

1 A gloomy future for light-bellied brent geese in Tusenøyane, Svalbard, under a changing predator
2 regime

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4 Jesper Madsen^a, Cornelia Jaspers^b, John Frikke^c, Ove M. Gundersen^d, Bart A. Nolet^{e,g}, Koen Nolet^e,
5 Kees H.T. Schreven^e, Christian Sonne^f, Peter de Vries^e

6 ^aDepartment of Bioscience, Aarhus University, Grenåvej 14, 8410 Rønne, Denmark. ORCID ID:
7 0000-0003-3246-0215.

8 ^bDTU Aqua, Danish Technical University, Kemitorvet, Lyngby, Denmark. ORCID ID: 0000-0003-
9 2850-4131.

10 ^cWadden Sea National Park Secretariat, Rømø, Denmark

11 ^dNorwegian Farmers' Association, Steinkjer, Norway

12 ^eDepartment of Animal Ecology, Netherlands Institute of Ecology, Droevendaalsesteeg 10, PO Box
13 50, 6700 AB Wageningen, The Netherlands. B. Nolet ORCID ID: 0000-0002-7437-4879.

14 ^fDepartment of Bioscience, Aarhus University, Frederiksborgvej 399, 4000 Roskilde, Denmark.
15 ORCID ID: 0000-0001-5723-5263.

16 ^gDepartment of Theoretical and Computational Ecology, Institute for Biodiversity and Ecosystem
17 Dynamics, University of Amsterdam, Science Park 904, 1098 XH Amsterdam, The Netherlands

18

19 JM: jm@bios.au.dk

20 JF: jofri@danmarksnationalparker.dk

21 OMG: Ove.Martin.Gundersen@bondelaget.no

22 CJ: coja@aqua.dtu.dk

23 BN: B.Nolet@nioo.knaw.nl

24 KS: K.Schreven@nioo.knaw.nl

25 CS: cs@bios.au.dk

26 PV: P.deVries@nioo.knaw.nl

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29 Abstract

30 The endangered population of light-bellied brent geese breeding in Svalbard and Northeast
31 Greenland used to have its core breeding area in the archipelago of Tusenøyane in southeast
32 Svalbard. Studies carried out during 1987-1991 showed that the Tusenøyane population was subject
33 to heavy egg predation due to polar bears and, in one year, arctic foxes. Revisiting some key nesting
34 islands in August 2018, we found few nests used by brent geese and no families. Among other bird
35 species, such as barnacle goose and common eider, very few young were observed as well. As
36 potential predators polar bears, or signs of their recent presence, were observed on most islands, and
37 great skuas occurred on almost all islands, with 60 individuals on Lurøya, formerly an important
38 island for geese. In contrast, only a single pair of great skuas was observed 30 years ago. The
39 observations suggest that recent expansion of great skuas in the North Atlantic, including Svalbard,
40 has led to a novel extreme predation pressure, additional to that caused by mammalian predators.
41 There seems little chance for brent geese and other birds to recruit successfully in Tusenøyane. That
42 brent geese have been absent for an extended period is indicated by the fact that the favoured food
43 plant *Cochlearia officinalis*, formerly depleted by brent geese, now occurs in high densities. Despite
44 the loss of Tusenøyane as a breeding ground, the population of brent geese has increased in recent
45 decades, inferring that the population now recruits from remote but mainly unknown breeding
46 grounds.

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50 Corresponding author: Jesper Madsen, Department of Bioscience, Aarhus University, Grenåvej 14,
51 8410 Rønde, Denmark, jm@bios.au.dk

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56 Introduction

57 The majority of arctic-breeding geese in the Western Palearctic and North America have increased
58 dramatically in population sizes during the past 4-5 decades (Fox & Leafloor 2018). Irrespectively,
59 some populations remain small and endangered, such as the population of light-bellied brent goose
60 (*Branta bernicla hrota*) breeding in Svalbard, Northeast Greenland and Franz Josef Land and
61 wintering in Denmark and Northeast England. This is one of the smallest goose populations
62 worldwide. In the 1960s, the population was reduced to c. 2,000 individuals, probably caused by
63 overexploitation due to hunting on the Danish wintering grounds (Madsen 1987). Following legal
64 protection in Denmark in 1972, the population gradually recovered, reaching 4-5000 in the late
65 1980s and 8-10,000 during 2010-2016 (Clausen & Craggs 2018). The species is redlisted in
66 Svalbard (Henriksen & Hilmo 2015). Not until the 1980s, the main breeding grounds in Svalbard
67 were surveyed, namely Tusenøyane in the southeast corner of Svalbard. In 1985, Persen (1986)
68 found 435-600 breeding pairs on the islands, suggesting this was the core breeding area for the
69 population. By that time, nesting brent geese suffered from heavy predation due to polar bears
70 (*Ursus maritimus*) in most years and, in one year, arctic foxes (*Vulpes lagopus*)(Madsen et al 1989,
71 1992, 1998). However, since then, there has been no systematic survey of the breeding numbers and
72 their productivity in the area. Satellite-tracking of individual geese caught on the Danish spring
73 staging areas has suggested that the brent geese do not migrate to the breeding grounds in
74 Tusenøyane anymore but rather go to other sites in Svalbard and Northeast Greenland (Clausen et
75 al. 2003 and unpubl.). In August 2018, we revisited some of the islands in Tusenøyane which had
76 been surveyed in 1987, 1989 and 1991. The aim of this investigation was to make a status of the
77 light-bellied brent geese through a survey of the nest use as well as brood-rearing geese and other
78 species of birds and to look for clues why the brent geese may have abandoned the area.

79

80 Study area, material and methods

81 Tusenøyane (76°57'N 22°10'E) is known for hosting a significant proportion of the breeding pairs of
82 the Svalbard/Northeast Greenland light-bellied brent goose population. The islands are small
83 (typically less than 1 km in diameter) and rocky and the vegetation is very poor, with patches of wet
84 moss carpets with protruding *Cochlearia officinalis* and *Carex* spp. Freshwater ponds are found on
85 some islands. Brent geese place their nests in patches which become snow free early, sheltered
86 between rocks, drift wood or whale bones. Breeding pairs are territorial. Barnacle geese (*Branta*
87 *leucopsis*) also occur in low numbers (in 1987 with a colony of 17 nests on Hornøya; Madsen et al.
88 1989); they place their nests in dry, rocky terrain, however, in contrast to brent geese they are
89 colonial.

90 During 7-8 August 2018, we visited Tusenøyane in southeast Svalbard by ship and went ashore
91 on islands which had previously been visited during 1987-1991, namely Lurøya, Kalvøya, Langåra
92 and Hornøya in Tiholmane and Havmerra and Kvalbeinøya in Schareholmane, which were known
93 to host nesting and brood-rearing brent geese (Madsen et al. 1989, 1992, 1998; Bregnballe &
94 Madsen 1990). We searched for nests used by geese during the same year by walking in lines, 5-10
95 m apart, covering the entire islands. Used nests were identified by fresh down in nest bowls and
96 remains of egg shells. Because most nests were well sheltered among rocks, whale bones or drift
97 wood, nest down was intact and not blown away. Goose nests were differentiated from common

98 eider (*Somateria molissima*) nests by white/light grey down and white body feathers. Brent goose
99 nests were differentiated from barnacle goose nests by the lack of faeces on the rim and within close
100 proximity of the nest (barnacle goose males rest in close proximity to the nesting females and
101 produce heaps of faeces, while brent males stay at a distance of the nest) as well as by body feather
102 characteristics (Fig. 1). A nesting attempt was classified as successful if eggshells with membranes
103 were found in the down in the nest cup and as failed if no eggshells were found, or eggshells with
104 signs of pecking by gulls indicating predation. Empty nests were regarded as being predated, either
105 by polar bears (which swallow the entire egg) or by gulls/skuas which may transport the eggs away
106 from the nest. The entire islands were searched for families of geese and other breeding birds using
107 binoculars and telescopes. Furthermore, we sailed around the islands Bölscheøya (77°13'N 22°00')
108 and Rugla in Tiholmane and searched for families of geese. Since the islands are very remote from
109 the main islands in south Svalbard, it is highly unlikely that they would swim away from the islands
110 and thereby being missed. Nest searching was similar to the method used in 1987-1991.

111

112 Results

113 The results of the nest and goose family surveys in 2018 are summarised in Table 1, with a
114 comparison to the findings in 1987, 1989 and 1991. In 2018, a total of four nests used by brent
115 geese were found, three of which had hatched while one was predated. However, no families were
116 observed. A total of 25 nests of barnacle geese was found, of which 12 had hatched while 13 were
117 predated. However, only two families of barnacle geese were observed, on Bölscheøya. A total of
118 26 nests of common eider were found, of which 11 had hatched, and six broods were observed. A
119 total of 14 territorial pairs of arctic skua (*Stercorarius parasiticus*) were observed, but only one
120 juvenile was identified. Among a total of c. 500 territorial arctic terns (*Sterna paradisaea*), less than
121 10 juveniles were seen (although probably underestimated because we did not approach the shores
122 where terns settled), and among 23 territorial pairs of glaucous gull (*Larus hyperboreus*), only five
123 pairs had young. Finally, in 17 pairs of red-throated diver (*Gavia stellata*), only two pairs had
124 young. We observed a polar bear resting on Rugla and two on Skråholmen east of Schareholmane,
125 while fresh bear faeces were found on Lurøya, Kalvøya and Schareholmane. Arctic fox was not
126 observed nor were there signs of their presence in terms tracks or fox predated bird carcasses. Pairs
127 of great skua (*Stercorarius skua*), which appeared to be territorial, were present on all islands,
128 except for Havmerra. On Lurøya, c. 60 birds were present. Young or juveniles were not observed,
129 but swooping behaviour suggested defence of young.

130

131 Discussion

132 Surveys in the 1980s showed that Tusenøyane was the core breeding site for the Svalbard/Northeast
133 Greenland population of light-bellied brent geese (Persen 1986; Madsen et al. 1989), however the
134 reproductive success was highly variable, depending on the presence of polar bears or, in one year
135 (1989), arctic foxes which deterred geese from nesting, except from few islands where no foxes
136 were present (Madsen et al. 1992, 1998). It was observed that polar bear presence was related to the
137 presence of drift ice, and most bears moved out of the Tusenyøane archipelago with the retreat of
138 the sea ice. In years with little drift ice present in the area during the nesting period, the population

139 as a whole bred successfully, while in years with dense drift ice, the population bred very poorly.
140 Not only did polar bears predate nests but they also created disturbance, flushing nesting brent
141 goose females from the nests, which were subsequently predated by arctic skuas. In August 2018,
142 polar bears were present in Tusenøyane despite the fact that there was no ice, which suggests that
143 the behaviour of the bears has changed over the 30 year period. On the west coast of Svalbard it has
144 also been observed that within recent decades, polar bears have roamed along the coast during the
145 summer period, heavily predated on eggs of island-breeding colonial barnacle geese and other
146 species, probably in response to a decreasing extent of sea ice with global warming (Prop et al.
147 2015). Similarly, in western Hudson Bay, Canada, earlier sea ice breakup has led to an advanced
148 onshore movement of polar bears and consequent increased predation on colonially nesting lesser
149 snow geese (*Chen caerulescens caerulescens*) (Rockwell & Gormezano 2009). It is highly likely
150 that polar bears were also present in Tusenøyane in June-July 2018; however, it is remarkable that
151 among the breeding brent and barnacle geese as well as common eiders, we found that a relatively
152 high proportion had actually hatched, namely 47% for the three species pooled. This is higher than
153 what was found in 1987 and 1991, namely 19% (n = 413 nests of all three species) and 17% (n = 47
154 brent goose nests), respectively (Madsen et al. 1989, 1992; J. Madsen unpubl.). Hence, this suggests
155 that it was not the polar bear presence which caused the very poor breeding outcome observed in
156 August 2018. Arctic foxes, which can deter geese from breeding, were not observed.

157 During 1987-1991, only a single pair of great skuas was observed in the study area. In 2018,
158 they were present on almost all islands. In particular Lurøya held a large concentration. The great
159 skua is confined to the northeast Atlantic, originally mainly breeding in Scotland, with key
160 populations being located on Orkney and the Shetland islands. During the last century the
161 population has expanded its breeding range northwards in the Atlantic (Mitchell et al. 2004),
162 recently expanding as far northeast as Franz Josef Land (Gavrilo 2013) and Novaya Zemlya
163 (Pokrovskaya 2016). In the Barents Sea region the species has occurred on Bear Island since 1970
164 (Anker-Nilssen et al. 2007) and a large colony of up to 1000 pairs has now established (H. Strøm
165 pers. comm.). In Svalbard, the great skua is now observed all around the archipelago (H. Strøm
166 pers. comm.). Breeding great skuas are known to feed on young and adults of seabirds as well as
167 fish (Bayes et al. 1964; Jakubas et al. 2018) and fish discards (Votier et al. 2004). In 1987-1991, we
168 observed great skuas in Tusenøyane foraging on common eider eggs, eider ducklings and adult
169 kittiwakes (*Rissa tridactyla*), and they were also seen attacking family groups of brent geese (J.
170 Madsen unpubl.).

171 Although we do not have conclusive evidence, we ascribe the almost complete failure of
172 recruitment in geese, eiders and possibly other bird species in 2018 to the increase in great skuas
173 because this is the only species likely to exert a heavy predation pressure on young, whereas polar
174 bears (and arctic foxes) are mostly predated eggs. The high additional predation pressure is likely
175 to have contributed to the longterm decline in the breeding numbers. Also eiders have diminished in
176 the study area: in 1987, we found more than 300 eider nests (J. Madsen unpubl.), which was
177 reduced to 26 in 2018. From Scotland, it is well known that great skuas can exert heavy predation
178 pressure on other seabirds, to an extent that it is of conservation concern (Heubeck et al. 1997; Oro
179 & Furness 2002; Votier et al. 2006). Our observations suggest that the spread of the great skua in
180 the Barents Sea region may be a reason of concern for some coastal breeding bird populations;
181 however, systematic studies are needed to substantiate this further.

182 With regard to the light-bellied brent geese, we found indirect evidence that the low number of
183 breeding pairs was not just an erratic phenomenon in a single year. During 1987-1991, we found
184 that brent geese depleted their main food plant *Cochlearia officinalis* on Lurøya, probing for the
185 nutritious roots in the moss carpet, and plants were generally small and in a first-year non-flowering
186 stage (Madsen et al. 1998). In 2018, the moss carpets on Lurøya were densely covered by flowering
187 (two-years or older) *Cochlearia* plants, and only low densities of holes from goose probing for roots
188 were observed (Fig. 2). Hence, the recovery of *Cochlearia* suggests that geese have not been
189 present in significant numbers for several years.

190 Despite the functional loss of Tusenøyane as a breeding site for light-bellied brent geese, this
191 has not caused a decline in the overall population size. On the contrary, the population as a whole
192 has doubled within the last 2-3 decades, inferring that the population now recruits from remote but
193 mainly unknown breeding grounds. The growth has taken place despite low and declining overall
194 productivity (registered by age counts in the autumn flocks) but compensated by increased survival,
195 which is suggested to be caused by improved food conditions and milder winters in the
196 Danish/English wintering quarters (Clausen & Craggs 2018). Brent geese are known to breed
197 scattered in low numbers in Northeast Greenland (Boertmann et al. 2015), but apart from that, there
198 is little information about currently used breeding sites in Svalbard. From a conservation
199 perspective, it is of high importance to identify the breeding areas to safeguard these from
200 antropogenic development such as disturbance from tourism.

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202

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208

209 Disclosure statement

210 No potential conflict of interest was reported by the authors.

211

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214

215 Data availability

216 Observations of birds and mammals will be uploaded to artsobservasjoner.no.

217

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289

290 Table 1. Breeding status of light-bellied brent geese in Tusenøyane, Svalbard in 1987, 1989, 1991
291 and 2018. Not all islands were visited each year.

292

	1987		1989		1991		2018	
	nests	families	nests	families	nests	families	nests	families
Lurøya	38	11	0	0	47	10	0	0
Kalvøya	11	7	0	0		5	3	0
Langåra	5	1	0	0		2	0	0
Hornøya	4	0	0	0			0	0
Havmerra	10	2	1	0			1	0
Kvalbeinøya	4	0	0	0			0	0

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298 Figure legends

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300 Figure 1. Nests of light-bellied brent goose (A) and barnacle goose (B), Tusenøyane 1987. Photo:
301 Jesper Madsen.

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303 Figure 2. Moss carpet with protruding *Cochlearia officinalis*, Lurøya, Tusenøyane, August 2018.
304 Small holes in the moss carpet are caused by geese probing for *Cochlearia* roots. Photo: John
305 Frikke.

306

307 Figure 1

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311 Figure 2

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