Basic and Applied Ecology 78 (2024) 39–40

Contents lists available at ScienceDirect

Basic and Applied Ecology

journal homepage: www.elsevier.com/locate/baae

Editorial

Sensory pollution by artificial light: Implications for ecology and evolution

Biodiversity is declining worldwide and, in addition to land- and sea-use change, climate change, direct exploitation, and biological invasions, pollution is considered to be one of the main drivers for the decline (IPBES, 2019). One form of pollution is sensory pollution, which is often neglected (Dominoni, Halfwerk, Baird, Buxton, Fernandez-Juricic et al., 2020). Sensory pollution often disrupts acoustic, visual or olfactory signals and communication of organisms, which are key to display appropriate behaviour in space and time, and to interact with other organisms. Since this disruption may come with consequences for survival and reproduction, this sensory pollution can be particularly detrimental for population persistence and biodiversity (Dominoni et al., 2020; Lurling & Scheffer, 2007; Senzaki, Barber, Phillips, Carter, Cooper et al., 2020; Sordello et al., 2020; van Grunsven, van Deijk, Donners, Berendse, Visser et al., 2020). One form of sensory pollution that is increasingly acknowledged to have detrimental ecological and evolutionary consequences is artificial light at night (hereafter ALAN).

ALAN has rapidly increased over the past decades (Kyba, Altintas, Walker & Newhouse, 2023). It is increasingly acknowledged, that it threatens biodiversity at multiple levels of biological organisation (Hoelker, Bolliger, Davies, Giavi, Jechow et al., 2021; Jagerbrand & Spoelstra, 2023), from genes (e.g., Golden, 1995) to physiology (e.g., Dominoni, Quetting & Partecke, 2013) to behaviour (e.g., Russart & Nelson, 2018), to populations and communities (e.g., Knop, Zoller, Ryser, Gerpe, Hörler et al., 2017), to ecosystems and landscapes (e.g., Barre, Spoelstra, Bas, Challeat, Ing et al., 2021). Moreover, impacts are not limited to nocturnal species, but artificial light at night might indirectly also affect diurnal organisms (Rich & Longcore, 2006), leading to altered physiology, behaviour, and species interactions during daytime (e.g., Giavi, Fontaine & Knop, 2021). The impact of ALAN can be seen across the terrestrial, aquatic as well as aerial biomes, and across species from different taxonomic groups, ranging from unicellular organisms (e.g., Quraishi & Spencer, 1971), to plants (Bennie, Davies, Cruse & Gaston, 2016), to invertebrates (Owens & Lewis, 2018), and vertebrates (Grubisic, Haim, Bhusal, Dominoni, Gabriel et al., 2019).

In this Special Issue we compiled seven papers that studied the effect of ALAN on a variety of organisms in aquatic as well as terrestrial biomes, in particular aquatic invertebrates (Moyse, Firth, Smyth, Tidau & Davies, 2023), fish (Georgiou, Reeves, da Silva & Fobert, 2024; Vega, Jechow, Campbell, Zielinska-Dabkowska & Hölker, 2024), terrestrial plants (Haynes, Miller, Serrano-Perez, Hey & Emer, 2023), terrestrial invertebrates (Haynes et al., 2023; Longcore, 2023; Seymoure, Parrish, Egan, Furr, Irwin et al., 2024), terrestrial mammals (Ditmer, Carter, Hersey, Leclerc, Wittemyer et al., 2023; Longcore, 2023), birds (Longcore, 2023; Seymoure et al., 2024), reptiles (Longcore, 2023), and amphibians (Longcore, 2023).

At the individual level, Longcore (2023) compiles a unique compendium on species visual sensitivity to light from previously published research that used behavioural responses, electroretinograms, and reflectance within the eye. This compendium gives an excellent overview of the sensitivity of the major taxa groups to ALAN, from which recommendations of how spectral tuning might help to reduce the impact of light pollution can be inferred. Also at the individual level, Georgiou et al. (2024) show behavioural responses of a coral reef fish to ALAN.

At the community level, two studies show that the visual perception of the prey by the predator is modified by the altered light conditions due to artificial light at night, depending on the spectral composition of the artificial light source. One study focused on aquatic predator-prey interactions (Moyse et al., 2023) and one on terrestrial predator-prey interactions (Seymoure et al., 2024). Also for the terrestrial system, a study showed that plant-herbivore interactions might be altered due to changes in the feeding frequency of the herbivore exposed to ALAN (Haynes et al., 2023).

Finally, at the landscape level, two studies focused on how ALAN might function as a barrier to species movement. One study showed that ALAN in combination with infrastructure can affect the movement behaviour of mule deer (Ditmer et al., 2023). Similarly, in the aquatic realm, model scenarios suggest that illuminated bridges might act as barriers for migrating fish (Vega et al., 2024).

This special issue gives insight into the different mechanisms and processes underlying the effects ALAN has on sensory ecology. It clearly shows that the mechanisms and processes are complex and act at different levels of biological organization. While the special issue was originally planned on various types of sensory pollution, the clear bias of studies towards ALAN gives an indication of how important this sensory pollution has become over the past years and how detrimental its effects can be. At the same time, this highlights that other types of pollutants, for instance noise and chemical pollution, are still understudied when it comes to their sensory effects. Furthermore, we are still far from fully

https://doi.org/10.1016/j.baae.2024.04.005

Available online 24 April 2024

appreciating the complexity of the potential impacts that co-occurring pollutants might have on wild species and ecosystems. Similarly, how sensory pollutants might interact with other drivers of biodiversity decline, such as climate change, is largely unknown. The studies compiled here, highlight how the understanding of the underlying processes and mechanisms behind the impact of sensory pollutants can help us to design and implement effective mitigation measures, which we should urgently set in place in order to halt the ongoing decline of biodiversity.

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