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2 **Geolocators reveal an unsuspected moulting area for Isle of May**
3 **Common Guillemots *Uria aalge***

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19 **Capsule** Data from geolocators deployed on adult Common Guillemots from a colony in southeast
20 Scotland indicated that they normally winter in the North Sea up to 1000 km southeast of the colony.
21 However, one bird unexpectedly moved 3000 km northeast to moult in the Barents Sea.

22

23 Ringing has shown that adult Common Guillemots *Uria aalge* from the Isle of May, southeast
24 Scotland (56°11'N, 2°33'W, c.15,000 pairs in 2010) disperse outside the breeding season with
25 recoveries along coasts from Shetland and southwest Norway, south to the Bay of Biscay and west to
26 southern Ireland but with concentrations along the southern and western shores of the North Sea
27 (Fig. 1; Reynolds *et al.* 2011). Such recoveries give a general picture of distribution but probably
28 under-represent birds wintering well offshore since birds dying there are unlikely to be reported and
29 the distribution of those that are found will be highly biased towards locations with accessible
30 coastlines that are regularly visited by members of the public. However, the development of miniature
31 ring-mounted geolocators has revolutionized our ability to track seabirds that winter in remote regions
32 and/or well away from land and has produced spectacular results that would have been impossible
33 with traditional ringing (Egevang *et al.* 2010, Mosbech *et al.* 2012, Stenhouse *et al.* 2012). We
34 therefore deployed geolocators on Guillemots breeding on the Isle of May to obtain wintering
35 distributions to check if they highlighted the use of previously unsuspected areas.

36

37 Adults with chicks on the Isle of May were caught using a noose attached to a 3-m pole or
38 lowered over the head using a fishing rod in June 2011 ($n = 40$), 2012 ($n = 25$) and 2013 ($n = 40$).
39 Birds were caught in five sub-colonies where catching caused minimal disturbance. Each bird was
40 equipped with a geolocator (British Antarctic Survey, Cambridge, UK Mk15 in 2011 & 2012; Biotrack,
41 Dorset, UK, Mk3006 in 2013) attached to a plastic ring (combined weight 3.5g or $<0.4\%$ the mass of
42 the adults on which they were deployed) placed on one leg and a B.T.O. ring on the other leg. The
43 procedure took less than 3 min and most birds returned to the ledge immediately. To minimize
44 disturbance we did not wait in the colony until we had seen all the birds come back or record whether
45 individual birds fledged chicks. Seventy geolocators were retrieved in subsequent years, providing
46 information on the winters of 2011-12 (25 birds), 2012-13 (14 birds) and 2013-14 (22 birds). Each
47 year, some additional birds with loggers were present in the sub-colonies but were not caught since
48 this is an ongoing study and we wished to leave some devices on for several winters.

49 Light data from the geolocators were processed using the BASTrak software package (Fox
50 2010). We inspected daily light curves and estimated the timing of dawn and dusk using a threshold
51 of 10. Latitude, derived from day or night length, and longitude, derived from the timing of local
52 midday or midnight, were calculated using a sun elevation angle of -3° and the compensate
53 movement function (Fox 2010). Latitudes are unreliable around the equinoxes so positions 7
54 September to 19 October and 24 February to 5 April were excluded. Average error is in the order of
55 ± 200 km for geolocators (Phillips *et al.* 2004) so for birds with coastal distributions many positions will
56 be on land and such positions were not filtered out. However, a few clearly unrealistic positions ($<1\%$
57 of all locations), such as short-term (1 or 2 day) 'spikes' deviating >750 km from the core distribution of
58 an individual's location or track, were removed. Winter was defined as 20 October to 23 February and
59 kernel density maps for this period were produced in R 3.0.3 (R Development Core Team 2014).
60 Utilization distributions were estimated using Kernel density distribution with the "kernelUD" function in
61 the "adehabitat" package (Calenge 2006).

62 Between 1981 and 2013, 3,818 full grown and 13,430 young Guillemots were ringed on the
63 Isle of May giving 149 recoveries of birds 4 or more years old during the winter (defined as October-
64 March). This was a slightly longer period than used for the geolocators to allow for the likely delay
65 between a ringed bird dying and being found and reported. These recoveries were plotted along with
66 the 95, 75 and 50% kernel density contours using the same methods as for the geolocators. The

67 function “kerneloverlap” in the “adehabitat” package (Calenge 2006) was used to calculate the
68 proportional overlap between the 50% Kernel density estimations for geolocator positions and ringing
69 recoveries shown in Figure 1.

70 The winter range of Isle of May Guillemots as shown by geolocators covered the entire North
71 Sea, the Kattegat, the seas just north of Scotland and the very southern Norwegian Sea (Fig. 1a).
72 However, the core area was the central, western and southern parts of the North Sea. The winter
73 distribution as indicated by the ringing recoveries was similar, with a proportional overlap of 45% of
74 the 50% kernels (the core area), although slightly more extensive, especially through the English
75 Channel and into the Bay of Biscay (Fig. 1b). This might have been due to the much larger sample
76 size for recoveries since one bird with a geolocator was found dead in Charente-Maritime, France
77 ($45^{\circ} 41'N$, $1^{\circ} 14'W$) in February 2014. Its geolocator had ceased functioning so the bird was treated
78 as a ringing recovery and is the southernmost recovery plotted in Figure 1b. Thus, overall the
79 geolocator results indicated that Guillemots from the Isle of May made considerable use of the open
80 sea, at least in the southern North Sea where the waters are relatively shallow.

81 However, one bird did something unexpected (Fig. 2). This individual had been ringed as a
82 chick on the Isle of May in 2001 and so was 12 years old when the geolocator was deployed on 26
83 June 2013 in the same sub-colony as it was ringed and had also been recorded breeding in 2008.
84 Data from the geolocator indicated that during July 2013 the bird moved away from the Isle of May
85 into the northern North Sea so that by 31 July it was off the coast of Norway at $c.65^{\circ}N$. It continued to
86 move north but since the light intensity at these latitudes is constantly higher than the dusk/dawn
87 threshold of the geolocator at this time of the year, there were no further fixes until 20 August. By this
88 date the bird had rounded the North Cape and was in the Barents Sea, presumably with the large
89 numbers of Guillemots from colonies in North and Central Norway that occur here at this time (Barrett
90 & Golovkin 2000). It remained in the Barents Sea for two months before leaving on 25 October, was
91 back at $65^{\circ} N$ four days later and in the North Sea east of the Isle of May by 4 November. The bird
92 spent the remainder of the winter in the northern North Sea and around southwest Norway (Fig. 2).
93 There have been 754 recoveries of Guillemots ringed on the Isle of May but none of these has been
94 north of the Arctic Circle which makes this bird quite exceptional.

95

96 We did not know when the Barents Sea bird left the colony but in 2013 most breeding
97 Guillemots were last seen at their sites between 5 and 10 July. Following breeding, Common
98 Guillemots and Brünnich's Guillemots *Uria lomvia* undergo a full moult during which they are
99 flightless. Observations of captive Common Guillemots suggest that this lasts for 4-6 weeks (Birkhead
100 & Taylor 1977), whereas data-loggers deployed on Brünnich's Guillemots suggested a period of 9-11
101 weeks (Elliott & Gaston 2014). The only place that the geolocator bird could have been incapable of
102 flight for more than 4 weeks was when it was in the Barents Sea after its northeastward migration of
103 c.3000 km. This behaviour contrasts with that of Brünnich's Guillemots that became flightless within
104 days of leaving the colony (Elliott & Gaston 2014). Guillemots breeding on the Isle of May visit their
105 breeding sites during the late autumn (Harris & Wanless 1989) and Guillemots were seen on the
106 ledges on 8 November 2013 (Matt Bivins pers. comm.). This Barrent's Sea visitor returned to the
107 general vicinity of the Isle of May at this time,so it could well have visited its breeding site. In contrast,
108 fixes between December and February suggested that the bird was usually well away from the
109 colony, behaviour that accords with normal year-round patterns of attendance on the Isle of May
110 (Harris & Wanless 1984).

111 While the areas used in autumn and winter by this Isle of May bird was exceptional for this
112 population, they were remarkably similar to those of Guillemots breeding at Sklinna, Central Norway
113 (65°13'N, 10°58'E). Birds from this colony initially move north to the Barents Sea, move south in the
114 late autumn or early winter to waters of southern Norway and occasionally enter the northern North
115 Sea (Lorentsen & May 2012, personal data). Although Guillemots are highly philopatric, ringing of
116 chicks has shown that small numbers do recruit to colonies well away from where they were hatched.
117 For instance, eight chicks ringed in northern Scotland and the Western Isles have been recorded
118 when they were five or more years old in the breeding season at the Norwegian colonies of Sklinna,
119 Heryken, (67°26'N, 11°52'E), and Hornøya (70°23'N, 31°09' E) and were, or could potentially have
120 been, breeding (S-H. Lorentsen pers. comm., T. Anker-Nilssen pers. comm., R.T Barrett pers.
121 comm.). However, we know that the geolocator bird had been reared on the Isle of May so was
122 definitely not an immigrant from Norway. Guillemots ringed in the far north of Scotland have been
123 recovered in the autumn and winter along the coast of Norway up to the Barents Sea (Harris & Swann
124 2002, Robinson & Clark 2014) so deployment of geolocators on Guillemots in colonies in Shetland
125 may well indicate that the Barents Sea is an important moulting are for these populations.

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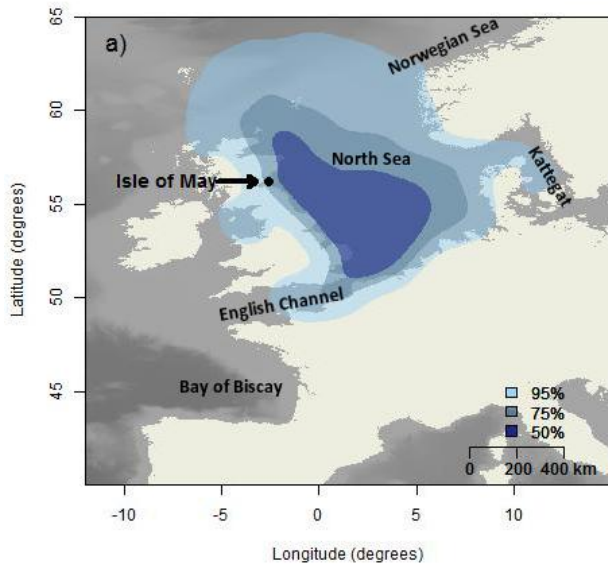
132 **REFERENCES**

- 133 **Barrett, R. T. & Golovkin, A. N. 2000.** Common Guillemot *Uria aalge*. In Anker-Nilssen, T., Bakken,
134 V., Strøm, H., Golovkin, A. N., Bianki, V. V. & Tatarinkova, I. P. e. (eds) *The Status of the*
135 *Marine Birds breeding in the Barents Sea Region*: 114-118. Norsk Polarinst. Rapp. Ser. 113.
136 Norwegian Polar Institute, Tromsø.
- 137
- 138 **Birkhead, T. R. & Taylor, A. M. 1977.** Moults of the Guillemot *Uria aalge*. *Ibis* **119**: 80-85.
- 139
- 140 **Calenge, C. 2006.** The package adehabitat for the R software: a tool for the analysis of space and
141 habitat use by animals. *Ecol. Model.* **197**: 516-519.
- 142
- 143 **Egevang, C., Stenhouse, I. J., Phillips, R. A., Petersen, A., Fox, J. W. & Silk, J. R. D. 2010.**
144 Tracking of Arctic terns *Sterna paradisaea* reveals longest animal migration. *Proc. Natl. Acad.*
145 *Sci. U.S.A.* **107**: 2078-2081.
- 146
- 147 **Elliott, K.H. & Gaston, A.J. 2014** Dive behaviour and daily energy expenditure in Thick-billed Murres
148 *Uria lomvia* after leaving the breeding colony. *Mar. Ornith.* **42**: 183-189.
- 149
- 150 **Fox, J.W. 2010.** *Geolocator Manual v8 (March 2010)*, British Antarctic Survey, Cambridge.
- 151
- 152 **Harris, M. P. & Swann, R. L. 2002.** Common Guillemot (Guillemot) *Uria aalge*. In Wernham, C. V.,
153 Toms, M., Marchant, J. H., Clark, J. A., Siriwardena, G. M. & Baillie, S. R. (eds.). *The*
154 *Migration Atlas; movements of the birds of Britain and Ireland*, 397-400. T. & A.D. Poyser,
155 London.
- 156
- 157 **Harris, M. P. & Wanless, S. 1984.** The effect of the wreck of seabirds in February 1983 on auk
158 populations on the Isle of May (Fife). *Bird Study* **31**: 103-110.
- 159
- 160 **Harris, M. P. & Wanless, S. 1989.** Fall colony attendance and breeding success in the Common
161 Murre. *Condor* **91**: 139-146.
- 162
- 163 **Lorentsen, S.-H. & May, R. 2012.** Inter-breeding movements of common guillemots (*Uria aalge*)
164 suggest the Barents Sea is an important autumn staging and wintering area. *Polar Biol.* **35**:
1713-1719.
- 165
- 166 **Mosbech, A., Johansen, K. L., Bech, N. I., Lyngs, P., Harding, A. M. A., Egevang, C., Phillips, R.**
167 **A. & Fort, J. 2012.** Inter-breeding movements of little auks *Alle alle* reveal a key post-
breeding staging area in the Greenland Sea. *Polar Biol.* **35**: 305-311.
- 168
- 169 **Phillips, R. A., Silk, J. R. D., Croxall, J. P., Afanasyev, V. & Briggs, D. R. 2004.** Accuracy of
170 geolocation estimates for flying seabirds. *Mar. Ecol. Prog. Ser.* **266**: 265-272.
- 171 **R Core Development Team. 2014.** *R: A language and environment for statistical computing.* R
172 *Foundation for Statistical Computing*, Vienna, Austria. Available at: <http://www.R-project.org/>.
- 173

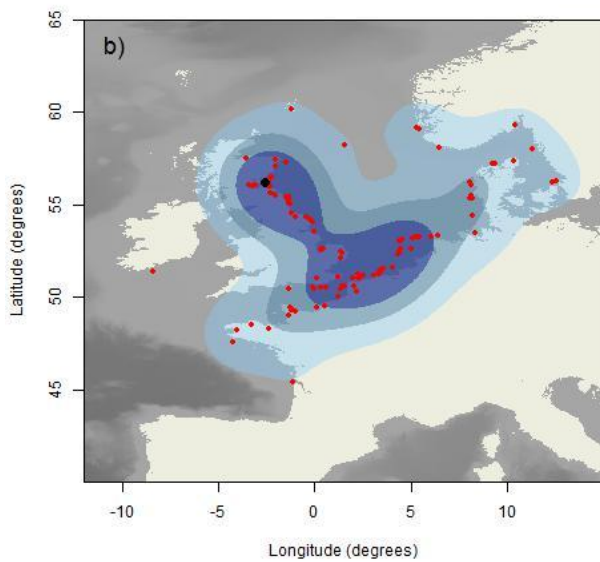
174 **Reynolds, T. J., Harris, M. P., King, R., Swann, R. L., Jardine, D. C., Frederiksen, M. & Wanless,**
175 **S.** 2011. Among-colony synchrony in the survival of Common Guillemots *Uria aalge* reflects
176 shared wintering areas. *Ibis* **153**: 818-831.
177
178 **Robinson, R.A. & Clark, J.A.** 2014. The Online Ringing Report: Bird ringing in Britain & Ireland in
179 2013. BTO, Thetford (<http://www.bto.org/ringing-report>, created on 30-May-2014).
180
181 **Stenhouse, I. J., Egevang, C. & Phillips, R. A.** 2012. Trans-equatorial migration, staging sites and
182 wintering area of Sabine's Gulls *Larus sabini* in the Atlantic Ocean. *Ibis* **154**: 42-51.
183
184 .
185

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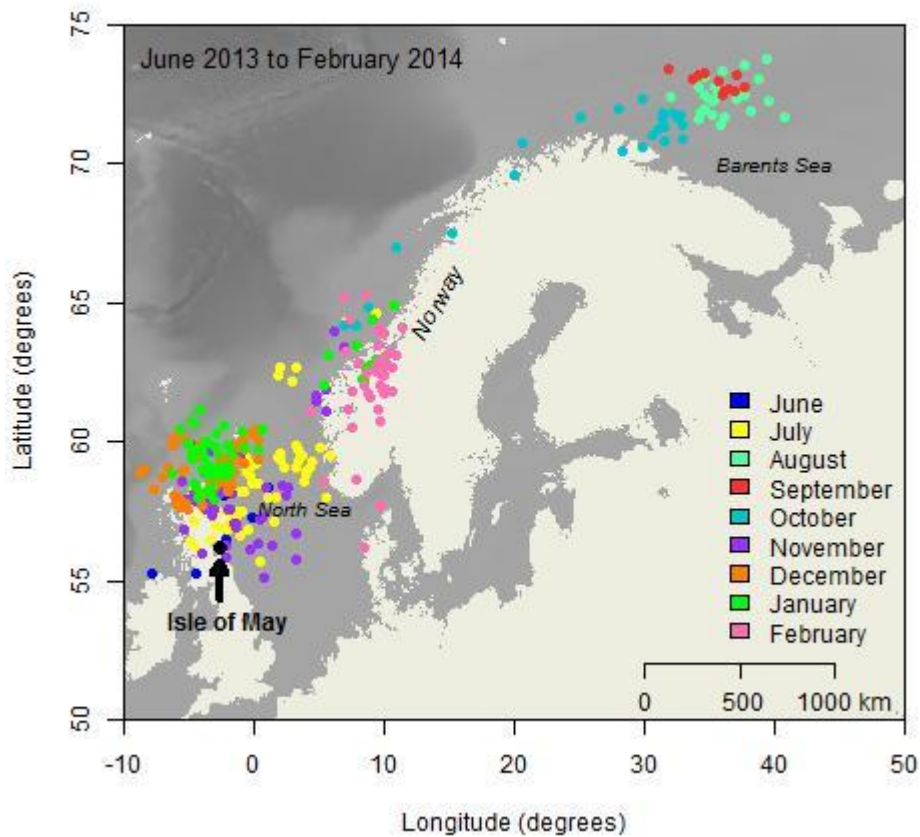
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190 Figure 1. a) Usage kernels 20 October to 23 February resulting from the deployment of geolocators
 191 on Common Guillemots breeding on the Isle of May over the 2011-12, 2012-13 and 2013-14 winters
 192 based on 61 bird-winters. b) Locations of 149 recoveries (red dots) of Common Guillemots ringed on
 193 the Isle of May and reported during October-March when they were at least four years old. In both
 194 plots the 95%, 75% and 50% kernels are shown in increasing dark shades of blue.

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197 Figure 2. The movements of a Common Guillemot breeding on the Isle of May. The inaccuracy of
 198 geolocators is in the order of ± 200 km (Phillips *et al.* 2004). Many estimated positions over land
 199 indicate that the bird was relatively close to the shore in parts of the year, and they were not filtered
 200 out (see methods).

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