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# 1 A gravel-covered iceberg provides an offshore breeding 2 site for ivory gulls *Pagophila eburnea* off Northeast 3 Greenland

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5 **Dominik A. Nachtsheim<sup>1</sup> · Claude R. Joiris<sup>1,2</sup> · Diederik D’Hert<sup>1</sup>**

6  
7 **Abstract** The ivory gull *Pagophila eburnea* is an Arctic seabird species whose distribution is  
8 tightly coupled to the availability of sea ice. During the last decades strong declines have been  
9 reported for breeding colonies in Canada and Greenland, which are usually located on  
10 nunataks or remote coastal islands. Here, we report the observation of a colony of ivory gulls  
11 breeding on a gravel-covered iceberg 70 km off Northeast Greenland in August 2014. It  
12 concerned approximately 60 adults, including two ringed individuals, and many chicks. This  
13 represents an unusual breeding site for the species, to be compared with a few cases of  
14 colonies on gravel-covered sea ice. Breeding on an offshore iceberg may be advantageous  
15 since it provides ultimate protection from predators. Furthermore, the proximity to the  
16 productive North East Water polynya may have been attractive to these gulls. As a  
17 consequence of this and previous observations, colony surveys should not solely focus on  
18 inland and coastal breeding habitats but should be extended towards the ocean.

19

20 **Keywords** Ivory gull · Breeding colony · Iceberg · Ice-rafted gravel · East Greenland  
21 Shelf

22

23 **Introduction**

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· D. A. Nachtsheim · C. R. Joiris ( ) · D. D’Hert  
Laboratory for Polar Ecology (PoE), 26130 Saint-Restitut, France  
e-mail: [crjoiris@gmail.com](mailto:crjoiris@gmail.com)

C. R. Joiris  
Conservation Biology Unit, Royal Belgian Institute for Natural Sciences, 1000 Brussels,  
Belgium

25 The ivory gull *Pagophila eburnea* is a small, pure white gull and inhabits the high Arctic  
26 (Gilchrist et al. 2008). It is closely associated with sea ice (Brown 1984; Melhum 1989;  
27 Spencer et al. 2014), where it feeds either on fish and invertebrates or scavenges on marine  
28 mammal carcasses killed by polar bears *Ursus maritimus* (Gilchrist et al. 2008; Karnovsky et  
29 al. 2009). Little is known about the ecology of this species but dramatic population declines  
30 have already been observed in Canada and Greenland during the last decades (Mallory et al.  
31 2003; Chardine et al. 2004; Gilchrist and Mallory 2005; Gilg et al. 2009). Our own data,  
32 collected from the same observation platform with the same methodology, show a decrease in  
33 ivory gull abundance in the Greenland Sea from a mean of 1.7 individuals per 30 minute  
34 count in the 1990 – 1993 period (Joiris et al. 1997) to 0.4 and 0.3 in 2008 and 2011,  
35 respectively (Joiris 2011; Joiris et al. 2014). Its relative abundance deeply changed as well: it  
36 was one of the three most abundant species in the nineties – together with northern fulmar  
37 *Fulmarus glacialis* and black-legged kittiwake *Rissa tridactyla* - but now does often not even  
38 belong to the top ten any more. The ivory gull is therefore currently listed as ‘Endangered’  
39 under the Species at Risk Act in Canada (COSEWIC 2006) and as ‘Near Threatened’ by the  
40 International Union for Conservation of Nature (IUCN) Red List of Threatened Species  
41 (BirdLife International 2012). The global population is estimated to be between 19,000 and  
42 27,000 individuals with still high uncertainties due to its occurrence in highly remote areas  
43 (BirdLife International 2012).

44 Its breeding range includes the Canadian Arctic, Greenland, Svalbard and Russian Arctic  
45 islands (Gilchrist et al. 2008). North-East (NE) Greenland in particular seems to be a hotspot  
46 for breeding sites (Gilg et al. 2009), possibly due to the vicinity to an attractive feeding  
47 ground: the North East Water (NEW) polynya. The ivory gull usually breeds in colonies,  
48 either inland on steep cliffs and nunataks or coastal on barren islands and lowlands. Colony  
49 size ranges between a few pairs and several hundred individuals with an average of 69 birds  
50 for the Greenland breeding population (Gilchrist and Mallory 2005; Gilchrist et al. 2008; Gilg  
51 et al. 2009). In rare cases ivory gulls use gravel-covered sea ice close to the coast as breeding  
52 platforms: Boertmann et al. (2010) discovered a breeding site including 125 adults and 35  
53 chicks on an ice floe covered with gravel in Independence Fjord, NE Greenland. We report  
54 here an even more extreme breeding habitat: a gravel-covered iceberg 70 km off NE  
55 Greenland.

56

## 57 **Materials and Methods**

58

59 The observation was made during research expedition PS87 on board RV *Polarstern* to the  
60 Arctic Ocean from 5 August to 8 October 2014. We conducted continuous surveys of seabirds  
61 and marine mammals divided into 30 min transect counts from the bridge of the vessel  
62 (approx. 18 m above sea level) as part of our long-term study on the at-sea distribution of  
63 upper trophic levels in the polar regions (see Joiris et al. 2014 for detailed method  
64 description). The main objective is to improve the knowledge on distribution and densities of  
65 marine birds and mammals in relation to influencing environmental factors, such as water  
66 masses, fronts and ice conditions (Joiris and Falck 2011; Joiris et al. 2014).

67

## 68 **Results and Discussion**

69

70 On 9 August 2014, at 6:30 (UTC) a large old tabular iceberg (~180 x 180 m) was spotted on  
71 the East Greenland Shelf (80°50'59"N, 8°56'57"W), partly covered with ice-rafted debris  
72 (Figs. 1 and 2; ice conditions are shown in Online Resource 1). The gravel was sampled and  
73 taken on board for geological analyses. First observations showed that the debris was  
74 composed of metamorphic rocks, such as quartzites and sandstones, and also igneous rocks,  
75 mafic (probably gabbro) and acidic (granites), suggesting an origin from moraine on a glacier  
76 in Greenland (E. Bazhenova, pers. comm.). Since the freeboard was estimated to be 10-15 m  
77 and the water depth was 70 m, we assumed that the iceberg was grounded, based on  
78 calculated keel depth for East Greenland icebergs (Dowdeswell et al. 1992).

79 From a distance an aggregation of ivory gulls could be observed on and around the  
80 iceberg. While the ship approached the iceberg, we noticed that the pile of gravel indeed  
81 supported a breeding ground for approximately 60 adult ivory gulls (Fig. 3). Juveniles of  
82 different age (from chicks in downy plumage to fledglings) were observed but not quantified  
83 because parts of the breeding site could not be sighted properly at close range and due to their  
84 excellent camouflage on the gravel (Fig. 3). Two colour-ringed adults were encountered,  
85 marked with a yellow plastic ring: one on the right leg, the other on the left leg, and a metallic  
86 ring on the other leg (Online Resource 2). They seem to correspond to birds from Greenland  
87 colonies where juveniles have been ringed since 2003 and adults since 2007 with yellow  
88 colour rings, used in Greenland only (O. Gilg pers comm.). The exact inscription could  
89 unfortunately not be read on the photographs.

90 So far, there have been some anecdotal reports of ivory gulls breeding on ice. It has long  
91 been suggested that these birds nest on offshore ice islands, which could never be confirmed  
92 (Uspenski in Johansen 1958). There are reports of ivory gulls breeding on gravel-covered ice

93 floes but they were located close to the coast (MacDonald and Macpherson 1962; Boertmann  
94 et al. 2010). An iceberg 70 km off the Greenland coast therefore provides ultimate protection  
95 against terrestrial predators, such as Arctic fox *Vulpes lagopus*, wolf *Canis lupus* and polar  
96 bears due to the iceberg's freeboard, whereas coastal colonies, even if located on sea ice, are  
97 still vulnerable to predation by these animals. Only avian predators (e.g. glaucous gull *Larus*  
98 *hyperboreus* and skuas *Stercorarius sp*) would be able to prey on the eggs and chicks in an  
99 iceberg colony.

100 Furthermore, the iceberg was located in the proximity of the NEW polynya (Online  
101 Resource 1), which is known for its productivity and corresponding abundances of marine top  
102 predators (Hirche et al. 1991; Joiris et al. 1997), making this is the most favourable breeding  
103 site within a 70 km radius in a food-rich region. The colony was in direct proximity of the  
104 polynya, not only during this period, but during the whole breeding season, from May to  
105 August (Online Resource 3). This makes it especially attractive to ivory gulls since these birds  
106 shuttle between breeding sites and feeding grounds in order to rear their chicks (Gilchrist et  
107 al. 2008; Spencer et al. 2014). They regularly cover large distances during their foraging trips,  
108 in some cases more than 100 km one-way, e.g. from inland nunataks (Gilg et al. 2009). Thus,  
109 it is energetically favourable for ivory gulls to breed close to rich feeding grounds. Therefore,  
110 breeding colonies tend to concentrate near polynyas, e.g. on Ellesmere Island near North  
111 Water polynya and in NE Greenland near NEW polynya (Gilchrist and Mallory 2005; Gilg et  
112 al. 2009). Since it has now been reported several times that ivory gulls breed on gravel-  
113 covered sea ice and icebergs (MacDonald and Macpherson 1962; Boertmann et al. 2010;  
114 present study), this should have implications for future colony surveys.

115

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122

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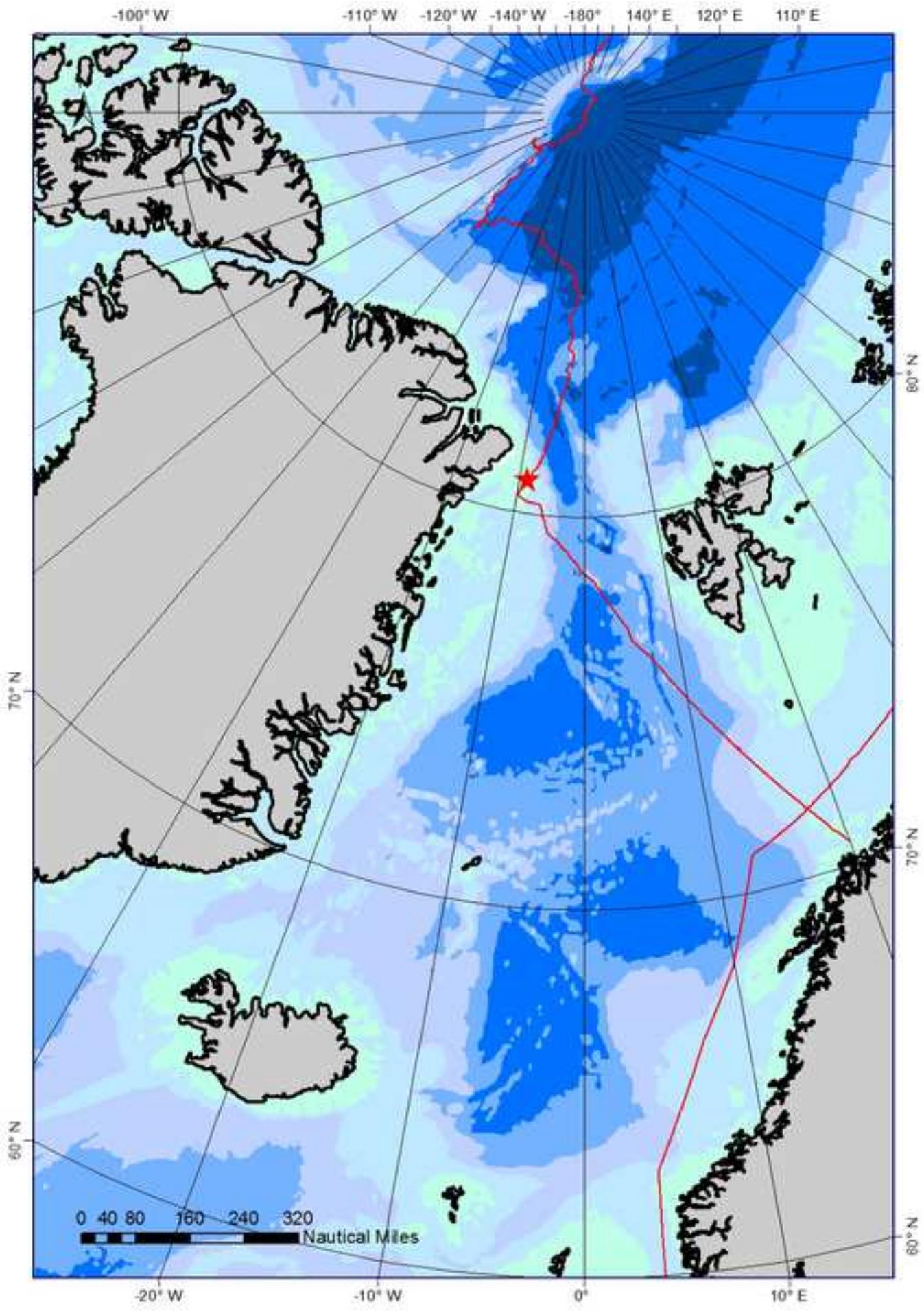
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163 **Fig. 1** Location of the gravel-covered iceberg, indicated by a red star. Red line illustrates  
164 cruise track of RV *Polarstern* during expedition PS87 (*partim*)  
165 **Fig. 2** View of the gravel-covered iceberg, 9 August 2014, 80°50'59"N, 8°56'57"W.  
166 Photograph W. Geissler (AWI)  
167 **Fig. 3** Ivory gulls *Pagophila eburnea* breeding on a gravel-covered iceberg: adults and  
168 juveniles of different age. Photograph D. A. Nachtsheim

Figure 1

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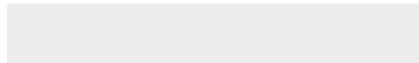
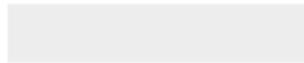






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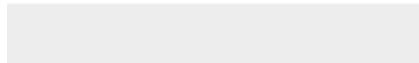
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