

## INSIDE JEB

## Whales no faster than other ocean inhabitants despite size



A tag being deployed on a blue whale. Photo credit: Duke Marine Robotics and NMFS Permit 16111.

About 4.5 million years ago, something big happened in the world of whales. Freed from the effects of gravity, the animals went on a colossal growth spurt – possibly when the climate switched, forcing them to voyage great distances between feeding grounds – to produce the behemoths we know today. But what effect did this change of scale have on the way these creatures propel themselves through the water? ‘Steady-state cruising by most vertebrates has been shown to occur in the 1–2 m s<sup>-1</sup> range regardless of body size’, says William Gough from Stanford University, USA, yet it wasn’t clear whether the largest creatures on the planet conform to this convention. In an ambitious collaboration, Jeremy Goldbogen, also from Stanford University, and colleagues across the globe – from California to Italy and South Africa to Greenland – trailed whales ranging in size from Antarctic minke whales (~9 m) to blue whales (~30 m) over a 4 year period to learn more about the scaling of whale manoeuvres.

‘Attaching data tags to whales is like playing tag in slow motion during an earthquake’, chuckles Gough, describing deploying the data loggers, which record water pressure and the animals’ movements, in addition to filming the animals’ behaviour while submerged. The scientists also used drones to film some of the tagged animals in Antarctica, South Africa, California, Greenland and the Azores, to get a sense of their size. ‘Drones are not as easy to fly as it looks, so flying them above whales takes some practice and skill’, says Goldbogen. Having retrieved the tags, which detached automatically after ~9 h on average, the team analysed the vibrations picked up by the movement sensors as the tag was dragged through the water to calculate the speed at which the animals were swimming.

However, when all the results were eventually in, it seemed that the vast creatures were towing the same line as other smaller ocean inhabitants, cruising along at an average speed of 1.9 m s<sup>-1</sup>

(although one small minke whale hit a top speed of almost 8.3 m s<sup>-1</sup>). And when the team calculated the whales’ tailbeat frequencies based on the movement sensors and plotted them on a graph against body length, it was clear that the largest whales beat their tails more slowly than the smallest whales, despite swimming at roughly the same speed. ‘The bigger you are, the more water you can push backward with each tailbeat, so a larger animal should be able to beat its tail more slowly and still push the same amount of water as a smaller animal beating its tail more rapidly’, says Gough.

In an additional twist of fate, the team realised that they had a fortuitous opportunity to measure the full range of a humpback whale’s tailbeat when an animal resurfaced soon after a tag had been attached. ‘The tag had slipped and attached itself to the tail. We knew immediately that this would be a once-in-a-lifetime deployment’, says Gough, who was able to calculate the ~2.6 m range of the massive tail sweeps from the pressure difference at the top and bottom of each tailbeat. However, when Gough evaluated the animals’ optimal swimming speed with Goldbogen and Jean Potvin from Saint Louis University, USA, it was slightly lower than the whales’ cruising speed, suggesting that whales, like fish, often trade off efficiency when going about their routine activities.

10.1242/jeb.216044

Gough, W. T., Segre, P. S., Bierlich, K. C., Cade, D. E., Potvin, J., Fish, F. E., Dale, J., di Clemente, J., Friedlaender, A. S., Johnston, D. W., Kahane-Rappoport, S. R., Kennedy, J., Long, J. H., Oudejans, M., Penry, G., Savoca, M. S., Simon, M., Videsen, S. K. A., Visser, F., Wiley, D. N. and Goldbogen, J. A. (2019). Scaling of swimming performance in baleen whales. *J. Exp. Biol.* **222**, jeb204172. doi:10.1242/jeb.204172

Kathryn Knight  
kathryn.knight@biologists.com