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Research into how marine mammals utilize energy helps determine the metabolic costs of anthropogenic noise

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By: Marshall Hawkins April 6th, 2020

Oceanic noise pollution has gained increasing attention over the past several years. Anthropogenic ocean noise is produced through shipping, oil and gas exploration, military sonar activity, etc. These influences are considered a potential stressor to marine life - marine mammals in particular. While there have been numerous investigations into the mass strandings of marine mammals, it is important to consider other ways marine noise might be affecting them, and how they respond to a perceived threat.

All toothed marine mammals are predatory and have varying ways of capturing their prey. Dolphins use speed and maneuverability to chase down and corral prey, while sperm whales dive to great depths to forage in the deep sea. Regardless of their feeding techniques or strategies, all of these animals require the use of energy so it is essential that this energy be used efficiently for the animal to remain healthy. Using more energy than the animal can replenish can put them at greater risk of injury, disease, or more at risk of predation

Imagine if whenever you sat down to have a meal, someone in the building pulled the fire alarm, and you had to evacuate. After this happened several times, you were then made to sprint as fast as you could. This is similar to how certain man made ocean noises affect marine mammals. Certain noises can elicit a flight response that can leave the animal exhausted and vulnerable.

To get a better understanding of the physiological needs of diving marine mammals, researchers from the University of California Santa Cruz conducted an experiment looking at the energy use of bottlenose dolphins during several different activities. Using a device that allowed them to measure the animal's rate of acceleration, they were able to calculate the force generated by a dolphin's forward movement through the water, as well they energy they generate along their x-y-z axes as they maneuver around a three-dimensional space. For both activities, the researchers trained the dolphins to exhale into a hood in order to collect the exhalation to see how much oxygen the dolphins used during their exercises.

The scientists were able to create formulas to determine exactly how much energy the dolphin used during periods of both relaxed movement and faster swimming. The formulas were then used to create an energy requirement model that could be applied to other species that cannot be studied in a controlled environment.

The Curvier's beaked whale is a deep diving cetacean considered especially sensitive to anthropogenic noise. Depth-accelerometer data, which included tail stroke frequency and underwater gliding time from a previous study done by DeRuiter (2013) was used and incorporated into the energy requirement model. The model indicated that increased stroke frequency and reduced glide time in response to anthropogenic noise could cause a 30% increase in the energetic costs of the beaked whale during a flight response.

By being able to predict these energetic costs, we can gain a better understanding of the physiological impacts of ocean noise on different marine species. This is important in filling the needs of conservation efforts aimed at protecting marine mammals. If anthropogenic noise and other stressors cause animals to use more energy than they are able to acquire, then we may need to regulate noise production in the oceans.

SOURCE: Williams, T., Kendall, T. L., Richter, B. P., Ribeiro-French, C. R., John, J. S., Odell, K. L., Losch, B. A., Feuerbach, D. A., Stamper, M. A. 2017, Swimming and diving energetics in dolphins: a stroke-by-stroke analysis for predicting the cost of flight responses in wild odontocetes, *Journal of Experimental Biology* **220**, 1135-1145