

Supplementary information

Insect communities under skyglow: diffuse night-time illuminance induces spatio-temporal shifts in movement and predation

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Tables S1-S11

Figures S1-S4

Table S1. Sown plant species in each EcoUnit. For every species 1000 seeds m⁻² were sown.

Species	Sown (mg/1000 seeds)
<i>Bromus hordeaceus</i>	3443.0
<i>Campanula patula</i>	65.0
<i>Cynosurus cristatus</i>	556.7
<i>Festuca pratensis</i>	2467.3
<i>Festuca rubra</i>	869.3
<i>Lathyrus pratensis</i>	10889.5
<i>Leucanthemum vulgare</i>	1004.0
<i>Lotus corniculatus</i>	1244.3
<i>Luzula campestris</i>	681.3
<i>Medicago lupulina</i>	2079.2
<i>Plantago media</i>	384.9
<i>Prunella vulgaris</i>	796.3
<i>Ranunculus repens</i>	1804.8
<i>Trifolium repens</i>	692.1
<i>Veronica chamaedrys</i>	205.4
<i>Vicia sepium</i>	12995.5

Table S2. Body masses and abundances of animals used for RFID movement tracking.

Species	Experimental block I (21.07. - 18.08.2020)		Experimental block II (15.09. - 13.10.2020)	
	Mean body mass [mg]	Abundance per unit	Mean body mass [mg]	Abundance per unit
<i>Abax parallelus</i>	302	2	269	5
<i>Calathus fuscipes</i>	67	6	75	6
<i>Carabus granulatus</i>	NA	NA	273	1
<i>Carabus nemoralis</i>	538	5	550	3
<i>Harpalus rufipes</i>	112	2	128	6
<i>Nebria brevicollis</i>	69	6	NA	NA
<i>Pterostichus melanarius</i>	151	4	NA	NA

Table S3. Overview of the response and predictor variables used to answer our four research questions (Q1-Q4) including units as well as spatial and temporal aggregation level. Aggregation on patch level means aggregation across the four individual patches in an EcoUnit contrary to aggregation on individual patch-level as in Q4.

Question	Response	Unit - response	Aggregation level - response		Predictor	Unit - predictor	Aggregation level - predictor	
			Spatial	Temporal			Spatial	Temporal
Q1	activity	number of detections	EcoUnit	day/night	ALAN	lux	NA	NA
Q2	activity	number of detections	matrix/ patch	day/night	ALAN	lux	NA	NA
Q3	predation	number of bites	none	14 days	ALAN	lux	NA	NA
Q4	predation	number of bites	individual patch	14 days	activity	number of detections	individual patch	14 days

Table S4a. Generalised linear mixed effects model results of the influence of night-time illuminance on EcoUnit-level daily movement activity (sum of detections per day/night) (Q1). Estimates are given on ln-scale, intercept is given at 1 lux.

Predictor	Estimate	Std. Error	p-value
Intercept	2.743	0.347	< 0.001
Slope: log10 night-time illuminance	0.014	0.022	0.530

Table S4b. Generalised linear mixed effects model results of the influence of night-time illuminance on EcoUnit-level individual daily movement (sum of detections per day/night, corrected for individual densities) (Q1). Estimates are given on ln-scale, intercept is given at 1 lux.

Predictor	Estimate	Std. Error	p-value
Intercept	2.793	0.253	< 0.001
Slope: log10 night-time illuminance	0.025	0.022	0.247

Table S5. Estimates for species-level responses of daytime and night-time movement activity to night-time illuminance. Insufficient data corresponds to species with fewer than 10 data points. Estimates are given on ln-scale, intercept is given at 1 lux.

		Intercept			Slope: log ₁₀ night-time illuminance		
		Estimate	Std. Error	p-value	Estimate	Std. Error	p-value
<i>Abax parallelus</i>	Day	2.833	0.152	<0.001	-0.036	0.045	0.414
	Night	2.890	0.144	<0.001	0.065	0.034	0.053
<i>Calathus fuscipes</i>	Day	0.907	0.188	<0.001	-0.075	0.055	0.169
	Night	1.247	0.140	<0.001	-0.115	0.041	0.005
<i>Carabus nemoralis</i>	Day	2.969	0.187	<0.001	0.270	0.121	0.024
	Night	3.158	0.119	<0.001	0.293	0.059	<0.001
<i>Carabus granulatus</i>	Day	3.624	0.122	<0.001	-0.483	0.098	<0.001
	Night	4.016	0.107	<0.001	-0.120	0.081	0.143
<i>Nebria brevicollis</i>	Day	0.404	0.523	0.440	insufficient data		
	Night	0.770	0.118	<0.001	0.044	0.088	0.612
<i>Pterostichus melanarius</i>	Day	0.522	0.196	0.007	0.238	0.150	0.113
	Night	1.006	0.125	<0.001	-0.314	0.089	<0.001
<i>Harpalus rufipes</i>	Day	-0.366	1.118	0.743	insufficient data		
	Night	1.004	0.147	<0.001	-0.071	0.092	0.442

Table S6a. Generalised linear mixed effects model results of the interaction between night-time illuminance and diel light cycle (day vs night) on movement activity (number of sensor crossing events per day/night) (Q1). Estimates are given on ln-scale, intercept is given at 1 lux.

Predictor	Estimate	Std. Error	p-value
Intercept [day]	2.527	0.362	< 0.001
Intercept [night]	2.840	0.360	< 0.001
Slope: log10 night-time illuminance [day]	- 0.099	0.038	0.008
Slope: log10 night-time illuminance [night]	0.069	0.028	0.014

Table S6b. Generalised linear mixed effects model results of the interaction between night-time illuminance and diel light cycle (day vs night) on individual movement (number of sensor crossing events per day/night, corrected for individual densities) (Q1). Estimates are given on ln-scale, intercept is given at 1 lux.

Predictor	Estimate	Std. Error	p-value
Intercept [day]	2.736	0.264	< 0.001
Intercept [night]	2.809	0.260	< 0.001
Slope: log10 night-time illuminance [day]	- 0.103	0.038	0.007
Slope: log10 night-time illuminance [night]	0.090	0.026	< 0.001

Table S7a. Generalised linear mixed effects model results of the interaction between night-time illuminance and habitat (patch vs matrix) on daytime movement activity (sum of detections per day/night) (Q2). Estimates are given on ln-scale, intercept is given at 1 lux.

Predictor	Estimate	Std. Error	p-value
Intercept [matrix]	2.649	0.336	< 0.001
Intercept [patch]	2.157	0.341	< 0.001
Slope: log10 night-time illuminance [matrix]	-0.183	0.054	< 0.001
Slope: log10 night-time illuminance [patch]	0.114	0.058	0.048

Table S7b. Generalised linear mixed effects model results of the interaction between night-time illuminance and habitat (patch vs matrix) on individual daytime movement (sum of detections per day/night, corrected for individual densities) (Q2). Estimates are given on ln-scale, intercept is given at 1 lux.

Predictor	Estimate	Std. Error	p-value
Intercept [matrix]	2.774	0.245	< 0.001
Intercept [patch]	2.510	0.254	< 0.001
Slope: log10 night-time illuminance [matrix]	-0.202	0.050	< 0.001
Slope: log10 night-time illuminance [patch]	0.127	0.058	0.030

Table S8a. Generalised linear mixed effects model results of the interaction between night-time illuminance and habitat (patch vs matrix) on night-time movement activity (sum of detections per day/night) (Q2). Estimates are given on ln-scale, intercept is given at 1 lux.

Predictor	Estimate	Std. Error	p-value
Intercept [matrix]	3.089	0.278	< 0.001
Intercept [patch]	2.178	0.282	< 0.001
Slope: log10 night-time illuminance [matrix]	0.072	0.033	0.028
Slope: log10 night-time illuminance [patch]	0.018	0.041	0.653

Table S8b. Generalised linear mixed effects model results of the interaction between night-time illuminance and habitat (patch vs matrix) on individual night-time movement (sum of detections per day/night, corrected for individual densities) (Q2). Estimates are given on ln-scale, intercept is given at 1 lux.

Predictor	Estimate	Std. Error	p-value
Intercept [matrix]	3.012	0.199	< 0.001
Intercept [patch]	2.253	0.206	< 0.001
Slope: log10 night-time illuminance [matrix]	0.087	0.032	0.008
Slope: log10 night-time illuminance [patch]	0.072	0.041	0.077

Table S9. Linear model results of the effect of night-time illuminance [lux] on the number of detected individuals for the second half of each temporal experimental block. Estimates are given on ln-scale, intercept is given at 1 lux.

Predictor	Estimate	Std. Error	p-value
Intercept	6.157	1.926	0.048
Slope: log ₁₀ night-time illuminance	-0.278	0.213	0.198

Table S10. Generalised linear mixed effects model results of the influence of night-time illuminance on EcoUnit-level predation rate (bite counts per 14 days) (Q3).

Predictor	Estimate	Std. Error	p-value
Intercept	1.421	0.037	< 0.001
Slope: log ₁₀ night-time illuminance	0.029	0.019	0.127

Table S11. Generalised linear mixed effects model results of the influence of individual-patch-level movement activity (sum of detections) on individual-patch-level predation rate (bite counts per 14 days per individual patch) (Q4).

Predictor	Estimate	Std. Error	p-value
Intercept	1.308	0.048	< 0.001
Slope: log10 movement activity	0.131	0.042	0.002

Figure S1. Spectrum of the LED used to simulate moonlight in the EcoUnits.

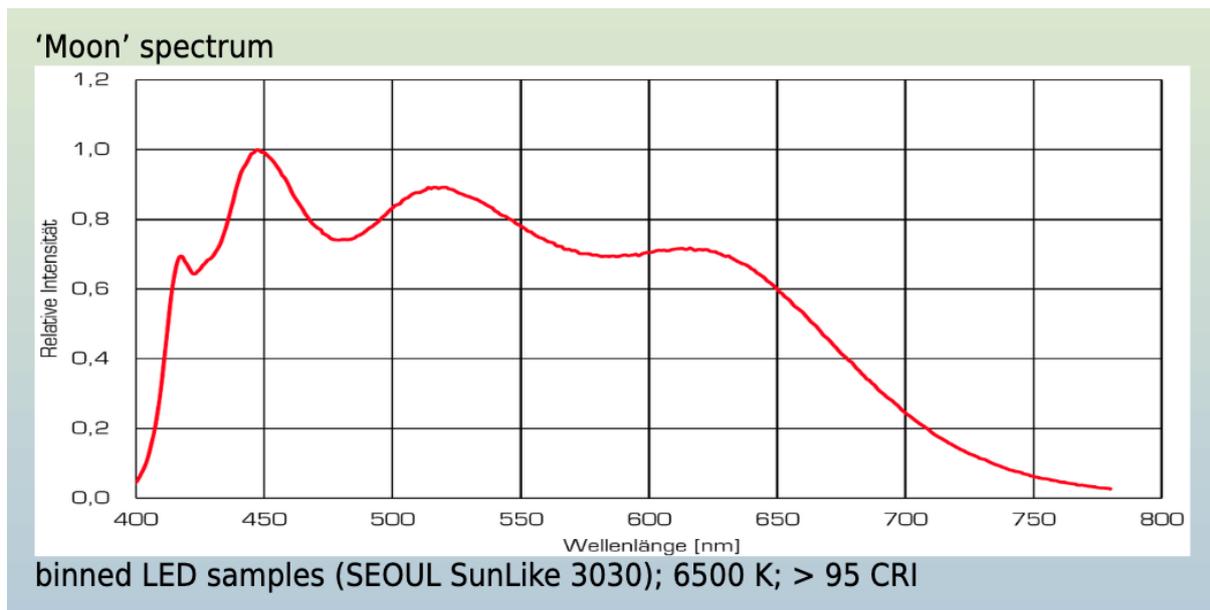
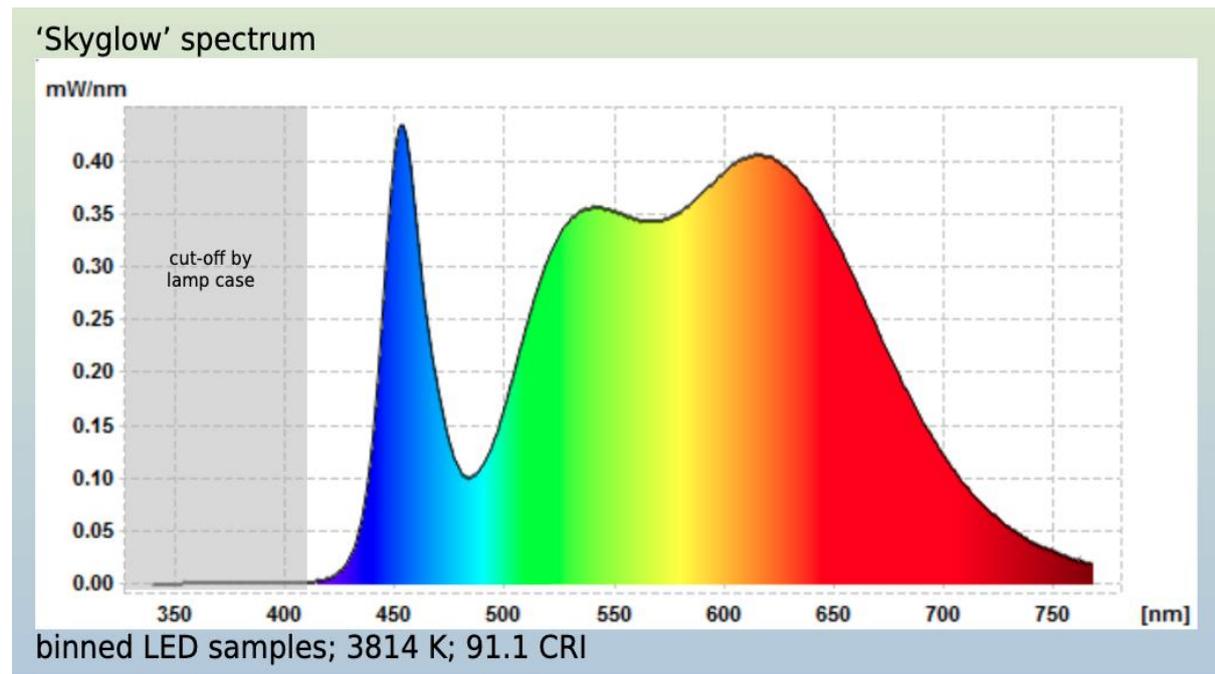


Figure S2. Spectrum of the LED used to simulate skyglow in the EcoUnits.



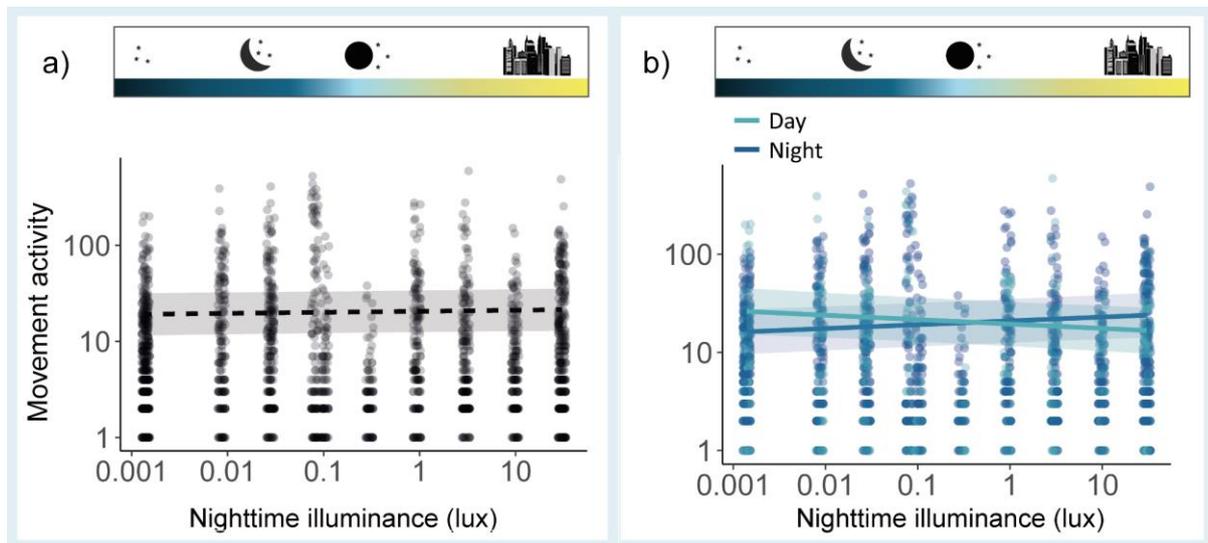


Figure S3. Individual movement (sum of detections per day/night, corrected for individual densities) in response to night-time illuminance. EcoUnit-level daily movement (per 24 hours) **(a)** and daytime (light blue) and night-time movement (dark blue) **(b)**. Dashed lines represent non-significant relationships ($p > 0.05$). Shaded regions represent 95% confidence intervals.

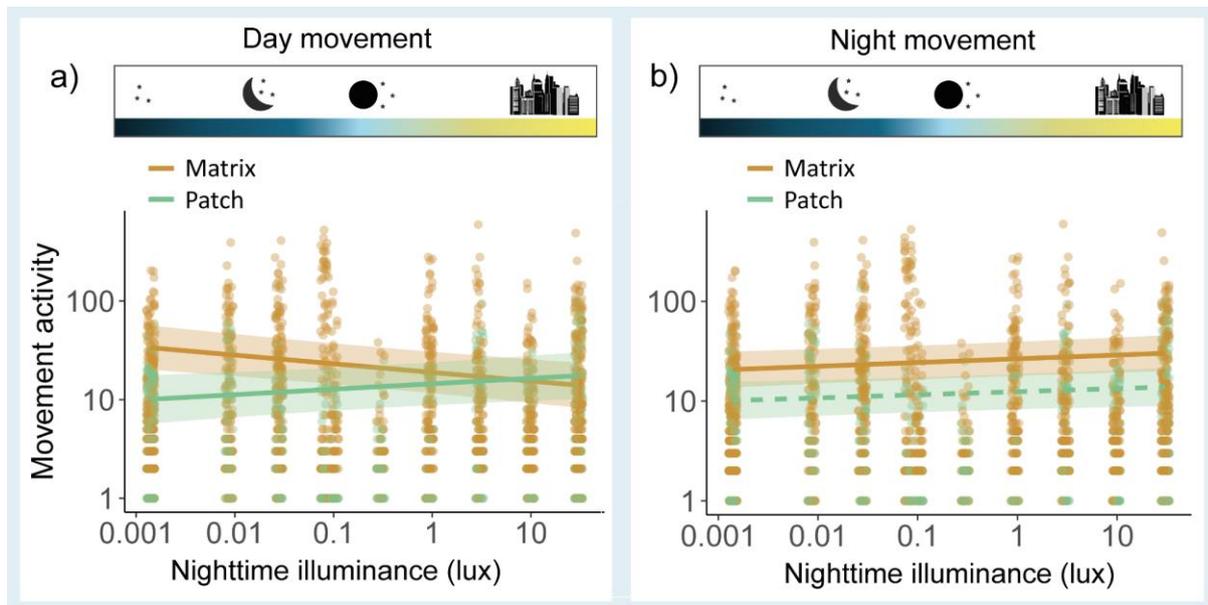


Figure S4. Individual movement (sum of detections per day/night, corrected for individual densities) in habitat patches (green) and matrix (orange) in response to night-time illuminance during the day (a) and during night (b). Dashed lines represent non-significant relationships ($p > 0.05$). Shaded regions represent 95% confidence intervals.