, G. A. Huttley, S. T. Kelley, D. Knights, J. E. Koenig, R. E. Ley, C. A. Lozupone, D. McDonald, B. D. Muegge, M. Pirrung, J. Reeder, J. R. Sevinsky, P. J. Turnbaugh, W. A. Walters, J. Widmann, T. Yatsunenko, J. Zaneveld, and R. Knight. 2010. QIIME allows analysis of high-throughput community sequencing data. *Nature Methods* **7**:335–336.
- Caporaso, J. G., C. L. Lauber, W. A. Walters, D. Berg-Lyons, C. A. Lozupone, P. J. Turnbaugh, N. Fierer, and R. Knight. 2011. Global patterns of 16S rRNA diversity at a depth of millions of sequences per sample. *Proceedings of the National Academy of Sciences* **108**:4516-4522.
- Edgar, R. C. 2010. Search and clustering orders of magnitude faster than BLAST. *Bioinformatics* **26**:2460-2461.
- Edgar, R. C. 2013. UPARSE: highly accurate OTU sequences from microbial amplicon reads. *Nature Methods* **10**:996.
- Frostegård, Å., A. Tunlid, and E. Bååth. 1993. Phospholipid fatty acid composition, biomass, and activity of microbial communities from two soil types experimentally exposed to different heavy metals. *Applied and Environmental Microbiology* **59**:3605-3617.
- Grime, J. P. 1979. *Plant Strategies and Vegetation Processes*. Wiley and Sons, Chichester, UK.
- Grime, J. P., J. G. Hodgson, R. Hunt, and K. Thompson. 1995. *The Electronic Comparative Plant Ecology*. Chapman & Hall, London, UK.
- Jenkinson, D. S., and D. S. Powelson. 1976. The effects of biocidal treatments on metabolism in soil—I. Fumigation with chloroform. *Soil Biology and Biochemistry* **8**:167-177.
- Kõljalg, U., R. H. Nilsson, K. Abarenkov, L. Tedersoo, A. F. S. Taylor, M. Bahram, S. T. Bates, T. D. Bruns, J. Bengtsson-Palme, T. M. Callaghan, B. Douglas, T. Drenkhan, U. Eberhardt, M. Dueñas, T. Grebenc, G. W. Griffith, M. Hartmann, P. M. Kirk, P. Kohout, E. Larsson, B. D. Lindahl, R. Lücking, M. P. Martín, P. B. Matheny, N. H. Nguyen, T. Niskanen, J. Oja, K. G. Peay, U. Peintner, M. Peterson, K. Põldmaa, L. Saag, I. Saar, A. Schüßler, J. A. Scott, C. Senés, M. E. Smith, A. Suija, D. L. Taylor, M. T. Telleria, M. Weiss, and K. H. Larsson. 2013. Towards a unified paradigm for sequence-based identification of fungi. *Molecular Ecology* **22**:5271-5277.
- Kuznetsova, A., P. B. Brockhoff, and R. H. B. Christensen. 2017. lmerTest Package: Tests in Linear Mixed Effects Models. *Journal of Statistical Software* **82**:1-26.
- Lenth, R. V. 2016. Least-Squares Means: The R Package lsmeans. *Journal of Statistical Software* **69**:1-33.
- McDonald, D., M. N. Price, J. Goodrich, E. P. Nawrocki, T. Z. DeSantis, A. Probst, G. L. Andersen, R. Knight, and P. Hugenholtz. 2011. An improved Greengenes taxonomy with explicit ranks for ecological and evolutionary analyses of bacteria and archaea. *The ISME Journal* **6**:610.
- Oksanen, J., F. G. Blanchet, M. Friendly, R. Kindt, P. Legendre, D. McGlenn, P. R. Minchin, R. B. O'Hara, G. L. Simpson, P. Solymos, M. H. H. Stevens, E. Szoecs, and H. Wagner. 2017. *vegan: Community Ecology Package*. R package version 2.4-2.

- Pawlett, M., K. Ritz, R. A. Dorey, S. Rocks, J. Ramsden, and J. A. Harris. 2013. The impact of zero-valent iron nanoparticles upon soil microbial communities is context dependent. *Environmental Science and Pollution Research* **20**:1041-1049.
- Vance, E. D., P. C. Brookes, and D. S. Jenkinson. 1987. An extraction method for measuring soil microbial biomass C. *Soil Biology and Biochemistry* **19**:703-707.
- White, T. J., T. Bruns, S. Lee, and J. Taylor. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. Pages 315-322 in M. A. Innis, D. H. Gelfand, J. J. Sninsky, and T. J. White, editors. *PCR protocols: a guide to methods and applications*. Academic Press Inc., New York.