Sensory pollution and the biodiversity crisis

Imagine you are a female frog on a warm spring night in the year 1719. In the distance, you can hear a chorus of male frogs calling at a wetland, calling to you through the darkness. You like that sound – these chaps sound like the right chaps for you. The only light comes from the stars, white and shiny, far above. You set off towards the sound, hopping across uneven ground, making steady progress. When you arrive, the chorus is loud and insistent with hundreds of voices, overlapping and urgent. You move around slowly, listening hard; it's only possible to distinguish a few individual voices at a time. Eventually you make your choice – a fellow with a low-pitched, energetic call. He sounds like he's got the resources, the stamina and the experience to be a high-quality father to your children. You make contact with that lucky fellow, make your intentions known. He climbs on your back in a close embrace and as a pair you position yourselves at the edge of the wetland. You deposit hundreds of eggs into the water; he fertilizes them. And then you say goodbye to your instant family, confident that most of your eggs will hatch to become strong and healthy tadpoles. Not all of them will make it to the next life stage, and fewer will make it to adulthood. But the water is clean and well vegetated, and your tiny children are already equipped with the chemical and behavioural defences they'll need to avoid predators and make their own way in the world.

Imagine now you are a female frog on a warm spring night in the year 2019. In the distance, a chorus of male frogs is calling at a wetland, calling to you through the semi-darkness. But it's difficult for you to hear them over the sound of traffic from a nearby highway. What was once a communication distance of a kilometre or more has been reduced by a factor of ten – you need to be much closer to be sure of what you're hearing, to be sure that the chaps who are calling are the right chaps for you. Although it is night time, light is all around, reflecting down from the sky and shining directly from street lamps that march away into the distance. There are no stars to be seen. When you arrive at the wetland, there are fewer voices but they still overlap each other in their urgency. With a constant, low rumble of urban noise in the background, it is easier for you to hear the higher-pitched voices in the chorus, which tend to belong to smaller males. Do these squeaky fellows have the resources and experience to be a good father to your children? Eventually you make a choice, and as a pair you and your selected partner position yourselves at the edge of the wetland. You deposit hundreds of eggs into the water; he fertilizes them as best he can, although his sperm count is significantly lower than that of his ancestors from 300 years ago. The wetland has an urbanized watershed and contains a vast array of chemical pollutants: heavy metals, pesticides, antibacterial agents and traces of human pharmaceuticals. Even at low concentrations, these substances can impact on the survival of your children – directly through increased mortality, and indirectly through behavioural changes that will leave them more susceptible to predation. How can you be confident that they will make it to the next life stage, and then on into adulthood?

This scenario is just one of millions that play out every day in human-altered environments; it highlights only a few

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Amphibians are among the many organisms vulnerable to the negative effects of sensory pollution (pictured are European common frogs [*Rana temporaria*]).

of the ecological impacts of sensory pollution. Sensory pollutants – including anthropogenic noise, artificial light at night and chemical contaminants – disrupt the sensory processes of wildlife across the evolutionary spectrum (Halfwerk and Slabbekoorn, 2015). Anthropogenic noise impairs hearing and acoustic communication in groups as diverse as insects, fish, frogs, birds and mammals, impacting behaviour, reproductive success and the detection of predators and prey (Parris, 2015; Shannon *et al.*, 2016). Artificial light at night disrupts natural photoperiods and changes the spectral properties of nocturnal light, with far-reaching impacts on the physiology, behaviour, ecology and evolution of animals and plants (Longcore and Rich, 2004; Gaston *et al.*, 2013). Globally, its effects are expected to increase further with the move from sodium lamps to cool-white light-emitting diode (LED) lamps for roadway lighting (Gaston *et al.*, 2015). Chemical pollutants disrupt olfaction (smell), including chemical communication between individuals of the same species and the olfactory detection of predators (Lürling and Scheffer, 2007). Many chemical pollutants also act as endocrine disrupters, affecting invertebrates and vertebrates alike with significant consequences for development, behaviour and fitness (Clotfelter *et al.*, 2004; Hayes *et al.*, 2011). However, the combined effects of the myriad sensory pollutants experienced by wildlife remain poorly understood (Halfwerk and Slabbekoorn, 2015; Hale *et al.*, 2017).

Reducing the ecological impacts of sensory pollution is conceptually simple but will take a coordinated effort between policy-makers, land managers, urban planners and the general public. Legislation to protect people from excessive urban noise (including road-traffic and air-traffic noise) should be extended to protect other species and their acoustic environments, particularly threatened species and those that rely heavily on acoustic communication (Parris, 2015). Detailed guidelines for reducing light pollution are available from the International Dark Sky Association (www.darksky.org); the general principles are to reduce the duration and brightness of artificial lights, ensure that lights are targeted where they are needed and shielded to prevent upward glow, and to avoid lights with a predominance of energy in the blue portion of the spectrum (Longcore *et al.*, 2018). Mitigating the ecological impacts of chemical pollution in agricultural and urban areas will require the protection of wildlife from chemical contaminants that already exist in the environment, removal of these contaminants where feasible, and a much greater effort to prevent further additions to terrestrial, freshwater and marine ecosystems. Ensuring that unpolluted habitats are available for and attractive to wildlife will also be crucial (*e.g.*, by ensuring urban wetlands intended for biodiversity do not receive storm-water run-off, and by discouraging wildlife from using polluted wetlands [Hale *et al.*, 2019]). It is also worth remembering that a quieter, darker and cleaner environment will bring substantial benefits for human health and well-being – for we, after all, are wildlife too. ■

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References

Clotfelter ED, Bell AM and Levering KR (2004) The role of animal behaviour in the study of endocrine-disrupting chemicals. *Animal Behaviour* **68**: 665–76.

Gaston KJ, Bennie J, Davies TW and Hopkins J (2013) The ecological impacts of nighttime light pollution: A mechanistic appraisal. *Biological Reviews* **88**: 912–27.

Gaston KJ, Visser ME and Hölker F (2015) The biological impacts of artificial light at night: The research challenge. *Philosophical Transactions of the Royal Society B* **370**: 20140133.

Hale R, Piggott JJ and Swearer SE (2017) Describing and understanding behavioral responses to multiple stressors and multiple stimuli. *Ecology and Evolution* **7**: 38–47.

Hale R, Swearer SE, Sievers M and Coleman R (2019) Balancing biodiversity outcomes and pollution management in urban stormwater treatment wetlands. *Journal of Environmental Management* **233**: 302–7.

Halfwerk W and Slabbekoorn H (2015) Pollution going multimodal: The complex impact of the human-altered sensory environment on animal perception and performance. *Biology Letters* **11**: 20141051.

Hayes TB, Anderson LL, Beasley VR *et al.* (2011) Demasculinization and feminization of male gonads by atrazine: Consistent effects across vertebrate classes. *Journal of Steroid Biochemistry and Molecular Biology* **127**: 64–73.

Longcore T and Rich C (2004) Ecological light pollution. *Frontiers in Ecology and the Environment* **2**: 191–8.

Longcore T, Rodríguez A, Witherington B *et al.* (2018) Rapid assessment of lamp spectrum to quantify ecological effects of light at night. *Journal of Experimental Zoology* **2018**: 1–11.

Lürling M and Scheffer M (2007) Info-disruption: Pollution and the transfer of chemical information between organisms. *Trends in Ecology and Evolution* **22**: 374–9.

Parris KM (2015) Ecological impacts of road noise and options for mitigation. In: van der Ree R, Smith DJ and Grilo C, eds. *Handbook of Road Ecology*. John Wiley & Sons, New York, NY, USA: 151–8.

Shannon G, McKenna MF, Angeloni LM *et al.* (2016) A synthesis of two decades of research documenting the effects of noise on wildlife. *Biological Reviews* **91**: 982–1005.

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