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Pushed to the limit: food abundance determines tag-induced harm in penguins

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Abstract

*The energetic costs of animal movement change with body condition, although the consequences of this for foraging efficiency are rarely considered. We deployed externally attached devices to Magellanic penguins (*Spheniscus magellanicus*), known to increase the costs of swimming via increased drag in a consistent manner, and noted, however, that foraging behaviour and efficiency varied dramatically between years. We used our results to construct an energetics-based model and found that small increases in drag due to the attachment of externally attached tags predicted accelerating harm as prey availability decreased, which accorded with our observations. This explains earlier observations of differential breeding success in tagged versus untagged penguins in particular years, highlights the importance of understanding how animal body condition may affect population processes in general and advocates caution in interpretations of tag-derived data over variable environmental conditions.*

Keywords: *animal welfare, body condition-dependent cost of transport, drag, energy expenditure, Magellanic penguin, *Spheniscus magellanicus**