European Commission

Science for Environment Policy

Nocturnal use of LEDs negatively affects freshwater microorganisms, Germany

31 January 2019
Issue 520
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Almost a quarter of the world's non-polar land surface experiences light pollution, and there is concern that this adversely affects illuminated ecosystems. Currently there is a global move from yellow sodium lighting to white LED lighting, which emits different wavelengths of light. A recent study found that LED artificial light at night (ALAN) reduced the biomass of periphyton by 62% in a freshwater drainage ditch in Westhavelland Nature Park, Brandenburg, Germany.

ALAN has been shown to negatively effect terrestrial animals such as bats and insects with impacts on a range of behaviours, including foraging and commuting, emergence, roosting, breeding and hibernation[1,2]. Due to the different colour of light emitted by LED lighting from traditional yellow sodium lighting, it is expected to increase the ecological impacts of ALAN on many organisms. Impacts of LED ALAN on freshwater ecosystems are less well known, but with 80% of the world's population living within 3 km of a body of freshwater, these ecosystems are also subject to the effects of artificial light.

The European Research Council has funded UK research[3] to establish the effects of street lighting and light pollution on the environment. It found that street lighting changes the abundance of plants, herbivores and predators, with pervasive ecological impacts. Nuanced approaches to such lighting will, therefore, be required to limit these. The EU has not defined regulatory indicators for light pollution[4].

A recent study sought to record the impact of the transition from sodium lights to LED artificial light at night (ALAN) on microorganisms in a freshwater drainage ditch. Experiments were conducted in a drainage ditch in a rural nature park in Germany, classified as a 'dark sky reserve'. LED and High-Pressure sodium (HPS) lights were used at night, to mimic urban street lighting. The effects of ALAN on the biomass and pigment composition of the drainage ditch's periphyton (freshwater organisms attached or clinging to plants or submerged surfaces) were recorded. The researchers expected that the LED lights would have a greater impact on photosynthesising organisms than the sodium lamps, as the spectral make-up of light from LEDs — which contains photosynthetically active light, including blue light — means they are more likely to affect circadian rhythms and photosynthesis.

The ALAN effects were measured during a 13-week period, with samples of periphyton taken from the artificial intervention site and from two control sites, without ALAN, for comparison. Sodium lamps were used in two experiments in the summer and winter of 2014 and LEDs in one experiment in the winter of 2015.

Floating frames with strips submerged into the water were used as substrate on which periphyton could grow. These were sampled at weeks one to four in the summer sodium experiment; and at weeks five, six, seven, eight and 13 in the winter sodium and LED experiments. Each sampling involved four randomly cut strips of substrate from each site — submerged in a vial containing ditch water from that site. Water biochemistry — pH, temperature, dissolved oxygen and conductivity — was measured when samples were collected.

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Source: Grubisic, M., van Grunsven, R., Manfrin, A., Monaghan, M. and Hölker, F. (2018). A transition to white LED increases ecological impacts of nocturnal illumination on aquatic primary producers in a lowland agricultural drainage ditch. *Environmental Pollution*, 240: 630–638.

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1. Stone, E., Harris, S. and Jones, G. (2015). Impacts of artificial lighting on bats: a review of challenges and solutions. *Mammalian Biology*, 80(3), pp.213-219.

2. Grubisic *et al*. 2018. Insect declines and agroecosystems: does light pollution matter? *Annals of Applied Biology*, 173:2. Doi: 10.1111/aab.12440

3. ECOLIGHT (Ecological effects of light pollution) project, funded under "Ideas" programme, implementing the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007 to 2013).

4. How artificial nighttime lighting negatively affects ecological communities. (2017). *Research*eu Results Magazine:*, (68), p.26.

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The periphyton was brushed from the substrate into the water and the suspension was poured into a graduated cylinder and filtered using a vacuum filtration process. The content was then dried at 65°C until the mass stabilised and the dry mass was recorded. A subsample from the initial suspension was refrigerated at –80 °C for 48 hours to stimulate cell splitting, allowing pigment composition analysis of the cell contents, to see which colour-reflecting materials were present.

There was no effect either on biomass or species composition — shown by pigments present — due to the sodium lights in the summer or winter; however, compared to the control sites, the LEDs used under a similar illumination level (approximately 20 lux) reduced the biomass of the periphyton in the winter experiment by 62%. This is the first study to examine the effects of ALAN on periphyton in a lowland freshwater ecosystem and partly confirms findings of a study that examined the effects on periphyton from a sub-alpine stream[5].

This study adds to a growing body of data highlighting the negative impacts of nocturnal illumination using LED lights on natural ecosystems. The researchers highlight an impact on freshwater producers at the base of an ecosystem, which provide food for trophic levels higher up — this can be used as a basis for further research. The impacts of this body of research can help to inform future EU policy on urban ALAN planning and limits, and the appropriate places to transition from sodium lights to LEDs in Europe.

5. Grubisic, M., Singer, G., Bruno, M., van Grunsven, R., Manfrin, A., Monaghan, M. and Hölker, F. (2017). Artificial light at night decreases biomass and alters community composition of benthic primary producers in a sub-alpine stream. *Limnology and Oceanography*, 62(6), pp.2799-2810.