

Little auk migration and feeding ecology

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Little auk is the most numerous seabird in the north Atlantic, and Greenland is estimated to hold 80 % of the world breeding population making it a species of national responsibility. In the assessment area 3.5 mill little auks were estimated to breed very concentrated at the coasts around the Scoresby Sund Polynya (Kampp *et al.* 1987).

Little has been known on ecology and key marine habitats for this little auk population. However, recently French researchers (CEFE, Montpellier) and NERI/GINR initiated studies at Kap Höegh, Liverpool Land, to investigate the ecology of this high arctic species. Main objectives are responses to a changing climate and location of important at-sea areas during the seasonal cycle.

Migration and staging areas

In the breeding season of 2007 and 2008, little auks were caught at nests and fitted with small geolocators on tarsus bands. Five geolocators were retrieved the following breeding season and recorded light regime data from the previous year were downloaded. The accuracy of the calculated positions is quite coarse, typically within approximately ± 150 km for individual locations. However, a model-based smoothing was applied to the position data, and coordinates predicted daily for each bird were connected in chronological sequence to reconstruct paths of movement during the non-breeding season (Figure 1). The daily predictions of longitude and latitude were also used for identifying staging areas.

For the five recaptured birds the median post breeding departure time from the colony was 8 August (range 25 July-13 august) while arrival the following year could be determined for three birds arriving from beginning of May to mid-June. A very remarkable result is that after breeding all birds moved towards northeast and staged in the Greenland Sea in an area between Jan Mayen and Svalbard between end of August and beginning of October. This is probably a moulting area and an important feeding area for little auks. During winter the little auks were mostly staging far offshore Newfoundland, but one bird staged most of November offshore Southwest Greenland and one bird

was south of Iceland until February when the geolocator stopped recording prematurely. This study is described in a recent paper by Mosbech *et al.* (2012).

Foraging ecology during the breeding season

The chick meals at Kap Höegh are dominated by *Calanus* copepods (95 %), and in total it has been estimated that chick-rearing little auks needed to catch about 59,800 copepods per day, which is equivalent to about six copepods caught per second spent underwater (Harding *et al.* 2009). These astonishing results underline the importance of areas with dense patches of large, energy-rich copepods to little auks. The quality of little auk foraging areas is to some extent determined by ocean temperature because the distribution and abundance of the large lipid-rich *Calanus* copepod species are associated with cold water (Falk-Petersen *et al.* 2007, Loeng & Drinkwater 2007).

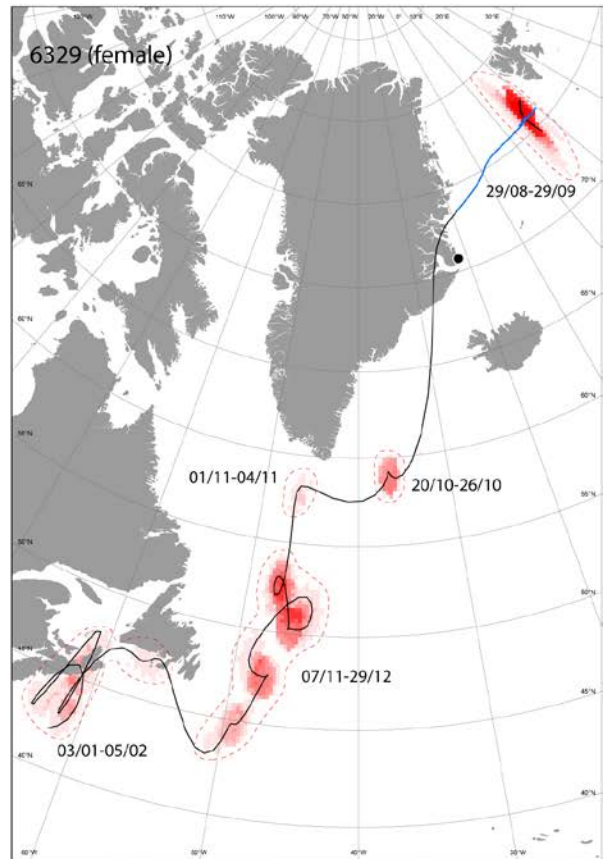
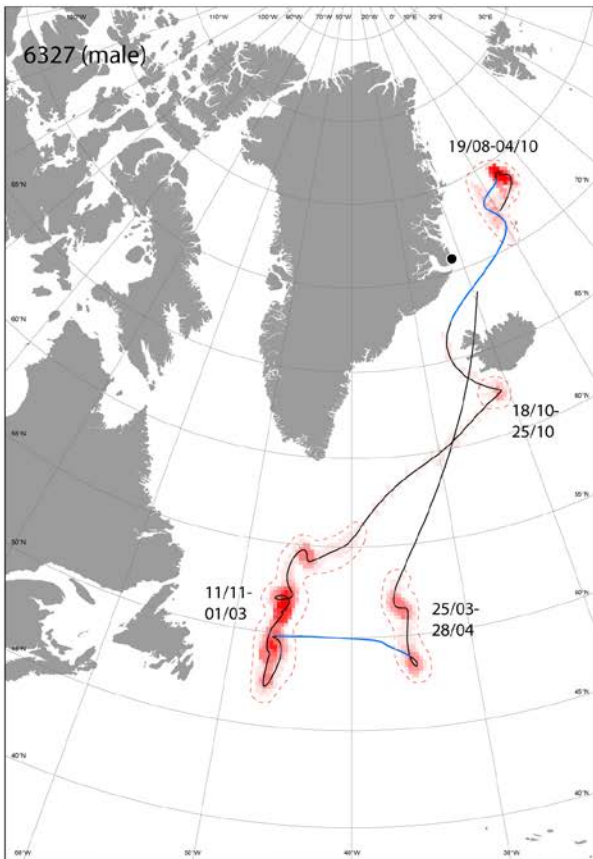
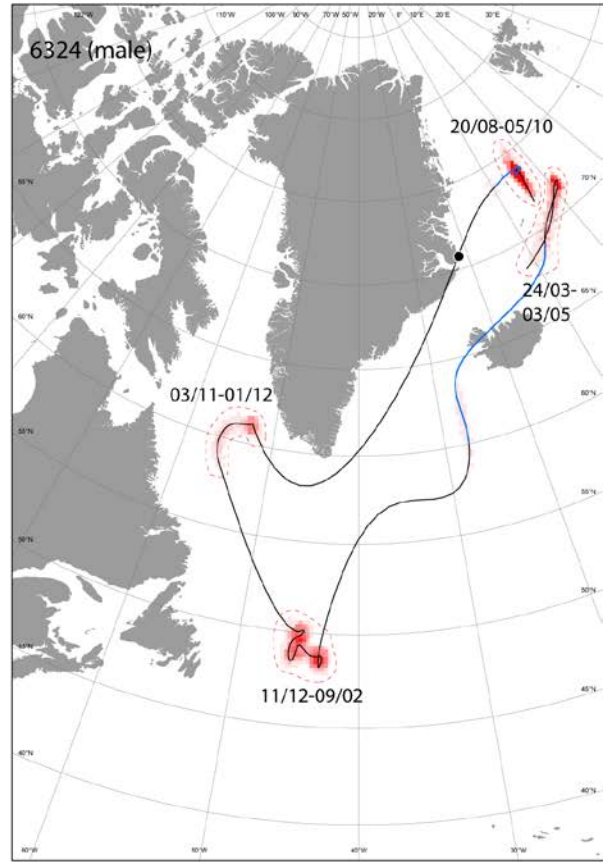
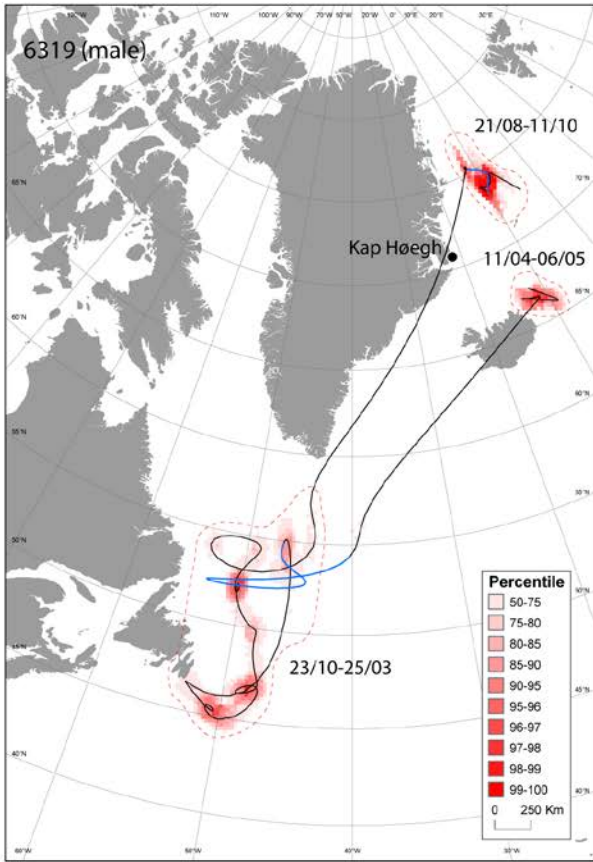
Welcker *et al.* (2009) did a comparative study of foraging ecology during chick rearing in the colony at Kap Höegh, and at three colonies at Svalbard (Hornsund, Isfjorden and Kongsfjorden). They found that at Kap Höegh compared to the three colonies at Svalbard, sea surface temperature was lower (0.34° C at Kap Höegh and between 1.96° C and 5.64° C at the Svalbard colonies), little auks spent less time foraging (80 % compared to 87-93 % at the Svalbard colonies) and their “long” foraging trips were shorter (69 ± 11 km compared to between 129 ± 16 km and 219 ± 17 km at Svalbard). These results document the good conditions at Kap Höegh for this high arctic seabird.

Foraging Ecology during the non-breeding season

New research indicates that the winter may be the real bottleneck for the little auk populations. Fort *et al.* (2010b) has shown that the winter foraging effort is twice the one measured in the breeding season (Harding *et al.* 2009) during which birds have to forage for themselves and as well as for their chicks. During winter (December-January), birds perform impressively, with hundreds of dives conducted daily (min = 234, max = 718). The mean dive duration is 45 sec (max = 73.4 sec) and mean dive depth is 12 m (max = 50.2 m). During this season, birds spent 24 % of their time diving. These results highlight the importance of resource availability for wintering little auks. They devote a high proportion of their time to capture prey and might be unable to increase their foraging effort in response to a degradation of their environment for example a change in food availability/quality.

The year-round trophic status of little auks breeding at Kap Høegh has been determined using stable isotope analyses. Little auks perform two distinct moults per year: one complete moult in autumn (September-October) that involves the replacement of the complete body plumage, and a partial moult in winter (March) when only feathers from the neck and head are replaced. Analysing blood, 'head feather' and 'body feather' samples collected on breeding birds, makes it possible to establish the trophic status and isotopic niche of little auks during summer, autumn and winter (Fort *et al.* 2010a). Briefly, birds showed a strong inter-seasonal variation in trophic status, suggesting an important dietary shift between summer and autumn, and between autumn and winter. These changes are most likely due to a modification of food availability in the upper layer of the water column. Soon after summer, copepods (including *Calanus* spp. species), which are the favourite prey of little auks, are known to perform a vertical migration to depths of several hundred meters to undergo diapause, thereby becoming inaccessible to the birds, which can only dive to 50 m (Fort *et al.* 2010b, see below). During autumn, little auks are thus expected to feed on alternate prey. For instance, larger, energy-richer amphipods feeding at higher trophic levels might be consumed by little auks in early autumn (Stempniewicz 2001). In winter (March), the birds displayed a second dietary shift and fed at low trophic levels similar to those of summer (similar $\delta^{15}\text{N}$). Measured winter $\delta^{15}\text{N}$ values are in agreement with birds preying upon copepods (Sato *et al.* 2002, Karnovsky *et al.* 2008) which migrate back to surface waters following the phytoplankton bloom. This bloom occurs from February off Newfoundland (Henson *et al.* 2009), and copepods might therefore be available to diving little auks during their winter moult in this region. Such information notably highlights the ability of little auks to modulate their feeding ecology depending on the temporal availability of their prey and also to exploit a wide range of prey, ranging from calanoid copepods to fish larvae. The information is also essential to understand how this species responds to a constraining and changing environment, notably in the context of climate change already leading to a modification of prey/zooplankton availability/quality in North Atlantic waters (Beaugrand *et al.* 2010).

The results of study were published in this paper: Fort, J., Moe, B., Strøm, H., Gremillet, D., Welcker, J., Schultner, J., Jerstad, K., Johansen, K.L., Phillips, R.A., & Mosbech, A. 2013. Multicolony tracking reveals potential threats to little auks wintering in the North Atlantic from marine pollution and shrinking sea ice cover. – *Diversity and Distributions* 19: 1322-1332. DOI: 10.1111/ddi.12105.



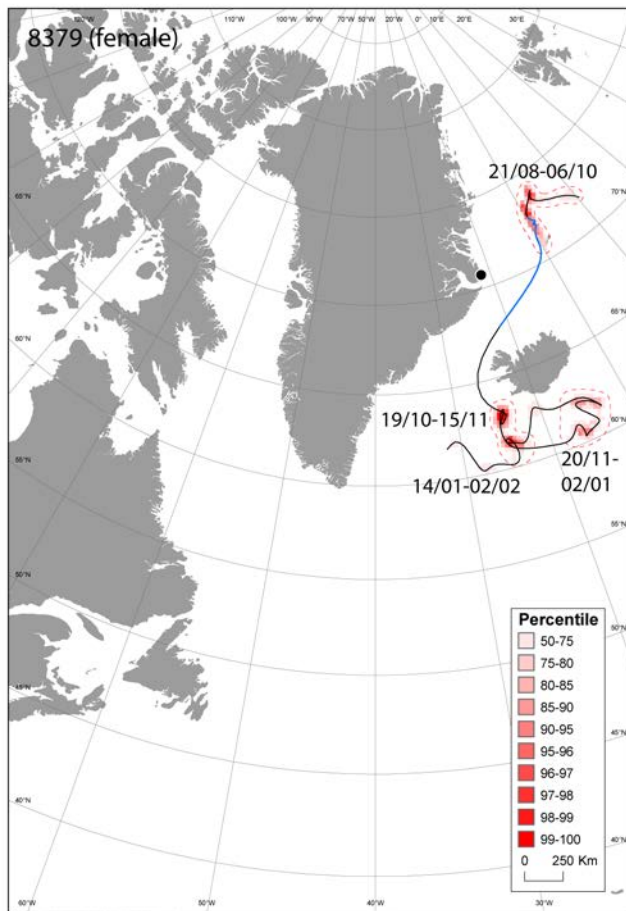


Figure 1. Path of movement of 5 little auks (3 males and 2 females) equipped with a geolocator at the breeding colony Kap Höegh near Scoresby Sund in 2007 (4) and 2008 (1, ID 8379). All birds were recaptured a year after deployment. The maps show the most likely track for each bird based on modelling of a daily location. Blue sections of the path highlight equinox periods where latitude data are unreliable. The red areas indicate staging areas estimated as a relative measure of duration of stay taking into account the uncertainty of the locations. A very remarkable result is that after breeding, all birds moved towards northeast and staged between Jan Mayen and Svalbard from the end of August to the beginning of October.

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