INSIDE JEB

Humpbacks disturbed within 3 km of noise

A humpback whale breaching. Photo credit: Project BRAHSS (Behavioural Response of Australian Humpback whales to Seismic Surveys).

Little is known about the effects of loud sounds on migrating whales, but Rebecca Dunlop, from the University of Queensland, Australia, explains that there is a great deal of concern about the impact of noise as our oceans become rowdier. Explaining that one of the main sources of noise is oil and gas exploration, Dunlop describes how geologists fire off loud acoustic air guns to probe the structure of the ocean floor in search of fossil fuels. However, it was unclear how humpback whales might react to these sounds and whether the proximity of the disturbance is a concern. 'If you heard the quiet noise of a burglar in your house at 3 a.m., I'm guessing you'd respond much more to that than to your loud toddler singing at the top of his or her voice – so context matters', points out Dunlop. In addition, it wasn't clear whether the animals were disturbed by the gas guns themselves, or the noise of the towing boat's propeller. Wondering whether migrating humpback whales might be more likely to veer away from nearby soft sounds than remoter loud noises, Dunlop, Douglas Cato and an extensive team of collaborators investigated the animals' reactions to strings of repetitively firing air guns as they were towed for an hour across the migrating whales' path.

Locating one team of observers on a cliff above Peregian Beach and a second team 11 km south on 'Mount Emu', Dunlop and her colleagues were able to track the whales' movements before the air guns began firing, while the guns were going off and for an hour after. 'Michael Noad ran what probably ended up being one of the biggest studies of its kind with 100 plus people in the field', says Dunlop. Then, having entered the animals locations as they surfaced into the VADAR tracking system, Eric Kniest, from the University of Newcastle, Australia, was able to reconstruct the whales' courses and clearly saw them slowing and veering away from the airguns as they drew closer, suggesting that the whales were actively avoiding the air guns.

However, the team needed to understand exactly how loud the air gun discharges were as they reached each animal to disentangle the effects of the sound intensity and proximity on its behaviour. Rob McCauley, from Curtin University, Australia, painstakingly reconstructed maps of the intensity of each air gun blast as it reverberated through the water and reached the whales by taking account of the acoustic qualities of the sea floor. In addition, he calculated the propeller noise intensity as the vessels towed the silenced air guns.

Then, with all of the observations in hand, Lindsay Scott-Hayward, from the University of St Andrews, UK, created maps that related the air gun noise, and sound from the ship, to the vessel's distance from the whale groups – which ranged from 10 km to about 500 m – to show that both proximity and air gun noise intensity had a significant effect on the animals' behaviour. 'Humpback whales were more likely to avoid the air gun arrays, but not the boats alone, within 3 km of the source at levels over 140 re. 1 μPa^2', says Dunlop. Having identified the least invasive locations for prospecting acoustic air guns in relation to migrating humpback whales, Dunlop adds, 'Developing mitigation measures based on more accurate dose–response models can only help… improve interactions between humans and cetaceans'.

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Dunlop, R. A., Noad, M. J., McCauley, R. D., Scott-Hayward, L., Kniest, E., Slade, R., Paton, D. and Cato, D. H. (2017). Determining the behavioural dose–response relationship of marine mammals to air gun noise and source proximity. *J. Exp. Biol.* **220**, 2878-2886.

Kathryn Knight

Homing pigeon flights change with confidence

A homing pigeon carrying a GPS sensor and an accelerometer to detect motion. Photo credit: Lucy Taylor.

Each homing pigeon embarking on a lengthy homeward journey is following in the wingbeats of the human tradition of pigeon keeping dating back thousands of years. Equipped with internal compasses for guidance, young pigeons gradually build up a picture of the terrain surrounding their loft, which they eventually call on when displaced further. However, Dora Biro and Lucy Taylor, from the University of Oxford, UK, were curious to learn more about how pigeons build confidence as a route becomes more familiar. 'When I think about how I move when navigating, I move differently if I am not sure where I am going compared to when I am walking a known route', says Taylor, adding, 'We imagined the same may also be true for birds'.

Teaming up with biomechanics expert Steven Portugal, from Royal Holloway, University of London, UK, Taylor and Biro attached accelerometers, which detect motion, coupled with GPS sensors to young pigeons to monitor their wingbeat patterns and routes as the aviators became increasingly familiar with the return journey home from two locations, 3.85 and 7.06 km away.

'The pigeons were very cooperative', says Taylor, recalling that they were content to be held while the motion sensors were secured to their backs before being released individually. However, Taylor had to be prepared for the notoriously unpredictable British summer. High winds, cloud, rain and extreme heat can affect a bird's ability to navigate home, so Taylor was on standby for much of the season to catch the few days when the conditions were ideal and the team could fit in two homing flights per day. Then, having collected 200 acceleration readings each second during flights lasting 5 min up to several hours, Taylor was faced with the colossal task of synchronising over 48 million data records to build a complete understanding of each homing flight as the birds gained in confidence.

After analysing the immense data set, the trio was able to identify clear patterns in the pigeons' behaviour. As the birds became more experienced, their routes meandered less and became more direct until they converged on an efficient flight path by the sixth return journey. In addition, the animals flapped their wings harder (their torsos bobbed up and down more) and increased their speed as they became more confident of their path. Summing up their observations, Taylor says, 'Pigeons flap their wings differently depending on how well they know a landscape', adding that early flights from unfamiliar locations are likely to be more energetically costly as the pigeons fly more slowly and take less direct routes.

Reflecting on the study, Taylor says, 'We didn't know at the start whether the birds would flap differently depending on how well they know a terrain', and she and her colleagues are now optimistic that their observations could help other scientists investigate how animals navigate. '[These] flight characteristics may be used as "signatures" of birds' familiarity with a navigational task… that could be utilised to provide new insights, through non-invasive methods, into the decision-making and navigational strategies of birds', says Taylor.

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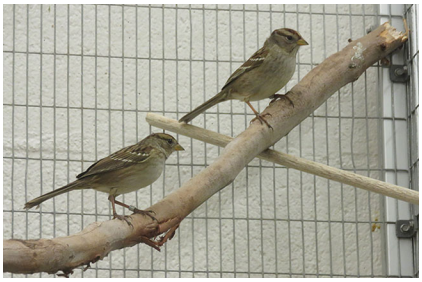
Taylor, L. A., Portugal, S. J. and Biro, D. (2017). Homing pigeons (*Columba livia*) modulate wingbeat characteristics as a function of route familiarity. *J. Exp. Biol.* **220**, 2908-2915.

Kathryn Knight

Morning recital accelerates migrating sparrow moult



Juvenile Nuttall's white-crowned sparrows. Photo credit: Helen Chmura.

There's always so much to remember when you're packing for a long journey, and when migrating species begin their preparations for departure they focus on building their muscles and fat stores in readiness. However, when breeding grounds are the migrants' final destination, the females must also anticipate the conditions that will greet them and ensure that they will be in tip-top reproductive condition when they arrive. In contrast, species that stay put have more information about the environment in which they will lay their eggs. 'Scientists who study how animals pick when to breed hypothesize that migrant and resident birds use different kinds of cues from the surrounding environment to get their bodies ready to lay eggs', says Helen Chmura, from the University of California, Davis, USA. Although cues such as increasing day length are known to trigger migrant preparations for departure, Chmura, John Wingfield and Thomas Hahn wondered whether other factors may fine-tune bird breeding preparations and whether some cues may be more significant for species that stay put than species that migrate before breeding.

Focusing on white-crowned sparrows that live in Northern California, Chmura and Hahn collected females from two closely related members of the family: Gambel's white-crowned sparrows, which migrate north to breed in Northern Washington, Canada and Alaska; and their home-loving relatives, Nuttall's white-crowned sparrows, which spend the entire year in California. Back in the lab, the duo and a large team of assistants separated the migratory Gambel's sparrows from the Nuttall's sparrows. Then they simulated the dawn chorus each day from early February until late April, playing recordings of the migratory males' serenades to their females, while ensuring that the non-migrating resident females listened to recordings of males from their own neck of the woods: 'Resident sparrows have regional song dialects', says Chmura. Meanwhile, two other groups of the birds experienced a silent simulated sunrise. Then, Chmura, Hahn and Simone Meddle monitored the birds' reproductive hormones, ovarian development and the condition of the birds' plumage – in case they moulted – to find out whether the males' melodies had any effect on the breeding preparations of the migrants and their stay-at-home cousins.

However, when the team compared the development of the birds' reproductive systems, they were surprised that listening to recordings of the males' songs had no effect on the females' reproductive preparations. Even though the preparations of the resident Nutall's sparrows for breeding were more advanced than those of the migrating Gambel's sparrows, listening to the male's serenades had not fine-tuned the Nuttall's sparrows' preparations further. However, when the team compared plumage of the migrants that had been serenaded with those that had experienced a silent sunrise, it was clear that a morning recital accelerated the migrants' moulting process.

So it appears that recordings of the males' arias didn't make either migrant or resident birds prepare to breed more quickly: either the birds weren't listening to the recordings, or they were listening, but didn't pay attention to the information. However, listening to the dawn chorus can help migrants replace their plumage more quickly in preparation for a swift departure. And Chmura adds, 'Understanding the similarities in how migrants and residents use and respond to environmental cues is important, as frequently these differences are used to underpin predictions about how they will respond to climate change'.

10.1242/jeb.166470

Chmura, H. E., Meddle, S. L., Wingfield, J. C. and Hahn, T. P. (2017). Effects of a social cue on reproductive development and pre-alternate molt in seasonally breeding migrant and resident female songbirds (*Zonotrichia leucophrys*). *J. Exp. Biol.* **220**, 2947-2956.

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