

# Researchers find clue to explain how penguins know when to surface

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Image: Wikipedia

(PhysOrg.com) -- Anyone who has ever swum around near the bottom of a swimming pool, or flippered along an ocean floor for any length of time without benefit of an air supply knows that there is a decision making process going on from the moment the dive begins: when to surface?

In people, the process clearly involves some calculating. The deeper a person dives, the more time must be allotted to reach the surface. A miscalculation can result in panic, or worse tragedy. But then, people aren't exactly at home in the deep water; but [penguins](#) are. So, how do they figure out when it's time to surface? Surely they're not thinking it over the whole time, that would take away from focusing on the reason for the dive. Finding and eating fish. That's what Dr Kozue Shiomi and

his colleagues from the University of Tokyo wanted to know, so they set about studying emperor penguins to find out. As it turns out, as they explain in their paper published in *The Journal of Experimental Biology*, it's not so much about timing as it is about energy used in flapping their wings underwater to chase after prey.

Dr. Shiomi and his team studied the penguins in their two major diving environments: in open water, and when diving from and returning to a hole in the ice. In both cases, the birds were timed to see how long their foraging expeditions under the water lasted.

When fishing in open water, the ten free-rangers studied, over the course of 15,978 dives stayed under for an average of 5.7 minutes. When fishing from a hole in the ice however, the three birds under study dived 495 times but stayed under much longer, which led the researchers to believe that the penguins' decision to end their time under water wasn't about how long they'd been under at all. This led them to consider the possibility that it was based on energy expended instead, which is how they came to start counting how many times the penguins flapped their wings to propel themselves while chasing after fish.

Turns out regardless of whether the penguins are fishing in [open water](#), or through a hole in the ice, they flap on average 237 times before surfacing. Thus, it seems rather clear that they are basing their time spent under water on energy spent flapping, rather than on some predetermined time span; though, how they count and keep track, is still anyone's guess.

**More information:** Point of no return in diving emperor penguins: is the timing of the decision to return limited by the number of strokes? *J Exp Biol* 215, 135-140. January 1, 2012. doi: 10.1242/jeb.064568

## Abstract

At some point in a dive, breath-hold divers must decide to return to the surface to breathe. The issue of when to end a dive has been discussed intensively in terms of foraging ecology and behavioral physiology, using dive duration as a temporal parameter. Inevitably, however, a time lag exists between the decision of animals to start returning to the surface and the end of the dive, especially in deep dives. In the present study, we examined the decision time in emperor penguins under two different conditions: during foraging trips at sea and during dives at an artificial isolated dive hole. It was found that there was an upper limit for the decision-to-return time irrespective of dive depth in birds diving at sea. However, in a large proportion of dives at the isolated dive hole, the decision-to-return time exceeded the upper limit at sea. This difference between the decision times in dives at sea versus the isolated dive hole was accounted for by a difference in stroke rate. The stroke rates were much lower in dives at the isolated hole and were inversely correlated with the upper limit of decision times in individual birds. Unlike the decision time to start returning, the cumulative number of strokes at the decision time fell within a similar range in the two experiments. This finding suggests that the number of strokes, but not elapsed time, constrained the decision of emperor penguins to return to the surface. While the decision to return and to end a dive may be determined by a variety of ecological, behavioral and physiological factors, the upper limit to that decision time may be related to cumulative muscle workload.

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