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Ultrasound jams echolocation to keep bats safe near wind turbines

Soprano pipistrelles (*Pipistrellus pygmaeus*) flying around a bat box. Photo credit: Jens Rydell.

Wind farms are springing up all over the planet, with impeccable carbon credentials. But these apparently gentle giants are not as benign as they may first appear. Birds and bats are at risk when commuting and foraging in the vicinity as the turbine blades sweep through the air at speeds of up to 325 km h^{-1}. Fortunately, bats tend to avoid noisy locations and can be deterred from straying into the path of wheeling turbine blades by speakers broadcasting ultrasonic sound up to 100 kHz, well beyond the highest frequencies that humans hear (~20 kHz). However, Gareth Jones, Marc Holderied and Lia Gilmour from the University of Bristol, UK, with Simon Pickering from Ecotricity Group Limited, UK, were curious to find out why bats avoid locations that are simply too noisy.

'Animals can respond to noise in their environment in a number of ways; it can be distracting or can mask other important sounds that an animal might need to hear, or just simply be irritating enough to cause animals to avoid it', says Gilmour. However, instead of testing the effects of noise deterrents on bats near wind turbines, Gilmour and her colleagues set up ultrasound speakers on the banks of the River Teme, UK, frequented at dusk by various bats including soprano pipistrelles (*Pipistrellus pygmaeus*) and Daubenton's bats (*Myotis daubentonii*). 'River sites are often teeming with bats due to the high insect activity there, so we chose these sites to make it easier to see an effect of the deterrent', says Gilmour. First, she located two commonly used bat deterrent ultrasound speakers 2 m above the ground and filmed the bats in 3D with a pair of thermal imaging cameras, while recording their echolocation calls and bat chit-chat in silence. Then, she switched on the speakers for 5 min, while continuing to record their calls and manoeuvres, to see how the ultrasound altered the animals' behaviour.

After repeating the process five more times over the course of an hour and at different positions along the river, Gilmour began painstakingly deconstructing the animals' movements and found that the bats were avoiding the riverside locations when the ultrasound speakers were on. 'Overall, bat activity was reduced by up to 30%, which is what we would expect for distances up to 30–40 m from the deterrent', says Gilmour. And, when she analysed the sounds produced by the soprano pipistrelles, they produced less of the echolocation calls used when closing in for a kill. The bats were hunting less in the vicinity of the noisy speakers, although they were still chattering to each other, so the noise hadn't drowned them out entirely. Gilmour also discovered that the bats flew more swiftly through the noisy area, took more direct routes and avoided flying near the speakers when they were switched on. In addition, the soprano pipistrelles dropped the pitch of their echolocation calls, reducing the bandwidth from 32.5 kHz when the speakers were silent to 26.7 kHz when they were on, to reduce jamming of their echolocation by the ultrasonic din and improve their chances of hearing returning echolocation calls.

So why were the bats avoiding the riverbank when the ultrasonic speakers were on? 'The deterrent sound likely reduced the bat's ability to hear returning echoes of their echolocation signals, causing a reduction in foraging in the river areas', says Gilmour. She suspects that bats avoid foraging in noisy locations where their echolocation is jammed, helping them to steer clear of hazardous wind turbine blades surrounded by a protective ultrasound force field.

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Gilmour, L. R. V., Holderied, M. W., Pickering, S. P. C. and Jones, G. (2021). Acoustic deterrents influence foraging activity, flight and echolocation behaviour of free-flying bats. *J. Exp. Biol.* **224**, jeb242715. doi:10.1242/jeb.242715.

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