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1 **Artificial light at night reverses monthly foraging**
2 **pattern under simulated moonlight**

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4

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10

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Accepted Version

12 Abstract

13 Mounting evidence shows that artificial light at night (ALAN) alters biological processes across levels
14 of organisation, from cells to communities. Yet, the combined impacts of ALAN and natural sources
15 of night-time illumination remain little explored. This is in part due the lack of accurate simulations
16 of the complex changes moonlight intensity, timing, and spectra throughout a single night and lunar
17 cycles in laboratory experiments. We custom-built a novel system to simulate natural patterns of
18 moonlight to test how different ALAN intensities affect predator-prey relationship over the full lunar
19 cycle. Exposure to high intensity ALAN (10 and 50lx) reversed the natural lunar guided foraging
20 pattern by the gastropod mesopredator *Nucella lapillus* on its prey *Semibalanus balanoides*.
21 Foraging decreased during brighter moonlight in naturally lit conditions. When exposed to high
22 intensity ALAN, foraging increased with brighter moonlight. Low intensity ALAN (0.1 and 0.5lx) had
23 no impact on foraging. Our results show that ALAN alters the foraging pattern guided by changes in
24 moonlight brightness. ALAN impacts on ecosystems can depend on lunar light cycles. Accurate
25 simulations of night-time light cycle will warrant more realistic insights into ALAN impacts and also
26 facilitate advances in fundamental night-time ecology and chronobiology.

27 Introduction

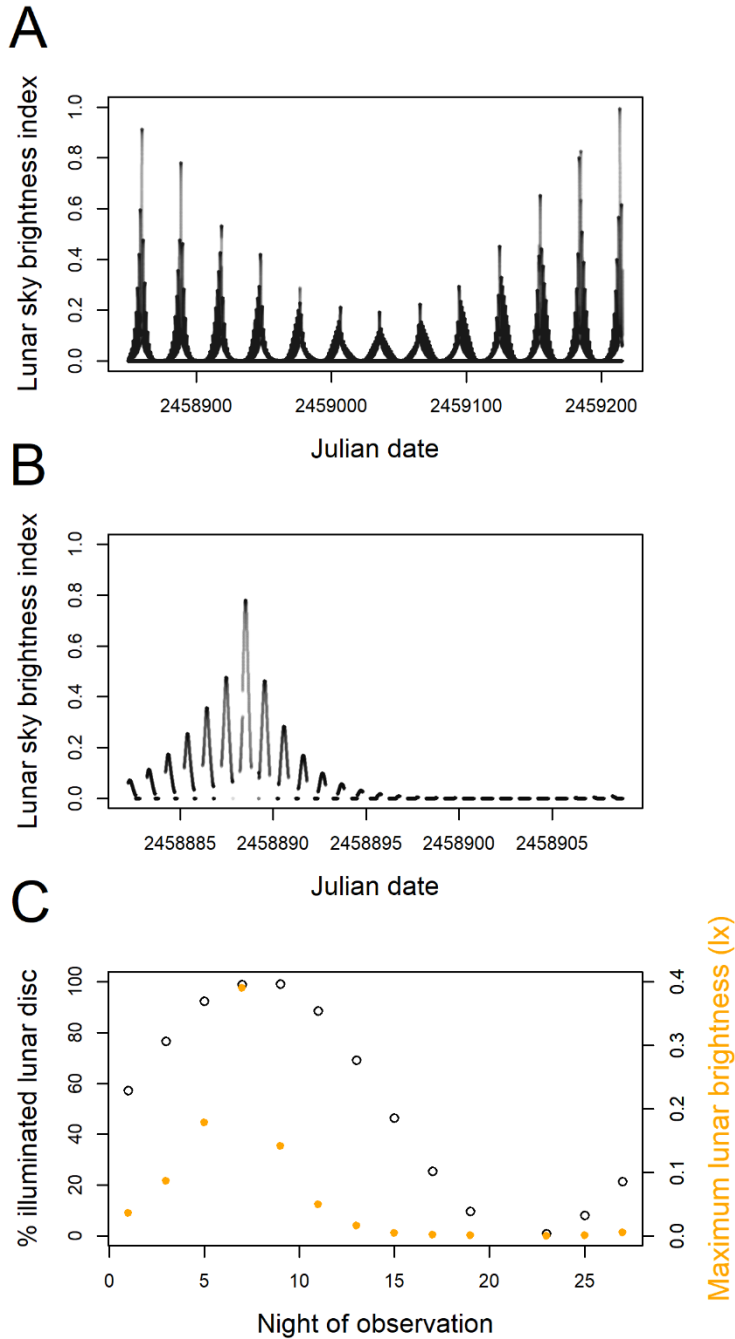
28 Ecological light pollution is now an established field of global change research [1]. Satellite night-
29 time imagery illustrates unequivocally the vast global extent of artificial light at night (ALAN). At least
30 80% of the world's population is exposed to ALAN [2] and its influence is expanding both in area
31 (2.2% per year) and intensity (1.8% per year) [3]. Mounting evidence shows that ALAN alters
32 biological processes across levels of organisation, from cells to communities, and across a range of
33 biomes, taxa and spatial scales [4, 5]. Accurate prediction and mitigation of ALAN impacts demand a
34 deeper understanding of how they are modified by other factors that shape the natural night-time
35 light environment and biological adaptations to them.

36 The moon is the single most important source of environmental night-time illumination. It drives
37 large-scale ecosystem processes and a diverse array of physiological and behavioural rhythms [6],
38 the most widely known being lunar entrained global synchronised mass spawning in corals [7]. Lunar
39 driven phenological life-history events such as reproduction and migration are found across the
40 animal kingdom in marine [8-11], terrestrial [12, 13] and freshwater [14, 15] habitats across the
41 globe. Lunar rhythms influence organisms' growth [16] and activity patterns [12]. Moonlight
42 intensity affects communication [13], orientation [17] and risk-reward trade-offs [18, 19]. Recent
43 research suggests that ALAN interferes with lunar guided migration [20], orientation [21], sleep time
44 [22] and reproduction [23] at intensities similar to natural moonlight.

45 Current evidence of ALAN disrupted lunar biology is often limited to characterising only the moon
46 phases, which do not reflect the lunar cues organisms are likely to detect in the wild. Moon phases
47 describe the lunar cycle as the portion of illuminated lunar disc as observed from Earth and suggest a
48 sinusoidal pattern in lunar intensity when, in reality, the pattern of changes in lunar brightness
49 throughout a cycle follows extreme peaks and troughs as the moon transits the sky [Fig 1; 24]. Lunar
50 intensity varies throughout the night, with day, month, year and enneadecaeteris (the ~19 year
51 metonic cycle) for any location and time, owing to variations in lunar phase angle, altitude and
52 atmospheric scattering (Fig 1A & B) [25, 26].

53 We built a novel system that allows us to quantify the ecological impacts of ALAN over a full lunar
54 cycle simulating the timing and intensity of moonlight as experienced in nature. Rather than
55 simulating sinusoidal changes in lunar phases, our system simulates natural night-time conditions for
56 a specified location and date (Fig 1B & C). We exposed the gastropod mesopredator *Nucella lapillus*
57 to a range of seven ALAN intensities, from low levels within the range of natural lunar light
58 intensities (0.1 and 0.5lx), up to levels (10 and 50lx) similar to those experienced by organisms close
59 to ports, harbours and street lights [27]. We measured the foraging probability of *Nucella* on its

60 prey, the barnacle *Semibalanus balanoides*, over an entire lunar cycle. We asked a) whether ALAN
 61 impacts vary over the lunar cycle; b) whether ALAN impacts are expressed during the night or
 62 daytime; and c) whether ALAN impacts change over the duration of the experiment (due to
 63 acclimation).



64

65 **Figure 1 Lunar cycle in nature and in the laboratory for Menai Bridge, UK. A) Lunar cycle in nature**
 66 **over 12 month in 2020 (astronomical unit Julian date, days elapsed since January 1st 4713 BC) as**
 67 **lunar sky brightness index (normalised to 1 = 0.5lx); B) Lunar cycle in nature over the course of the**
 68 **experiment (February 2nd – March 2nd) as lunar sky brightness index (normalised to 1 = 0.5lx); C)**

69 **Lunar cycle in the laboratory as percentage illuminated disc following a sinusoidal pattern (circles,**
70 **left y-axis) and as maximum lunar brightness (in lx) (closed points, right y-axis).**

71

72 Methods

73 *Nucella* were collected from an artificial light naive shore on the island of Anglesey, UK (53°11'6"N,
74 4°29'35"W) on 31st of January 2020, and transported to the School of Ocean Sciences, Menai Bridge,
75 UK (53°13'57"N, 4°10'22"W). Individuals were sexed, and male *Nucella* marked for individual
76 identification and assigned to one of seven light treatment chambers (no ALAN, 0.1lx, 0.5lx, 1lx, 10lx,
77 10lx mitigation and 50lx). Each 0.16m³ light treatment chamber contained three 2l clear Perspex
78 tanks ($n = 21$; 20L x 12W x 13H cm), each of which housed 4 individuals ($n = 84$) in 0.5 μ m filtered UV
79 irradiated seawater changed every second day. *Nucella* had ad libitum access to rocks (ca. 50 cm²
80 surface area, < 5% of the total 1,072cm² available tank surface area) covered with their prey, the
81 barnacle *Semibalanus balanoides*, replaced every four days.

82 The natural daylight and moonlight regimes experienced by *Nucella* on their native shore were
83 simulated in each chamber. Daylight was simulated using an Aquaray Natural Daylight Tile set at
84 5000lx (mean 4781lx +/- 5%) and the BioLumen Control Unit (Tropical Marine Centre, UK)
85 programmed in real time to the sunrise and sunset times of Menai Bridge, UK (53°13'57"N,
86 4°10'22"W). To evenly diffuse the light and minimise bright spots [4], the daylight tile was covered
87 by 3mm frosted Perspex. Moonlight regimes were simulated using a bank of 2700-3500K 1.2 cd LEDs
88 housed within diffusing spheres to minimise light spots. Natural moonlight regimes were simulated
89 using a Pulse Width Modulated signal (scale 0-100%) applied to the 5V output of Raspberry Pi 3
90 model B+, with maximum lunar brightness set to 0.5lx (observable within 2020, Fig 1A). Lunar
91 brightness was adjusted from a look up table (1 minute resolution) of Zenith Sky Brightness
92 modelled for Menai Bridge. Modelling followed [27] whereby the moon's sky position and phase
93 angle are calculated from the time, date and geocentric coordinates of location (CRAN: astrolib). The
94 Zenith Sky Brightness is then modelled accounting for lunar phase, altitude, opposition, parallax and
95 atmospheric scattering according to [28]. Uniquely, in comparison to previous lunar simulations
96 under experimental laboratory settings, our system captures variability in night-time lighting as the
97 moon transits the sky [25, 26]. The spectrum of moonlight changes throughout the night with lunar
98 phase and elevation [29, 30]. As with twilight, this persists to be technically challenging [4] and
99 hence was not manipulated. ALAN was simulated between dawn and dusk (triggered using a
100 Celloptick 12V photocell) using Aquaray cool white FlexiLED strips (Tropical Marine Centre, UK), with
101 brightness controlled using voltage dimming. As the lens eyes [31] of aquatic gastropods typically

102 show peak spectral sensitivity from 470 to 505nm [32, 33], we evaluated a potential mitigation
103 solution using a long band pass (510nm–2200nm) yellow acrylic filter (www.knightoptical.com),
104 which minimises blue wavelengths prominent in LEDs. This was implemented in one of two 10lx
105 treatment chambers.

106 Behaviour was observed over one lunar cycle between February 2nd and March 2nd 2020 using
107 infrared time-lapse photography. GoPro Hero 4 cameras fitted with infrared pass lenses were
108 programmed with Blink Time Lapse Controllers for GoPros (CamDo, USA) to take one photo every
109 five minutes for 24 hours every second night over the 28 day period (= 289 photos per 24 hours, for
110 each of the 7 treatments, each of the 12 individually marked animals per treatment, for 13 nights of
111 observation = up to 315,588 photos. Due to a charging error, there are no observations for day 21,
112 see Fig 1C). This sampling frequency allowed the recording system to last for 24 hours (from 15:00
113 day 1 to 15:00 day 2) and to capture 13 nights without interruption over one lunar cycle. Images
114 were down-sampled from colour to 8-bit grayscale with ImageJ. Brightness and contrast were
115 adjusted to maximise visibility. Images were converted into a single time-lapse video for each 24
116 hour. Due to naturally high levels of inactivity in *Nucella*, we classed their behaviour as either
117 foraging (when sitting on the rock with barnacles) or not foraging (when not sitting on a rock). This is
118 a common metric for gastropod foraging and avoids disturbing animals [34-37]. We also recorded
119 whether the behaviour occurred day and/ or night-time leading to two data points per individual per
120 video. Due to the persistent technical challenges in simulating twilight timing, spectra and intensity
121 [4], we excluded footage taken over dusk and dawn.

122 We quantified whether *Nucella*'s foraging activity (binary: Foraging/Not Foraging) was affected by
123 ALAN (categorical: 0, 0.1, 0.5, 1, 10, 10 mitigation, 50lx) in interaction with either a) moonlight
124 intensity (continuous: maximum lunar brightness per night; Fig 1C), b) time of day (categorical: night
125 or day), and c) experimental day i.e. night of observation (continuous: night 1-27) using R (version
126 4.1.2). The latter explored potential collinear effects that may arise due to *Nucella* acclimatising. To
127 find the most parsimonious model, we first fitted a global binomial generalised linear model (GLM)
128 with the following interactions: ALAN*Moonlight + ALAN*NightofObservation + ALAN*TimeofDay.
129 Next, we used the dredge function (CRAN: MuMIn) which automates model selection through
130 subsetting the maximum model based on model weights derived from Akaike's Information Criterion
131 (AICs). The model explaining < 99% of the response based on weight and the lowest AICs included
132 ALAN*Moonlight + ALAN*NightofObservation + TimeofDay (see Table S1 for all models). This most
133 parsimonious GLM was compared to a intercept only model for validation using a likelihood ratio
134 test [38]. Since the GLM explained significantly more variance in the response than the intercept
135 only model ($\chi^2 = -80.58$, $df = 21$, $p < 0.001$), the GLM was refitted as generalised linear mixed effects

136 (GLMM) model (CRAN: lme4). Snail ID was nested in tank as a random factor to account for the
 137 experimental design. The significance of the GLMM parameters was quantified using the Type III
 138 ANOVA approach of stepwise model selection [39]. Again, models were compared using likelihood
 139 ratio tests. Significant difference between treatment levels were quantified by pairwise comparisons
 140 using the emtrends function (CRAN: emmeans) which allows to include a numerical predictor (here
 141 Moonlight) interacting with a factorial predictor (here ALAN). We did not adjust p -value to avoid
 142 inflating the Type I error. The predicted relationships and their 95% intervals were modelled for
 143 visual presentation using the predictInterval function (CRAN: merTools).

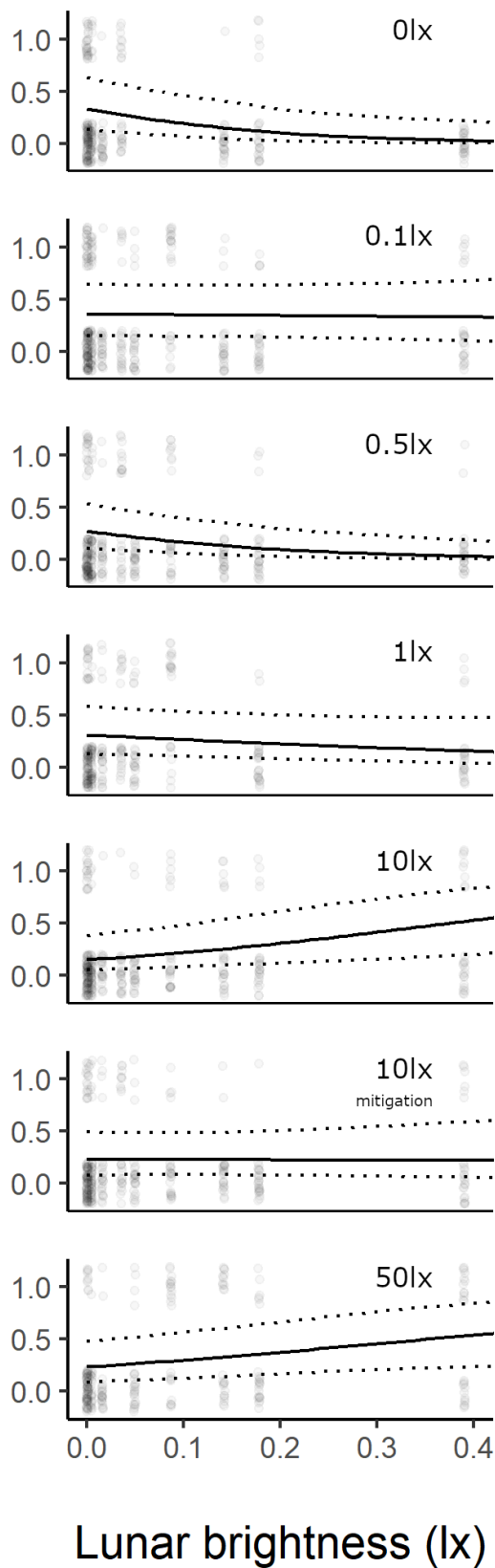
144 Results

145 Foraging activity was influenced by the nightly maximum lunar brightness, however, the direction of
 146 this relationship was significantly affected by exposure to different ALAN treatment levels
 147 (ALAN*Moonlight: $\chi^2 = 33.67$, $df = 6$, $p < 0.001$; Fig 2; Table 1, Table S2). Under natural night-time
 148 light simulations (no ALAN), *Nucella* were less likely to forage on brightly moonlit nights, while under
 149 high intensity ALAN (10 and 50lx), *Nucella* were more likely to forage on brightly moonlit nights (Fig
 150 2). Foraging activity in *Nucella* exposed to the mitigation treatment (filtered out light under 510nm)
 151 differed from both the 10lx treatment and control conditions (Fig 2; Table S2). (Fig 2; Table S2). The
 152 impact of ALAN on foraging was affected by night of observation ($\chi^2 = 17.29$, $df = 6$, $p = 0.008$; Table
 153 1, S3). Time of day had no effect on foraging ($\chi^2 = 0.18$, $df = 1$, $p = 0.670$).

154 **Table 1 The impact of artificial light at night, lunar brightness, night of observation and time of day**
 155 **on foraging in *Nucella lapillus*. Significant main effects and interactions are in bold.**

Factor	χ^2	df	p
ALAN*Moonlight	33.67	6	< 0.001
ALAN*Night of Observation	17.29	6	0.008
ALAN	4.89	6	0.558
Moonlight	1.74	1	0.187
Night of Observation	10.41	1	0.001
Time of Day	0.18	1	0.670

Occurrence of Dogwhelks foraging



156

157 **Figure 2** The interactive impact of different ALAN intensities and maximum lunar brightness on
158 **foraging occurrence in *Nucella lapillus*.** The figure shows the raw data (jittered dots), predicted
159 **relationships (solid line) and 95% prediction intervals (dotted lines).**

160 Discussion

161 Artificial light at night (ALAN) is known to affect lunar guided reproductive phenology [23],
162 orientation [20, 21] and community structure [19]. Our results demonstrate that ALAN can also alter
163 temporal patterns in foraging tuned to the naturally changing nightly lunar brightness throughout
164 the lunar cycle.

165 Under the simulation of natural moonlight, *Nucella* foraged less with increasing moonlight intensity.
166 Suppressed activity on brighter moonlit nights is a common pattern driven by risk-reward trade-offs
167 [12, 18, 19]. High intensity ALAN levels, however, reversed this pattern. *Nucella* was more likely to
168 forage during brighter moonlit nights under ALAN intensities of 10 and 50lx. The gastropod sensory
169 system allows *Nucella* to use chemical and visual channels to detect prey (mussels and barnacles)
170 and predators (crabs and birds) [33, 40]. The high intensity ALAN treatments masked the maximum
171 lunar brightness attained on any night during the experiment (0.39lx) and could have been bright
172 enough for *Nucella* to visually exclude predation risk. This interpretation aligns with previous
173 observations of *Nucella* foraging in the presence of predator olfactory cues when exposed to ALAN
174 but not in dark control treatments [41]. ALAN intensities of 0.5 and 1lx, which are similar to artificial
175 skyglow [20], could be too dark to allow accurate visual assessment of the environment and risk
176 perception.

177 A growing body of evidence indicates that ALAN has notable impacts on lunar guided biological
178 process [18-21, 23]. Here we show that ALAN impacts also depend on natural regimes of lunar
179 brightness. The brightness of naturally lit nights is a function of lunar phase, altitude and scattering,
180 yet studies investigating both ALAN impacts and chronobiological responses to moonlight simulate
181 the sinusoidal pattern of lunar phase at best [26, 42, 43]. Moonlight intensity does not change in a
182 sinusoidal pattern, as suggested by lunar phases, which give the portion of illuminated lunar disc as
183 observed from Earth. The full moon is 1.3 times brighter than can be accounted for solely by the
184 increase in percentage of illuminated lunar disc due to the so-called lunar opposition effect. This
185 phenomenon describes the non-linear intensity increase with decreasing phase angle [25, 27, 28]. In
186 nature, animals hardly experience maximum lunar brightness between 0.2 and 0.4lx. To quantify
187 biologically relevant ALAN impacts on organisms over a lunar cycle requires simulating the lunar
188 intensity accurately. Resolving technical challenges in mimicking the spectral composition of
189 moonlight [28, 30] will facilitate further mechanistic insight also into crepuscular processes [6, 7] and
190 ALAN disruptions to them. ALAN research is increasingly embedded into a multisensory pollution
191 approach [19, 44] to assess its interactions with other anthropogenic stressors like noise [45, 46] and
192 warming [47]. Future research that aims to facilitate a better understanding of anthropogenic

193 impacts on wildlife should also consider how these interact with natural factors. For ALAN research,
194 this means first and foremost lunar cycles described by temporal variability in moonlight intensity
195 through the night, month, year and enneadecaeteris. Our results highlight the importance of
196 accounting for moonlight when investigating ALAN impacts. In the laboratory setting, this means
197 accurately simulating moonlight. Doing so will provide novel mechanistic insights in the fields of
198 ecological light pollution, visual ecology, night-time ecology, and chronobiology; and improve the
199 application of experimental results to the real world.

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202 lighting system and assisting in animal husbandry.

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206 Author contributions

207 ST, JW, SJ and TD designed the study. JW and ST conducted the fieldwork and data collection. ST and
208 TW analysed the data. ST wrote the first draft with all authors contributing to writing and approval
209 of the final version.

210 The data are provided in the electronic supplementary material [48].

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Tidau et al. 2022 Artificial light at night reverses monthly foraging pattern under simulated moonlight

Supplementary material 1 - Model Outputs

Table S1 Selection of the most parsimonious models describing foraging occurrence in *Nucella lapillus*. Top 4 models (in bold) account for > 99% weight.

Intercept only	ALAN	Moonlight	Night of Observations	Time of Day	ALAN * Moonlight	ALAN * Night of Observation	ALAN * Time of Day	df	AICc	weight
-0.85827	+	-6.76216	-0.01941	NA	+	+	NA	21	1920.176	0.553489
-0.83496	+	-6.76257	-0.01941	+	+	+	NA	22	1922.058	0.216096
-0.74902	+	-7.14412	-0.02564	NA	+	NA	NA	15	1922.662	0.159699
-0.72587	+	-7.14456	-0.02564	+	+	NA	NA	16	1924.532	0.062702
-1.20403	+	-5.60636	NA	NA	+	NA	NA	14	1929.662	0.004824
-1.181	+	-5.6067	NA	+	+	NA	NA	15	1931.53	0.001895
-0.75522	+	-6.77049	-0.01944	+	+	+	+	28	1933.322	0.000774
-0.64602	+	-7.15162	-0.02566	+	+	NA	+	22	1935.73	0.000232
-1.81519	+	NA	0.022114	NA	NA	+	NA	14	1936.763	0.000139
-1.74053	+	-0.39783	0.018876	NA	NA	+	NA	15	1938.35	6.26E-05
-1.79231	+	NA	0.022116	+	NA	+	NA	15	1938.632	5.44E-05
-1.71763	+	-0.39787	0.018878	+	NA	+	NA	16	1940.221	2.46E-05
-1.10162	+	-5.61325	NA	+	+	NA	+	21	1942.719	7.05E-06
-1.19171	+	NA	-0.02093	NA	NA	NA	NA	8	1947.315	7.08E-07
-1.16907	+	NA	-0.02093	+	NA	NA	NA	9	1949.174	2.80E-07
-1.15217	+	-0.22053	-0.02258	NA	NA	NA	NA	9	1949.192	2.77E-07
-1.71615	+	NA	0.022149	+	NA	+	+	21	1949.827	2.02E-07
-1.12952	+	-0.22055	-0.02258	+	NA	NA	NA	10	1951.052	1.09E-07
-1.64142	+	-0.39811	0.018909	+	NA	+	+	22	1951.429	9.05E-08
-1.14733	NA	NA	-0.02079	NA	NA	NA	NA	2	1953.621	3.02E-08
-1.48539	+	NA	NA	NA	NA	NA	NA	7	1953.767	2.81E-08

Intercept only	ALAN	Moonlight	Night of Observations	Time of Day	ALAN * Moonlight	ALAN * Night of Observation	ALAN * Time of Day	df	AICc	weight
-1.52999	+	0.603712	NA	NA	NA	NA	NA	8	1954.301	2.15E-08
-1.12489	NA	NA	-0.02079	+	NA	NA	NA	3	1955.47	1.20E-08
-1.11918	NA	-0.16382	-0.022	NA	NA	NA	NA	3	1955.548	1.15E-08
-1.46286	+	NA	NA	+	NA	NA	NA	8	1955.625	1.11E-08
-1.50745	+	0.603763	NA	+	NA	NA	NA	9	1956.16	8.50E-09
-1.09674	NA	-0.16383	-0.022	+	NA	NA	NA	4	1957.398	4.58E-09
-1.41746	NA	NA	NA	NA	NA	NA	NA	1	1960.123	1.17E-09
-1.09201	+	NA	-0.02094	+	NA	NA	+	15	1960.314	1.07E-09
-1.46544	NA	0.636885	NA	NA	NA	NA	NA	2	1960.457	9.91E-10
-1.39514	NA	NA	NA	+	NA	NA	NA	2	1961.97	4.65E-10
-1.05245	+	-0.22065	-0.02259	+	NA	NA	+	16	1962.205	4.14E-10
-1.4431	NA	0.636938	NA	+	NA	NA	NA	3	1962.306	3.93E-10
-1.38629	+	NA	NA	+	NA	NA	+	14	1966.757	4.25E-11
-1.43085	+	0.604113	NA	+	NA	NA	+	15	1967.304	3.23E-11

Table S2 Posthoc contrasts of the impact of ALAN * Moonlight (expressed as maximum lunar brightness) on foraging occurrence in *Nucella lapillus*. Significant results are in bold (using pairwise comparisons).

Contrasts	Estimate	SE	<i>z</i>	<i>p</i>
0 – 0.1	-6.99	3.21	-2.18	0.029
0 – 0.5	-0.55	3.83	-0.14	0.887
0 – 1	-4.90	3.31	-1.49	0.136
0 – 10	-11.96	3.24	-3.69	<0.001
0 – 10M	-7.20	3.31	-2.18	0.030
0 – 50	-10.88	3.29	-3.31	<0.001
0.1 – 0.5	6.45	2.98	2.17	0.030
0.1 – 1	2.06	2.26	0.91	0.363
0.1 – 10	-4.97	2.16	-2.30	0.021
0.1 – 10M	-0.20	2.25	-0.09	0.928
0.1 – 50	-3.89	2.22	-1.75	0.080
0.5 – 1	-4.39	3.08	-1.42	0.155
0.5 – 10	-11.41	3.01	-3.79	<0.001
0.5 – 10M	-6.65	3.08	-2.16	0.031
0.5 – 50	-10.34	3.06	-3.38	<0.001
1 – 10	-7.02	2.31	-3.047	0.002
1 – 10M	-2.26	2.40	-0.94	0.346
1 – 50	-5.95	2.37	-2.51	0.012
10 – 10M	4.76	2.30	2.07	0.038
10 – 50	1.08	2.27	0.48	0.635
10M – 50	-3.69	2.36	-1.56	0.119

Table S3 Table S3 Posthoc contrasts of the impact of ALAN * Day of observation on foraging occurrence in Nucella lapillus. Significant results are in bold (using pairwise comparisons).

Contrasts	Estimate	SE	<i>z</i>	<i>p</i>
0 – 0.1	-0.03	0.03	-0.82	0.411
0 – 0.5	0.06	0.03	1.75	0.081
0 – 1	0.39	0.03	1.16	0.246
0 – 10	-0.04	0.04	-1.29	0.199
0 – 10M	-0.02	0.03	-0.46	0.644
0 – 50	0.06	0.03	1.42	0.155
0.1 – 0.5	0.09	0.03	2.74	0.006
0.1 – 1	0.06	0.03	2.15	0.031
0.1 – 10	-0.02	0.03	-0.61	0.545
0.1 – 10M	0.01	0.03	0.35	0.728
0.1 – 50	0.08	0.04	2.20	0.028
0.5 – 1	-0.02	0.03	-0.66	0.512
0.5 – 10	-0.11	0.04	-3.00	0.003
0.5 – 10M	-0.08	0.03	-2.27	0.023
0.5 – 50	<0.00	0.04	-0.07	0.945
1 – 10	-0.08	0.03	-2.48	0.013
1 – 10M	-0.05	0.03	-1.69	0.091
1 – 50	0.02	0.04	0.49	0.629
10 – 10M	0.03	0.03	0.88	0.380
10 – 50	0.10	0.04	2.51	0.012
10M – 50	0.07	0.04	1.85	0.064

Supplementary file S2 Spectral Measurements

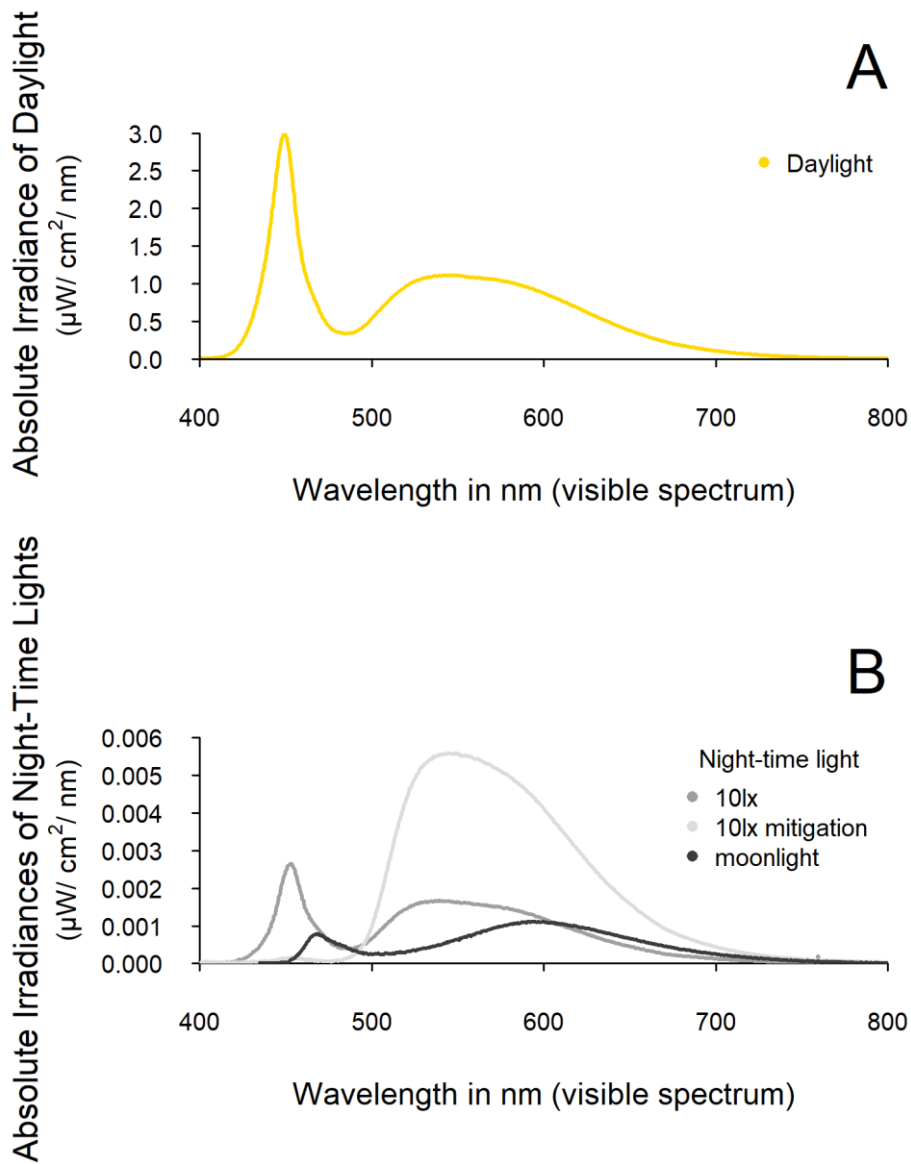


Figure S2 Spectral outputs day and night-time light sources as absolute irradiance ($\mu\text{W}/\text{cm}^2/\text{nm}$) within the visible range of 400-800 μm

Table S2 Energy content of the spectral outputs of day and night-time light sources as absolute irradiance ($\mu\text{W}/\text{cm}^2/\text{nm}$) within the visible range of 400-800 μm .

	Daylight	Moonlight	10lx ALAN	10lx ALAN mitigation
Total absolute irradiance	481.1601	0.3615943	0.5868144	1.471918
Peak absolute irradiance	2.992874 at 449.3 nm	0.001123044 at 590.62	0.002654932 at 452.70	0.005589028 at 547.80 nm