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Appendix I

Appendix 1a. Generalised linear model (GLM) estimates for differences in the abundance of *Bombus lapidarius* drones, queens and workers between study farms. All models are Poisson distributed.

Bombus lapidarius			
Drone	**Estimate ± SE**	**Z-value**	**P**
Intercept	4.06 ± 5.77	0.70	0.48
E6	5.11 ± 7.30	0.70	0.48
E7	-2.07 ± 1.10	-0.00	1.00
E8	-2.07 ± 1.10	-0.00	1.00
E9	-2.07 ± 1.10	-0.00	1.00
O1	-2.07 ± 1.10	-0.00	1.00
O2	-2.07 ± 1.10	-0.00	1.00
O3	-2.07 ± 1.10	-0.00	1.00
O4	1.66 ± 8.17	0.00	1.00
O5	-2.07 ± 1.10	-0.00	1.00
S10	-1.10 ± 1.16	--0.95	0.34
S6	2.88 ± 7.64	0.38	0.71
S7	-1.10 ± 1.16	-0.95	0.34
S8	-2.07 ± 1.10	-0.00	1.00
S9	-2.07 ± 1.10	-0.00	1.00
Queen	**Estimate ± SE**	**Z-value**	**P**
E6	-2.23 ± 2.99	-0.00	0.99
E7	-3.85 ± 4.23	0.22	1.00
E8	-3.85 ± 4.23	0.22	1.00
E9	-3.85 ± 4.23	0.22	1.00
O1	-3.85 ± 4.23	0.22	1.00
O2	2.16 ± 2.99	0.00	1.00
O3	-3.85 ± 4.23	0.00	1.00
O4	2.16 ± 2.99	0.00	1.00
O5	-3.85 ± 4.23	0.00	1.00
S10	-3.85 ± 4.23	0.22	1.00
S6	-3.85 ± 4.23	0.22	1.00
S7	-3.85 ± 4.23	0.22	1.00
S8	-3.85 ± 4.23	0.22	1.00
S9	-3.85 ± 4.23	0.22	1.00
Worker	**Estimate ± SE**	**Z-value**	**P**
Intercept	-2.23 ± 2.99	-0.00	1.00
E6	-3.85 ± 4.23	0.00	1.00

E7	-3.85 ± 4.23	0.00	1.00
E8	-3.85 ± 4.23	0.00	1.00
E9	-3.85 ± 4.23	0.00	1.00
O1	-3.85 ± 4.23	0.00	1.00
O2	2.16 ± 2.99	0.00	1.00
O3	-3.85 ± 4.23	0.00	1.00
O4	2.16 ± 2.99	0.00	1.00
O5	-3.85 ± 4.23	0.00	1.00
S10	-3.85 ± 4.23	0.00	1.00
S6	-3.85 ± 4.23	0.00	1.00
S7	-3.85 ± 4.23	0.00	1.00
S8	-3.85 ± 4.23	0.00	1.00
S9	-3.85 ± 4.23	0.00	1.00

Appendix 1b. Generalised linear model (GLM) estimates for differences in the abundance of *Bombus pascuorum* workers between study farms. The model is Poisson distributed.

Bombus pascuorum			
Drone	**Estimate ± SE**	**Z-value**	**P**
Worker			
Intercept	-1.03 ± 7.07	0.00	1.00
E6	6.93 ± 8.66	0.80	0.42
E7	-6.93 ± 1.23	-0.57	0.57
E8	-2.03 ± 1.10	-0.00	1.00
E9	-6.93 ± 1.23	-0.57	0.57
O1	-2.03 ± 1.99	-0.00	1.00
O2	-2.03 ± 1.99	-0.00	1.00
O3	-2.03 ± 1.99	-0.00	1.00
O4	9.16 ± 8.37	1.10	0.27
O5	-2.03 ± 1.99	-0.00	1.00
S10	4.05 ± 1.00	0.00	1.00
S6	-6.93 ± 1.23	-0.57	0.57
S7	-2.03 ± 1.99	-0.00	1.00
S8	-2.03 ± 1.99	-0.00	1.00
S9	-2.03 ± 1.99	-0.00	1.00

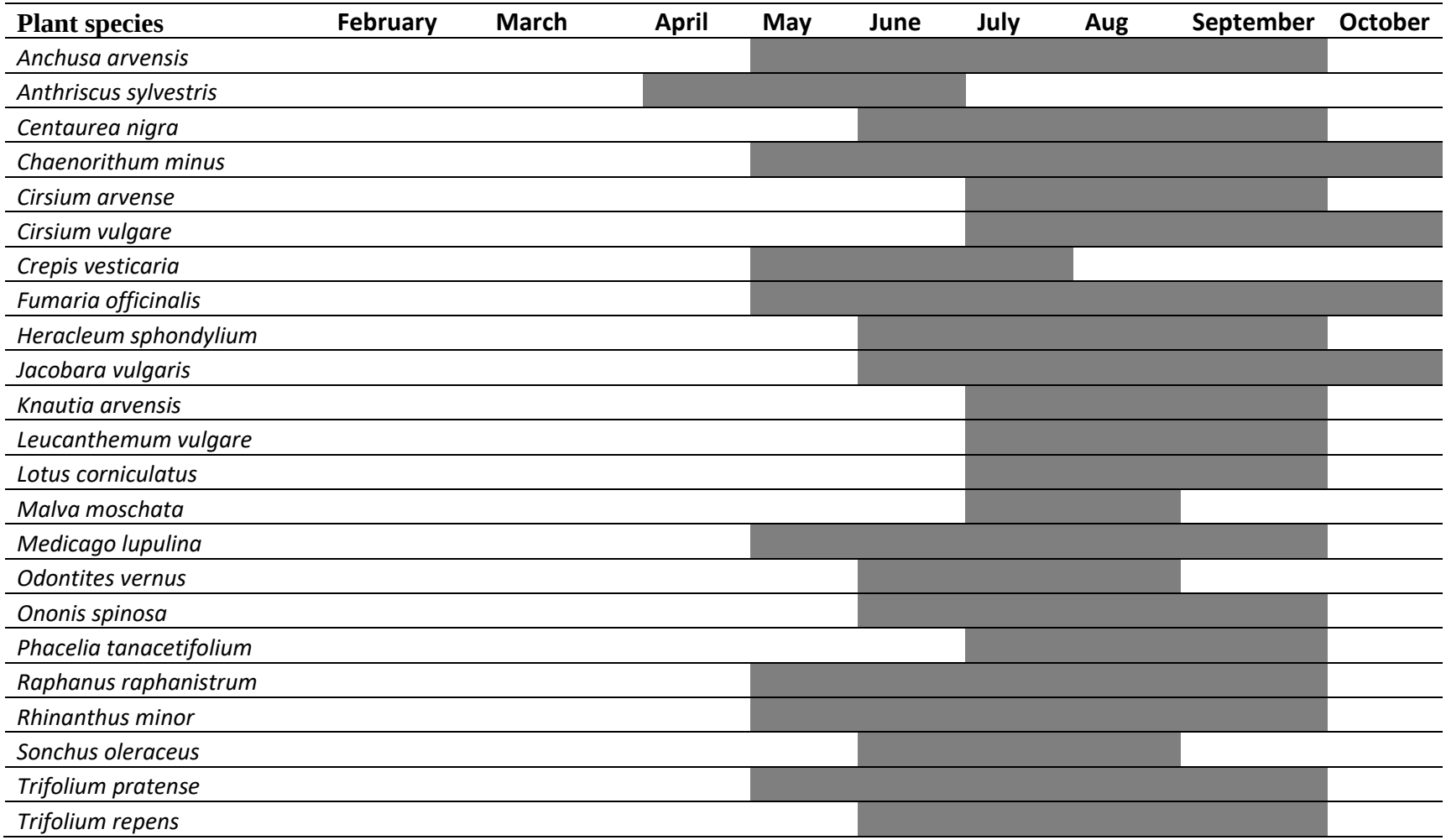
Appendix 1c. Generalised linear model (GLM) estimates for differences in the abundance of *Bombus terrestris/lucorum* drones, queens and workers between study farms. Drone and queen models are Poisson distributed and the worker model is Quasipoisson distributed.

Bombus terrestris/lucorum			
Drone	**Estimate ± SE**	**Z-value**	**P**
Intercept	-2.23 ± 2.99	-0.00	1.00
E6	-2.57 ± 4.23	0.00	1.00

E7	-2.57 ± 4.23	0.00	1.00
E8	-2.57 ± 4.23	0.00	1.00
E9	-2.57 ± 4.23	0.00	1.00
O1	-2.57 ± 4.23	0.00	1.00
O2	-2.57 ± 4.23	0.00	1.00
O3	-2.57 ± 4.23	0.00	1.00
O4	2.16 ± 2.99	0.00	1.00
O5	-2.57 ± 4.23	0.00	1.00
S10	-2.57 ± 4.23	0.00	1.00
S6	-2.57 ± 4.23	0.00	1.00
S7	-2.57 ± 4.23	0.00	1.00
S8	-2.57 ± 4.23	0.00	1.00
S9	-2.57 ± 4.23	0.00	1.00
Queen	**Estimate ± SE**	**Z-value**	**P**
Intercept	5.04 ± 7.07	0.00	1.00
E6	-2.03 ± 1.10	-0.00	0.99
E7	-2.03 ± 1.10	-0.00	0.99
E8	4.06 ± 9.13	0.44	0.66
E9	-6.92 ± 1.23	-0.57	0.57
O1	-2.03 ± 1.10	-0.00	0.99
O2	4.06 ± 9.13	0.44	0.66
O3	-8.40 ± 1.00	0.00	1.00
O4	-2.03 ± 1.10	-0.00	0.99
O5	-6.92 ± 1.23	-0.57	0.57
S10	-2.03 ± 1.10	-0.00	0.99
S6	-2.03 ± 1.10	-0.00	0.99
S7	-6.92 ± 1.23	-0.57	0.57
S8	-6.92 ± 1.23	-0.57	0.57
S9	-6.92 ± 1.23	-0.57	0.57
Worker			
Intercept	**Estimate ± SE**	**t-value**	**P**
E6	0.69 ± 0.94	0.74	0.47
E7	-0.29 ± 1.43	1.01	0.33
E8	-19.00 ± 7594.17	-0.00	1.00
E9	1.10 ± 1.08	1.01	0.33
O1	-19.00 ± 7594.17	-0.00	1.00
O2	-19.00 ± 7594.17	-0.00	1.00
O3	-19.00 ± 7594.17	-0.00	1.00
O4	0.56 ± 1.18	0.48	0.64
O5	0.69 ± 1.15	0.60	0.56
S10	0.92 ± 1.11	0.83	0.42
S6	1.25 ± 1.06	1.18	0.26
S7	1.32 ± 1.06	1.25	0.23
S8	0.81 ± 1.13	0.72	0.48
S9	0.69 ± 1.15	0.60	0.56

Appendix II

Table IIa. Gantt chart of Bombus forage plant flowering period, data extracted from Streeter et al. (2009). Plant species groups were excluded from this table (namely *Papaver* spp and *Taraxacum* spp.



Tripleurospermum inodorum	
Vicia sativa	

Table IIb. Gantt chart of *Bombus* activity according to sex, M=male (drone) and F=female (worker or queen), data extracted from Edwards and Jenner (2005).

Species	Sex	February	March	April	May	June	July	Aug	September	October
Bombus lapidarius	M									
Bombus lapidarius	F									
Bombus pascuorum	F									
Bombus terrestris/lucorum	M									
Bombus terrestris/lucorum	F									

Table IIc. Gantt chart of *Bombus* activity according to caste extracted from the study data over the survey period.

Species	Caste	April	May	June	July	Aug	September
Bombus lapidarius	Drone						
Bombus lapidarius	Queen						
Bombus lapidarius	Worker						
Bombus pascuorum	Worker						
Bombus terrestris/lucorum	Drone						
Bombus terrestris/lucorum	Queen						
Bombus terrestris/lucorum	worker						

References

Streeter D, Hart-Davies C, Hardcastle A, Cole F, Harper L. 2009. *Collins Wild Flower Guide*. Harper Collins Publishers.

Edwards, M. and Jenner, M., 2005. *Field guide to the bumblebees of Great Britain & Ireland*. Ocelli Ltd.

Appendix III. All vascular plants recorded during the botanical surveys, with their species names, common names, and the short-hand name used for Figs. 3 & 4.

Species name	**Common name**	**Short-hand**
Achillea millefolium L.	Yarrow	Ach-mil
Agrostis gigantea Roth	Black bent	Agro-cap
Agrostis stolonifera L.	Creeping bent	Agro-stol
Alopecurus pratensis L.	Meadow fox tail	Alo-pra
Anthriscus sylvestris (L.) Hoffm.	Cow parsley	Anthr-syl
Arrhenatherum elatius (L.) P. Beauv. ex J. Presl & C. Presl	False oat grass	Arr-ela
Brachythecium rutabulum (Hedw.) Schimp.	Rough-stalked feather-moss	Bra-rut
Bromus commutatus Schrad.	Meadow brome	Bro-com
Bromus hordeaceus L.	Soft brome	Bro-hor
Bromus sterilis L.	Barren brome	Bro-ste
Centaurea nigra L.	Common knapweed	Cen-nig
Chenopodium album L.	Fat-hen	Che-alb
Cirsium arvense (L.) Scop.	Creeping thistle	Cir-arv
Cirsium vulgare (Savi) Ten.	Spear thistle	cir-vul
Convolvulus arvensis L.	Field bindweed	Conv-arv
Cynosurus cristatus L.	Crested dog's-tail	Cyn-cri
Dactylis glomerata L.	Cock's foot	Dac-glo
Daucus carota L.	Wild carrot	Dau-car
Elymus repens (L.) Gould	Couch grass	Ely-rep
Festuca arundinacea Schreb.	Tall fescue	Fes-aru
Festuca pratensis Huds.	Meadow fescue	Fes-pra
Festuca rubra L.	Red fescue	Fes-rub
Galium aparine L.	Cleavers	Gal-apa
Galium mollugo L.	Hedge bedstraw	Gal-mol
Galium verum L.	Lady's bedstraw	Gal-ver
Geranium dissectum L.	Cut-leaved crane's-bill	Ger-dis
Heracleum sphondylium L.	Hogweed	Her-sph
Holcus lanatus L.	Yorkshire fog	Hol-lan
Holcus mollis L.	Creeping soft grass	Hol-mol
Leucanthemum vulgare Lam.	Ox-eye daisy	Leu-vul
Lolium perenne L.	Perennial ryegrass	Lol-per
Lotus corniculatus L.	Bird's-foot trefoil	Lot-cor
Medicago lupulina L.	Black medick	Med-lup
Phleum pratense ssp. bertolonii (DC.) Bornm.	Smaller cat's-tail	Phl-ber
Phleum pratense L.	Timothy	Phl-pra
Plantago lanceolata L.	Ribwort plantain	Pla-lan
Plantago major L.	Greater plantain	Pla-maj
Poa annua L.	Annual bluegrass	Poa-ann
Poa pratensis L.	Common meadow-grass	Poa-pra
Poa trivialis L.	Rough-stalked meadow-grass	Poa-tri
Prunella vulgaris L.	Self-heal	Prune-vul
Ranunculus repens L.	Creeping buttercup	Ran-rep
Rhinanthus minor L.	Yellow rattle	Rhi-min

Rubus fruticosus L.	Blackberry	Rub-fru
Rumex acetosella L.	Sheep's sorrel	Rum-acetose
Rumex crispus L.	Curly dock	Rum-cri
Rumex obtusifolius L.	Broad-leaved dock	Rum-obt
Trifolium pratense L.	Red clover	Trif-pra
Trifolium repens L.	White clover	Trif-rep
Urtica dioica L.	Stinging nettle	Urt-dio
Veronica persica Poir.	Common speedwell	Ver-per
Vicia cracca L.	Tufted vetch	Vic-cra
Vicia hirsute (L.) Gray	Hairy tare	Vic-hir
Vicia sativa L.	Common vetch	Vic-sat ssp nig

Appendix IV

Appendix IVa. Generalised linear model (GLM) estimates for the relationship between *Bombus lapidaries* drones abundance and Cirsium arvense, Sonchus oleraceus and Centaurea nigra. All models are Poisson distributed.

Bombus lapidarius	**Drone**		
Cirsium arvense	**Estimate ± SE**	**Z-value**	**P**
Intercept	-0.51 ± 0.26	-1.99	<0.05
Cirsium arvense	-0.09 ± 0.18	-0.52	0.61
Sonchus oleraceus	**Estimate ± SE**	**Z-value**	**P**
Intercept	-0.61 ± 0.27	-2.28	<0.05
Sonchus oleraceus	0.12 ± 0.30	0.41	0.68
Centaurea nigra	**Estimate ± SE**	**Z-value**	**P**
Intercept	-0.55 ± 0.29	-1.92	0.05
Centaurea nigra	-0.02 ± 0.19	-0.13	0.89

Appendix IVb. Generalised linear model (GLM) estimates for the relationship between *Bombus lapidaries* queens abundance and Crepis vesticaria. The models is Poisson distributed.

Bombus lapidarius	**Queen**		
Crepis vesticaria	**Estimate ± SE**	**Z-value**	**P**
Intercept	-0.55 ± 0.29	-1.92	0.05
Crepis vesticaria	-0.02 ± 0.19	-0.13	0.89

Appendix IVc. Generalised linear model (GLM) estimates for the relationship between *Bombus lapidaries* worker abundance and Anchusa arvensis (Poissom), Cirsium vulgare (Quasipoisson), Crepis vesticaria (Quasipoisson), Lotus corniculatus (Quasipoisson), Raphanus raphanistrum (Poisson), Tripleurospermum inodorum (Quasipoisson), Centaurea nigra (Quasipoisson), Leucanthemum vulgare (Quasipoisson), Medicago lupulina(Quasipoisson), Trifolium repens (Quasipoisson).

Bombus lapidarius	**Worker**		
Anchusa arvensis	**Estimate ± SE**	**Z-value**	**P**
Intercept	1.68 ± 0.08	20.87	<0.001
Anchusa arvensis	-0.79 ± 0.47	-1.67	0.09
Cirsium vulgare	**Estimate ± SE**	**T-value**	**P**
Intercept	1.00 ± 0.54	1.84	0.08
Cirsium vulgare	0.71 ± 0.30	2.35	**<0.05**
Crepis vesticaria	**Estimate ± SE**	**T-value**	**P**
Intercept	1.71 ± 0.40	4.23	<0.001
Crepis vesticaria	-1.19 ± 3.14	-0.38	0.71
Lotus corniculatus	**Estimate ± SE**	**T-value**	**P**
Intercept	1.36 ± 0.53	2.56	<0.05
Lotus corniculatus	0.29 ± 0.26	1.13	0.27

Raphanus raphanistrum	**Estimate ± SE**	**Z-value**	**P**
Intercept	1.61 ± 0.43	3.75	<0.001
Raphanus raphanistrum	0.23 ± 0.63	0.36	0.72
Tripleurospermum inodorum	**Estimate ± SE**	**T-value**	**P**
Intercept	1.86 ± 0.36	5.10	<0.001
Tripleurospermum inodorum	-8.20 ± 9.96	-0.82	0.42
Centaurea nigra	**Estimate ± SE**	**T-value**	**P**
Intercept	1.37 ± 0.54	2.51	<0.05
Centaurea nigra	0.25 ± 0.25	1.00	0.33
Leucanthemum vulgare	**Estimate ± SE**	**T-value**	**P**
Intercept	0.95 ± 0.67	1.37	0.18
Leucanthemum vulgare	0.49 ± 0.25	1.98	**0.058**
Medicago lupulina	**Estimate ± SE**	**T-value**	**P**
Intercept	1.49 ± 0.47	3.15	<0.01
Medicago lupulina	0.18 ± 0.20	0.92	0.37
Trifolium repens	**Estimate ± SE**	**T-value**	**P**
Intercept	1.65 ± 0.45	3.63	<0.01
Trifolium repens	-0.00 ± 0.25	-0.01	0.99

Appendix IVd. Generalised linear model (GLM) estimates for the relationship between *Bombus pascuorum* worker abundance and Cirsium arvense, Sonchus oleraceus, Trifolium repens. All models are Quasipoisson distributed.

Bombus pascuorum	**Worker**		
Cirsium arvense	**Estimate ± SE**	**T-value**	**P**
Intercept	-0.47 ± 0.32	-1.48	0.15
Cirsium arvense	-0.43 ± 0.53	-0.81	0.42
Sonchus oleraceus	**Estimate ± SE**	**T-value**	**P**
Intercept	-0.67 ± 0.35	-1.93	0.06
Sonchus oleraceus	0.12 ± 0.38	0.31	0.76
Trifolium repens	**Estimate ± SE**	**T-value**	**P**
Intercept	-0.86 ± 0.37	-2.37	<0.05
Trifolium repens	0.21 ± 0.13	1.60	0.12

Appendix IVe. Generalised linear model (GLM) estimates for the relationship between *Bombus* terrestris/lucorum queen abundance and Anchusa arvensis, Cirsium arvense, Cirsium vulgare, Crepis vesicaria, Anthriscus sylvestris, Rhinanthus minor. All models are Poisson distributed.

Bombus terrestris/lucorum	**Queen**		
Anchusa arvensis	**Estimate ± SE**	**Z-value**	**P**
Intercept	-0.88 ± 0.29	-3.06	<0.01
Anchusa arvensis	0.93 ± 0.30	3.07	**<0.01**

Cirsium arvense	**Estimate ± SE**	**Z-value**	**P**
Intercept	-0.61 ± 0.27	0.27	<0.05
Cirsium arvense	-0.17 ± 0.24	-0.70	0.48
Cirsium vulgare	**Estimate ± SE**	**Z-value**	**P**
Intercept	-0.77 ± 0.31	-2.48	<0.05
Cirsium vulgare	0.13 ± 0.27	0.51	0.61
Crepis vesicaria	**Estimate ± SE**	**Z-value**	**P**
Intercept	-0.89 ± 0.29	-3.07	<0.01
Crepis vesicaria	0.70 ± 0.24	2.92	**<0.01**
Anthriscus sylvestris	**Estimate ± SE**	**Z-value**	**P**
Intercept	-0.89 ± 0.30	-3.01	<0.01
Anthriscus sylvestris	0.90 ± 0.41	2.18	**<0.05**
Rhinanthus minor	**Estimate ± SE**	**Z-value**	**P**
Intercept	-0.80 ± 0.28	-2.89	<0.01
Rhinanthus minor	0.57 ± 0.34	1.68	0.09
Lotus corniculatus	**Estimate ± SE**	**Z-value**	**P**
Intercept	-0.63 ± 0.30	-2.12	<0.05
Lotus corniculatus	-0.09 ± 0.34	-0.37	0.72
Vicia sativa	**Estimate ± SE**	**Z-value**	**P**
Intercept	-0.64 ± 0.26	-2.44	<0.05
Vicia sativa	-0.38 ± 0.66	-0.58	0.56

Appendix IVf. Generalised linear model (GLM) estimates for the relationship between *Bombus* terrestris/lucorum worker abundance and Cirsium arvense, Cirsium vulgare, Crepis vesicaria, Heracleum sphondylium and Trifolium pratense. All models are Poisson distributed.

Bombus terrestris/lucorum	**Worker**		
Cirsium arvense	**Estimate ± SE**	**Z-value**	**P**
Intercept	1.36 ± 0.22	6.13	<0.001
Cirsium arvense	-0.33 ± 0.30	-1.11	0.28
Cirsium vulgare	**Estimate ± SE**	**Z-value**	**P**
Intercept	1.26 ± 0.26	4.92	<0.001
Cirsium vulgare	-0.06 ± 0.26	-0.24	0.81
Crepis vesicaria	**Estimate ± SE**	**Z-value**	**P**
Intercept	1.28 ± 0.22	5.87	<0.001
Crepis vesicaria	-0.92 ± 1.30	-0.71	0.48
Heracleum sphondylium	**Estimate ± SE**	**Z-value**	**P**
Intercept	1.33 ± 0.23	5.64	<0.001
Heracleum sphondylium	-0.20 ± 0.24	-0.85	0.40
Trifolium pratense	**Estimate ± SE**	**Z-value**	**P**
Intercept	1.08 ± 0.26	4.17	<0.001
Trifolium pratense	0.55 ± 0.42	1.31	0.20

Bombus terrestris/luccorum models would not run due to insufficient data.