AVIAN ENERGETICS IN A WARMING ARCTIC

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Study Description

The Arctic is warming nearly four times as rapidly as other regions of the planet, challenging the capacity of organisms to cope with shifting resources and maintain thermal balance. Tracking responses of free-living animals in dynamic environments can be challenging, but is increasingly enabled by advanced biologging approaches. We used data gathered from miniaturized bird-borne devices to demonstrate increases in energy expenditure with declining sea ice conditions and warming sea surface temperatures in a dove-sized seabird, the little auk (also named dovekie; *Alle alle*). This keystone species feeds on sea ice-associated copepods and inhabits large breeding colonies in the High Arctic.

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Photo 1. Little auks breed at remote sites in the High Arctic, with densely aggregated breeding colonies forming on rocky, sloped terrain, creating some challenges for fieldwork. Here, little auks at our Ukaleqarteq (Kap Höegh), East Greenland, study site rest on lichen-adorned rocks above nesting crevasses, with an excellent view. Far below, you can see the small, brick-red cabin (bottom right), which shelters teams during field campaigns funded by the French Polar Institute IPEV, as part of a long-term monitoring program. Especially in the face of climate change, little auks face considerable variation in sea ice conditions, which affects the availability of copepod prey. Note the open water—a low sea ice year. Photo credit: David Grémillet.

Photo 2. How do you track the behavior and energy use of an animal when it flies or dives out of view? We use a number of advanced biologging approaches to monitor the movement, behavior, and energy expenditure of little auks as they move between the colony, foraging sites at sea, and even wintering grounds. These approaches include triaxial accelerometers (described in the accompanying *Ecology* publication), time-depth recorders, GPSs, and GLSs. Here, a little auk equipped with a time-depth recorder poses on a rock, with a full gular pouch, indicating that it anticipates feeding its chick. To the upper right, a GLS-equipped little auk takes wing, and to the left Jérôme Fort (project co-PI) releases a GLS bird. Photo credit: Jérôme Fort (main photo and right inset) and David Grémillet (left inset).

Photo 3. Increased flight costs account for increased energy expenditure in low sea ice years, as little auks are forced to commute further to locate sea ice-associated prey. Here, little auks speckle the sky off the colony, with an iceberg in the background. Many of these birds are departing for the foraging grounds, while others may be returning from a foraging trip or circling the colony. Photo credit: Jérôme Fort.

Photo 4. Warm times, cold times. Considerable variation in weather conditions can occur during the breeding season. To the top left, a pair of little auks faces the midnight sun with an open, ice-free sound glassily visible behind them. To the top right, a bird alights at the colony in falling snow. At bottom left, a little auk at the colony looks over vanishing sea ice. At bottom right, project co-PI David Grémillet, equipped with a rifle to dissuade approach of a polar bear, stands by the on-site weather station. Phot credit: David Grémillet (upper two and lower left panels) and Melissa Grunst (lower right panel).

Photo 5. What is the purpose of modulating energy expenditure with fluctuating sea ice conditions? Very likely, to support reproductive success, which in the little auk means providing sufficient nutrients to a single chick. Here, a young little auk exercises its wings in preparation for its first flight. Photo credit: David Grémillet.

These photographs illustrate the article, "A keystone predator faces elevated energy expenditure in a warming Arctic", by Melissa L. Grunst, Andrea S. Grunst, David Grémillet, Akiko Kato, Paco Bustamante, Céline Albert, Émile Brisson-Curadeau, Manon Clairbaux, Marta Cruz-Flores, Sophie Gentès, Antoine Grissot, Samuel Perret, Eric Ste-Marie, Dariusz Jakubas, Katarzyna Wojczulanis-Jakubas, and Jérôme Fort, published in *Ecology*. https://doi.org/10.1002/ecy.4034.