Post-fledging movements of Atlantic Puffins from Skomer Island

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Abstract

The movements of seabirds during the immature period generally remain poorly understood, primarily due to the challenges involved with tracking birds that do not regularly return to a nest. This knowledge gap prevents us from gaining a full understanding of the areas used by seabird populations. Here, we attempted to track the post-fledging movements of Atlantic Puffins *Fratercula arctica* from Skomer Island (Wales, UK), by deploying geolocators on chicks ready to leave the nest. Despite our very small return rate (just two loggers out of 54, recording 485 and 196 days of data after fledging, respectively), our results provide a first glimpse into the distribution and scale of movements of young Puffins after fledging. The young Puffins undertook movements comparable in scale to those of post-breeding adults, and there were considerable differences between the two individuals. New initiatives to track juvenile seabirds in much larger numbers will hopefully soon provide more insight into seabird post-fledging movements.

Introduction

Advances in tracking technology and the miniaturisation of devices since the early 2000s have transformed our understanding of seabirds' migratory and non-breeding movements, especially through the use of geolocation devices. Although gaps remain, we now have good basic knowledge of the non-breeding movements of many pelagic seabird orders across most oceans, from the very large albatrosses (Weimerskirch & Wilson 2000) to the smallest storm petrels (Militão *et al.* 2022). The largest of the remaining knowledge gaps concerns the non-breeding movements of juvenile and immature individuals. Due to their long breeding deferral, low survival (compared to adults) and lower site philopatry, using archival geolocators to track the movements of seabirds after they fledge is time-consuming and expensive, as many loggers need to be deployed in order to recover a few, several years later. For these reasons, logger deployments on fledglings have rarely been attempted. Nevertheless, a small number of successful attempts have provided useful insight into post-fledging or immature movements, for example in shearwaters (Campioni *et al.* 2020; Wynn *et al.* 2022). Satellite transmitters are an alternative option, and have been used successfully to track juveniles in a range of species (Wienecke *et al.* 2010; Yoda *et al.* 2017; Lane *et al.* 2021; Frankish *et al.* 2022), but they can be heavier and/or require deployment with a harness, which can be challenging for seabirds, especially pelagic species (Phillips *et al.* 2003).

Understanding the at-sea movements of young seabirds after fledging and until they start breeding is necessary to gain a full understanding of a species' use of different sea areas. Such knowledge is essential for effective seabird conservation, as differences in distribution and behaviour between young and adult birds can lead to differential exposure to threats (Roman *et al.* 2020; Weimerskirch *et al.* 2023). This is especially important because juvenile and immature individuals can make up a high proportion of a population and have a large influence on population dynamics (Sæther *et al.* 2013), including demographic responses to environmental change (Monaghan 2007; Fay *et al.* 2017).

Here, we report on the attempt to track the post-fledging movements of Atlantic Puffins *Fratercula arctica* (hereafter Puffins) from Skomer Island, Wales, which holds the largest Puffin colony in Wales with around 15,000 breeding pairs. Puffins are a migratory species with large interpopulation differences in non-breeding distribution (Fayet *et al.* 2017). On Skomer, the adults have a dispersive migration, with different birds employing different migration routes and destinations with high individual repeatability (Fayet *et al.* 2016). To test whether this dispersive pattern arises during early life, we attempted to track the movements of chicks in their first few years of life. Our small sample size does not allow us to answer this question, but nevertheless provides novel insight into the movements of juvenile Puffins after they leave their natal burrow.

Methods

Fieldwork took place in July 2012 and 2013 on Skomer Island, Wales, UK (51°44'N, 5°19'W). Ethical approval was obtained from the British Trust for Ornithology, Natural Resources Wales, the Skomer Island Advisory Committee, and the University of Oxford Animal Welfare and Ethical Review Board. We caught 54 Puffin chicks that were close to fledging were by hand in the nest and fitted them with a metal ring and a geolocator (Biotrack, Mk4083) on a plastic ring (Figure 1). The device and attachment were < 2 g, i.e. < 0.7% of the bird's body mass on average. Bird handling time was kept to a minimum and was always under 10 minutes.

In the following years, three birds were resighted, i.e. a 5.6% resighting rate. The return rate of immature Puffins to Skomer, though difficult to estimate, is thought to be around 10–15% (Ashcroft 1979), so we expected to resight 5–8 birds. However, a Puffin mass mortality event in the Northeast Atlantic in the 2013-14 winter affected numerous adult and immature birds from Skomer (Morley *et al.* 2017) and led to a 20% drop in adult survival on Skomer the following year (Stubbings *et al.* 2016). It is very likely that this event also reduced immature survival and is therefore the cause of our low resighting rate.

Of the three resightings, one bird was seen alive on Skomer, where it has been seen in the colony every year from 2017 to 2022 but could not be recaptured, and two birds were recovered dead. One chick from the 2013 cohort (hereafter Bird 1) was recovered dead on Martin's Haven beach in Pembrokeshire, a few kilometres from Skomer Island, in summer 2015, over 700 days after fledging. The logger had stopped recording in late 2014, recording 485 days of data after fledging. A fledgling (hereafter Bird 2) from the 2012 cohort was recovered on a beach in Brittany, France (Phare d'Eckmühl, 47°47'N, 4°13'W), in February 2014, 584 days after its fledging date, during a large Puffin wreck along the French coast (Morley *et al.* 2017). The logger had stopped functioning before the bird died and recorded the bird's first 196 days after fledging. As part of a long-term study of adult Puffin migration on Skomer Island, the parents of Bird 1 were also tracked with geolocators for several years from 2014.

The light data were processed using the BASTrack software suite (British Antarctic Survey) to obtain locations. Erroneous locations were filtered out following a similar process to that used by Fayet *et al.* (2016). Locations 10 days on the spring side and 14 days on winter side of each equinox were also removed. Note that the remaining locations can still have an accuracy of ~180 km (Phillips *et al.* 2004). The monthly locations shown in Figure 2 were calculated by taking the mean latitude and longitude of all remaining daily locations within each month, provided there were six or more daily locations available for a given month.

Immersion data (measured as a proportion of time immersed per 10-minute window) were used to detect fledging date (first immersion in the sea), and date of death for Bird 2 (last flight). Immersion data were also used to calculate the time spent in flight each day, combining methods from Fayet *et al.* (2016) and Darby *et al.* (2022). This was estimated as the total time spent dry during daytime, excluding (1) measurements of time spent dry but with reduced light levels, and (2) measures either side of these, as they are most likely an indication of leg-tucking behaviour. Dry time during nighttime was not taken into account as it often results from birds tucking their leg under their wing (Fayet *et al.* 2016). There is much less leg tucking during daytime, so it is possible to use this measure of dry time as a proxy for time in flight. This is supported by the fact that the proportions of flight time calculated here match those calculated in adults using GPS (Global Positioning System) devices (Fayet *et al.* 2021) or using a dual tagging method with one geolocator on each leg (Darby *et al.* 2022). Nevertheless, our method may not remove all instances of leg tucking during daytime, so our calculations of flight time may still be overestimates (Darby *et al.* 2022).

Figure 1. Young Atlantic Puffin *Fratercula arctica* fitted with a geolocator shortly before fledging from Skomer Island, Wales. © *A. Fayet.*

Results

The two young Puffins both undertook large-scale, but distinct, movements after fledging in July (Figure 2). Bird 1 stayed close to southwestern UK and Brittany for the first three months (July to September), then moved towards northern Scotland until November, before returning to the English Channel for the rest of the winter. It then spent the spring in the Bay of Biscay and in the Atlantic Ocean southwest of Ireland. In its second year, it spent the five months the logger still functioned along the coast of Great Britain in the Irish and Celtic Seas, mainly around northwest Scotland. Bird 2 undertook even larger movements in its first seven months, taking a long northwest anticlockwise loop in the north Atlantic, visiting waters both further west, and further north, than Iceland.

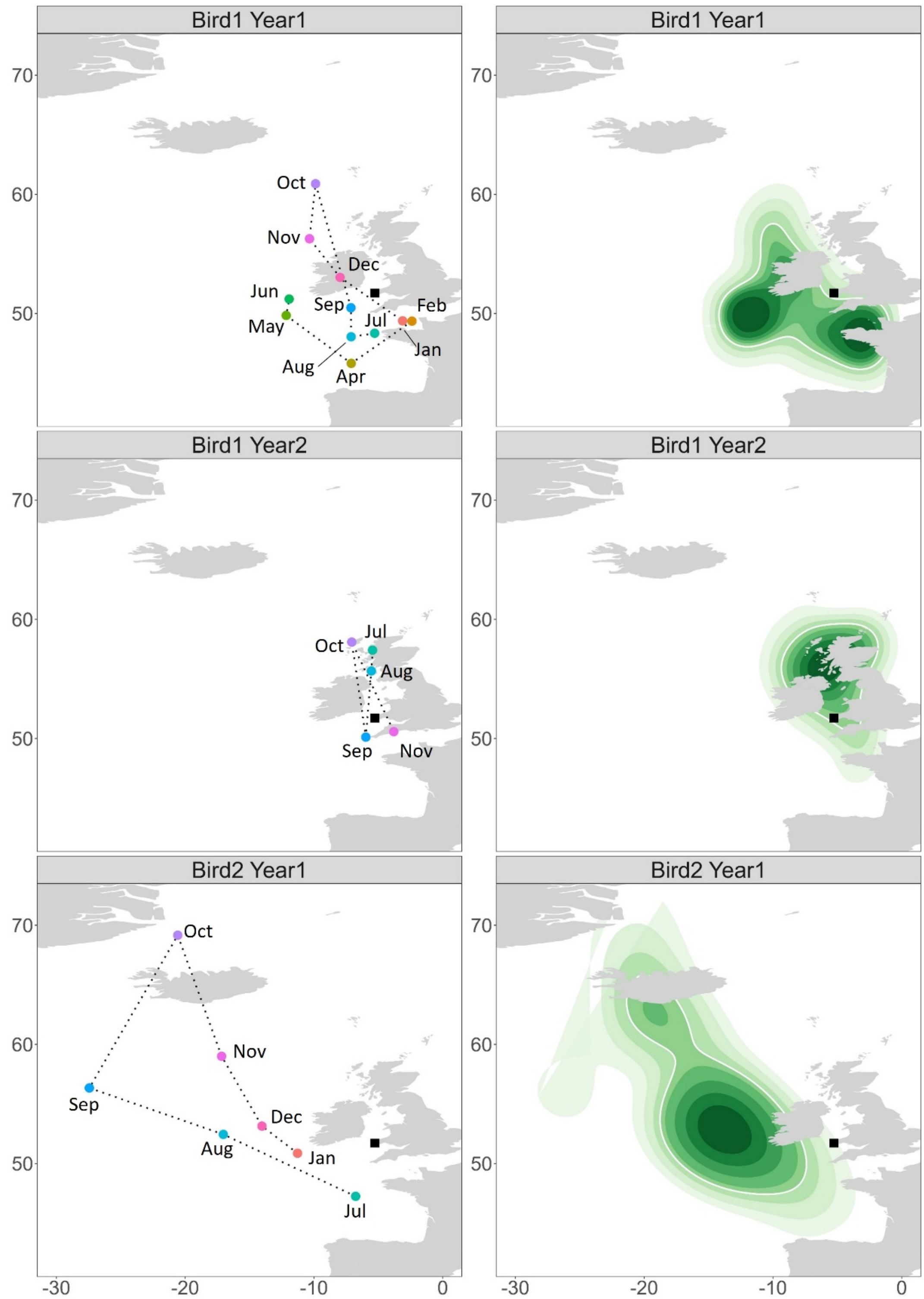

Figure 2. Distribution of two Atlantic Puffins *Fratercula arctica* from Skomer Island, Wales (black square) in the first year (top and bottom row) and second year (middle row) after fledging. The left-hand panels show the average position for each month, the right-hand panels the density distributions (90% in light green to 10% in dark green) for each period, with the core area (50% contour) highlighted with a white line. Note that positions on land are caused by the inherent inaccuracy of the geolocator system and do not mean that the bird was on land. There are no points for March as too few datapoints remained after filtering out inaccurate locations caused by the spring equinox.

The time that the two young Puffins spent in flight during daytime varied considerably over time (Figure 3). Both birds showed similar activity patterns during the first seven months of life (after which only one device continued to record), spending on average 30–90 minutes per day in flight from fledging during the first few months (until September), followed by a marked decrease in flight from October onwards, with almost no flight at all in the winter, except for one or two short peaks. For Bird 1, whose logger continued to record, flight increased again in spring and peaked over the bird's second summer, before decreasing again the following autumn. The data shown as a proportion of daytime is shown in Figure S2.

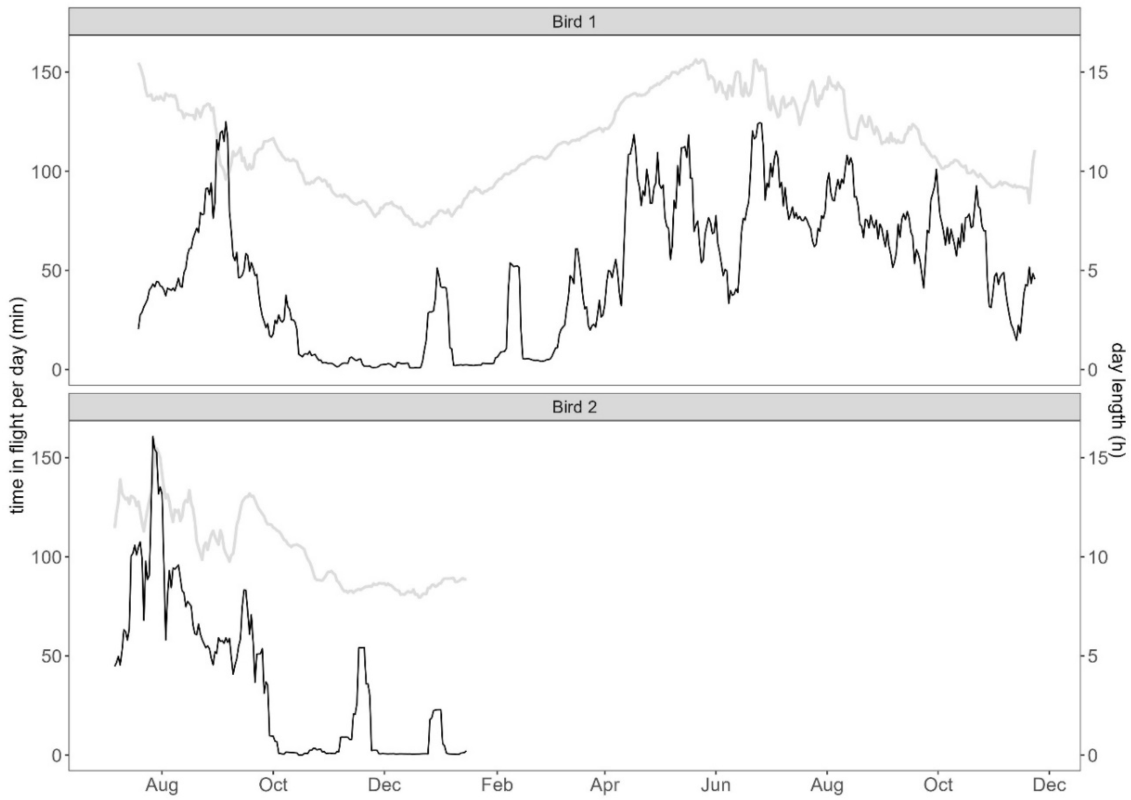

Figure 3. Time in flight per day (in black) calculated as a seven-day rolling average for each Atlantic Puffin *Fratercula arctica* from Skomer Island, Wales from its first fledging date until the device stopped recording. Day length at the location of the bird is shown in light grey.

Discussion

Despite its very limited sample size, our study reveals notable findings about the movements of Puffins in early life. First, it shows that juvenile Puffins can undertake movements on a scale comparable to the movements of adults in the months after fledging (Fayet *et al.* 2016), hundreds or even thousands of kilometres away from their natal colony. This confirms findings from ringing recoveries of first-year birds, which, although relatively scarce, have often been recorded far from natal colonies (Harris 1984). Like those of adults, recoveries of young birds ringed in western Britain are concentrated on the British, French and Spanish coasts (Harris 1984), but our study shows that juvenile birds may also make use of waters further west in the North Atlantic, which are also important areas for adult birds from multiple colonies (Harris *et al.* 2010; Jessopp *et al.* 2013; Fayet *et al.* 2017). Like adults from the same colony (Skomer Island), neither juvenile visited the North Sea.

Our results support findings of other tracking studies of flying seabirds, which found similar large-scale post-fledging movements in shearwaters, gannets and albatrosses (Yoda *et al.* 2017; Lane *et al.* 2021; Frankish *et al.* 2022). Despite the higher flight costs of Puffins compared to these species, both of the birds in our study spent a non-negligible amount of time in flight in the months after fledging (up to 60–90 minutes per day, although these numbers may be overestimates caused by noise driven by leg-tucking behaviour), which is consistent with the relatively long movements they undertook. The almost flightless period observed for both birds in October and November may be to do with moult, and is consistent with our (incomplete) knowledge of the timing of moult in adult birds (Harris *et al.* 2014; Darby *et al.* 2022).

Another interesting result is the difference in movements between the two birds, suggesting marked individual differences. While one bird headed straight out to the mid-Atlantic, the other spent several months closer to the Celtic Sea. Although these movements were recorded one year apart, and we cannot therefore rule out the birds simply responding to local conditions such as wind strength and direction. Similar differences exist in the adult post-breeding movements from Skomer (Fayet *et al.* 2016). The two parents of Bird 1 showed a similar, relatively local migration strategy (Appendix 1), but without additional data we cannot conclude whether this is a coincidence or not. Regardless, this difference between the two juveniles from the onset of fledging suggests that juvenile Puffins on Skomer do not have an inherited vector migration, unlike some shearwaters (Yoda *et al.* 2017; Wynn *et al.* 2022). The similarity in locations during September and October in Bird 1 over two consecutive years also weakly suggests a potential repeatability of movement strategies over the years. The dispersive but highly repeatable migration of adult Puffins on Skomer has been proposed to derive from exploratory movements of young Puffins, refined over the immature period (Guilford *et al.* 2011), and while our results do not allow us to properly test this hypothesis, they seem to support it.

Although our dataset does not allow us to draw robust conclusions about the distribution of Puffins in early life, our study sheds light on the large-scale area use of birds from the moment they fledge, which is likely largely underestimated here, given the marked differences we found between just two birds. Where juvenile and immature Puffins spend their time at sea will affect the threats they face and how vulnerable they may be to events such as cyclones (Reiertsen *et al.* 2021), so it is important to study their distribution more thoroughly. With no satisfactory harness solution yet found for diving seabirds, leg deployment of archival loggers remains to date the only option for tracking young Puffins at sea for any length of time. New initiatives to track juvenile seabirds in large numbers, such as that of the SEATRACK programme in the North Atlantic (https://seapop.no/en/seatrack), will hopefully bring answers in the near future. Such initiatives will be essential to fill gaps in our knowledge of the at-sea distributions of young individuals, while also shedding light on the ontogeny of migration routes in pelagic seabirds.

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Data availability

The data are available on the BirdLife Seabird Tracking database (https://www.seabirdtracking.org).

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Appendix 1

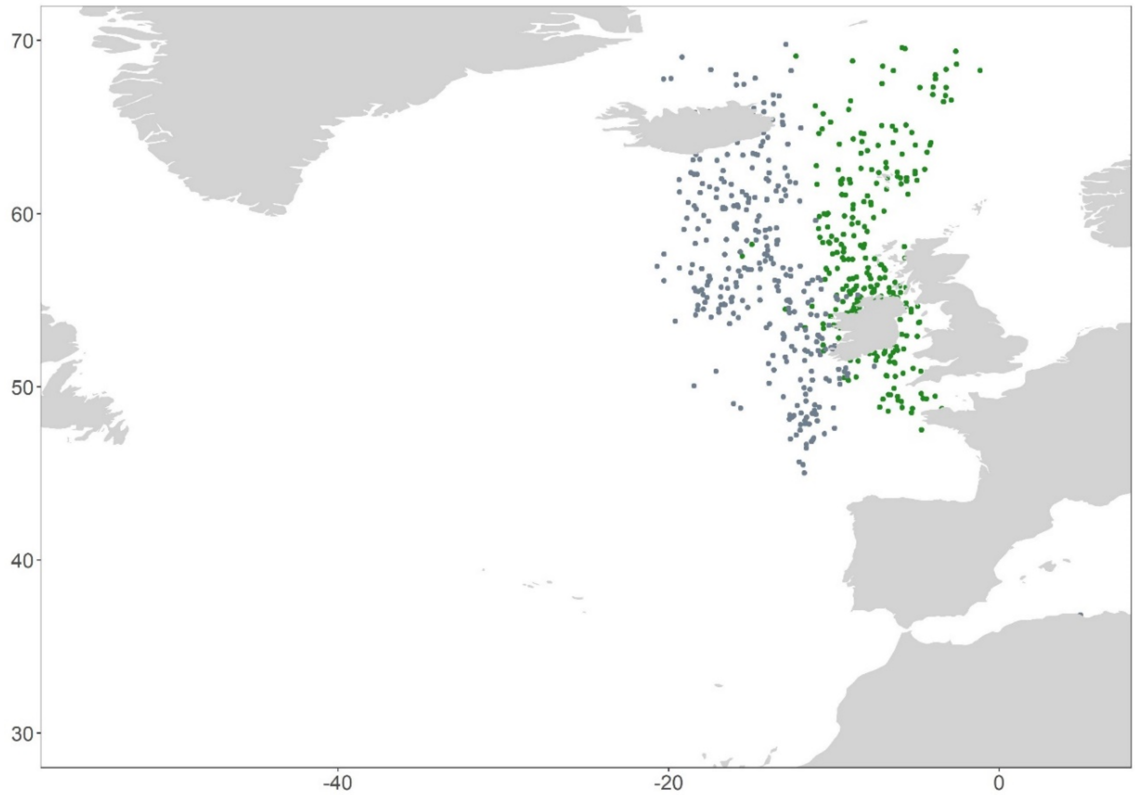

Figure S1. Daily locations of the two parents of Bird 1, an Atlantic Puffin *Fratercula arctica* from Skomer Island, (male in green, female in dark grey) during the 2014/15 post-breeding season.

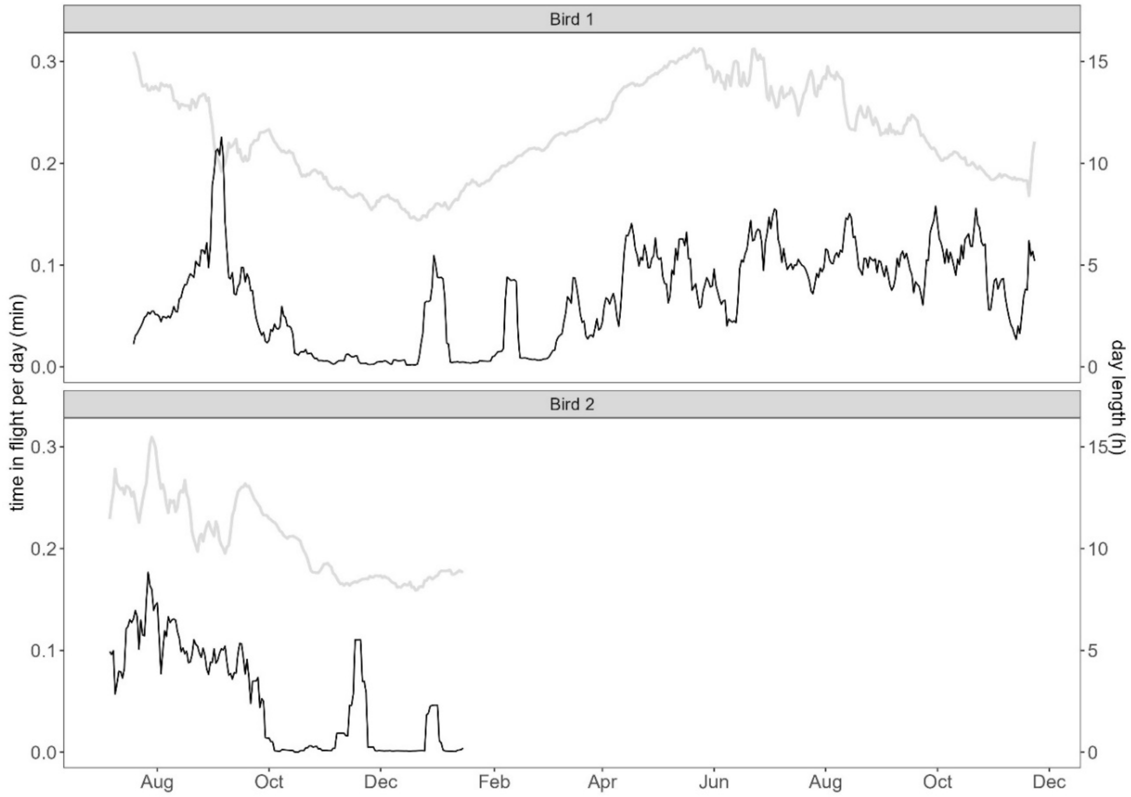

Figure S2. Proportion of daytime spent in flight per day (in black), calculated as a seven-day rolling average for each Atlantic Puffin *Fratercula arctica* from its first fledging date until the device stopped recording. Day length at the location of the bird is shown in light grey.