High energy expenditure at the core of a seabird's winter range: metabolic mechanisms for range limits

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Abstract

Understanding how geographic range limits are shaped is a central and challenging question in ecology that has become particularly critical in the context of global environmental changes. A central hypothesis in several theories for range limitations is that the density, fitness and performance of individuals decrease towards the edge of the range as organisms become maladapted when approaching the limit of their environmental tolerance ('Abundant-centre Hypothesis'). Energy is a critical resource, especially in winter when environmental conditions deteriorate, and this hypothesis predicts that high energy expenditure (low performance) at the range limit would lead to rapidly dwindling body mass and reduced fitness. We investigated this hypothesis in an Arctic breeding seabird wintering in the North-Atlantic, the black-legged kittiwake (Rissa tridactyla). From 2008 to 2019, we tracked 118 adult kittiwakes (n= 178 tracks) with geolocation devices and saltwater immersion sensors to estimate the time-activity budget and energy expenditure of individuals during winter, and estimated their reproductive success after their return to the colony during summer. Density was indeed higher towards the center of the range. However, contrary to the predictions, the energy expenditure of individuals was higher at the centre of the range and decreased towards the edge. In contrast, there were no spatial differences in the reproductive success of individuals wintering at the centre versus at the edge of their range. We conclude that performance and fitness did not increase towards the centre of the range, implying that although resource acquisition was likely higher at the abundant centre, energy expenditure was also higher, so that individual fitness was constant across the range.

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