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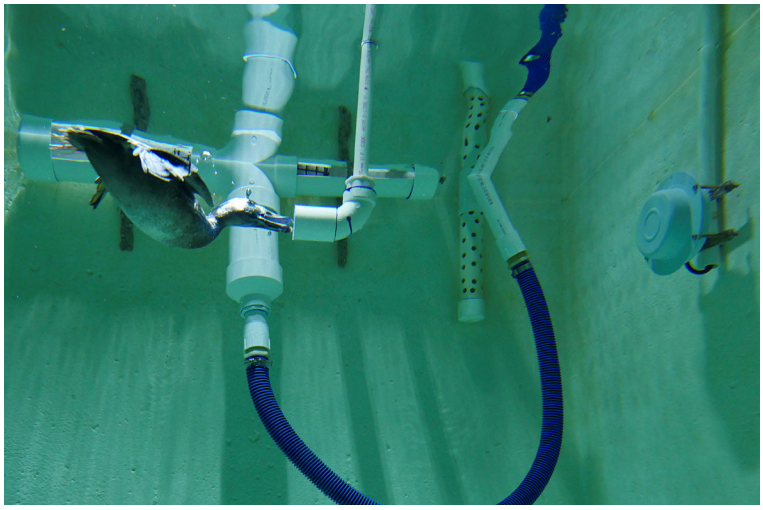
INSIDE JEB

Greedy ducklings teach scientists about submerged diving bird hearing



A surf scooter (*Melanitta perspicillata*) pecking an underwater target in a hearing trial. Photo credit: Kathleen McGrew.

The modern fishing industry is unnervingly efficient, but the inadvertent death toll is alarming. ‘Hundreds of thousands of seabirds are killed annually as a result of incidental bycatch in fisheries’, says Kathleen McGrew from Virginia Maryland College of Veterinary Medicine, USA, explaining that the birds become entangled in nets when diving to capture prey. ‘You also have to consider vulnerable and endangered species. Something has to be done to prevent their demise’, says McGrew, who wondered whether specifically designed noisy deterrents could warn seabirds away from diving near fishing nets. However, underwater hearing ability can differ dramatically from that in air; humans can hear sounds that that are pitched 10 times higher in water than in air, thanks to bones in the head carrying sound more effectively. McGrew, along with Sara Crowell, Jonathan Fiely, Alicia Berlin and Glenn Olsen from the US Geological Survey, Jennifer James and Heather Hopkins from the Naval Undersea Warfare Center, USA, and Christopher Williams from the University of Delaware, USA, decided to find out how well three species of diving duck hear when submerged.

But first the team needed to train ducklings to peck a button in return for a mealworm treat when they heard an underwater sound. ‘It’s pretty hard to teach an old duck new tricks, so we trained ducklings. That way, we could mould behaviour from day one’, says McGrew, who became mentor to long-tailed duck (*Clangula hyemalis*), surf scooter (*Melanitta perspicillata*) and common eider (*Somateria mollissima*) ducklings. Once the by then fully grown ducks were reliably pecking the target when they heard an underwater sound, McGrew played tones ranging from 500 to 4020 Hz at volumes between 85 and 135 dB, recording the pitch at which the birds began responding to the submerged beeps.

Plotting the youngsters’ hearing thresholds at each tone, it was clear that surf scooter hearing was sharpest at 1000 Hz, picking up the tone at 105 dB, while the 500 Hz and 2000 Hz tones had to be played louder, at 115 dB and 110 dB, before the birds could hear them. In contrast, the long-tailed ducks seemed to hear sounds ranging from 1000 to 2960 Hz best, while common eider duck hearing was equally sharp from 1000 Hz up to 4020 Hz. ‘Based on these observations, a device that makes sound to scare away the birds would ideally play sounds between 2000 and 3000 Hz’, says McGrew.

However, training broods of ducklings to let you know when they can hear a submerged sound takes time and patience. Could the team develop an alternative underwater hearing test? This time, McGrew teamed up with Crowell, Berlin, Fiely, Olsen, Hopkins and James to investigate whether measuring the submerged ducks’ brainwaves could tell them anything about their hearing.

After gently sedating individual ducks, the team carefully placed electrodes – to pick up the brain waves – near each duck’s forehead and just behind each ear before providing the animal with a breathing tube and briefly submerging it beneath the water while playing the same series of underwater tones. ‘The birds all made smooth recoveries before being returned to their pens when fully awake’, McGrew recalls. Impressively, the unconscious hearing tests were a success, reproducing the same threshold hearing plots that the team had obtained for the actively diving birds. Recording underwater brainwaves will allow researchers to understand how other diving bird species hear beneath the waves, without having to spend months training greedy ducklings.

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McGrew, K. A., Crowell, S. E., Fiely, J. L., Berlin, A. M., Olsen, G. H., James, J., Hopkins, H. and Williams, C. K. (2022). Underwater hearing in sea ducks with applications for reducing gillnet bycatch through acoustic deterrence. *J. Exp. Biol.* **225**, jeb243953. doi:10.1242/jeb.243953.

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