Geese in Northeast and North Greenland as recorded on aerial surveys in 2008 and 2009

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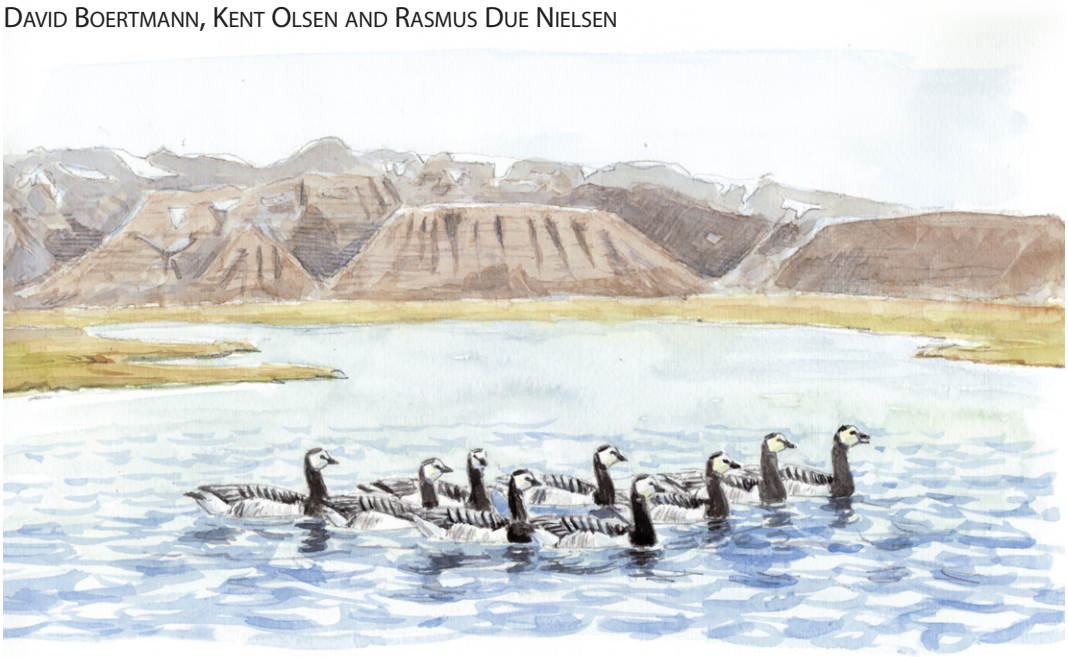

(Med et dansk resumé: Gæs i Nordøst- og Nordgrønland optalt fra fly i 2008 og 2009)

Abstract Aerial surveys of geese were carried out in July/August 2008 and 2009 in Northeast and North Greenland. Moulting Pink-footed Geese *Anser brachyrhynchus* had increased considerably in numbers compared to results of similar surveys in 1988 – up to three-fold in Jameson Land in 2008 – and the range of moulting birds now included North Greenland as far north as land is found. Moulting Barnacle Geese *Branta leucopsis* showed a similar increase compared to 1988 – two-fold in Jameson Land in 2008 – although the range was unchanged. The increase in the Pink-footed Goose and Barnacle Goose populations in Greenland is not unexpected as monitoring on the wintering grounds in the British Isles shows continued and marked increases in both populations. A higher number of both moulting Pink-footed and Barnacle Geese in Jameson Land in 2008 compared to 2009 may be the result of a very snow-rich spring in 2008. Breeding and moulting Light-bellied Brent Geese *Branta bernicla hrota* were found in several smaller concentrations along the North Greenland coasts between Kap Morris Jesup and Holm Land. They were more dispersed than previously recorded, with fewer birds in Kilen, where previously the major part of the population had occurred.

Introduction

The three goose populations, which breed and moult in Northeast and eastern North Greenland, winter in Northwest Europe where they are monitored every winter. The populations are the Greenland/Iceland flyway population of Pink-footed Goose *Anser brachyrhynchus* primarily wintering in Scotland, the Northeast Greenland flyway population of Barnacle Goose *Branta leucopsis* wintering in Ireland and Scotland and the East Atlantic flyway population of Light-bellied Brent Goose *Branta bernicla hrota* breeding also in Svalbard and primarily wintering in Denmark (Madsen *et al.* 1999). Both the Pink-footed and Barnacle Goose populations have a favourable conservation status because these populations are large and have increased markedly in recent decades. During the period covered by this report (1988 to 2009), the Pink-footed Goose population has doubled to reach 364 000 individuals in 2009, and the increase has continued (Salmon & Kirby 1990, Mitchell 2010, 2013). The Barnacle Goose population also doubled in

the same period to about 74000 in 2009 (Mitchell 2013, Mitchell & Hall 2013). By contrast, the Light-bellied Brent Goose population is currently considered to have an unfavourable conservation status; the population is numerically few (*c.* 7200 in 2009) and has been decreasing in most recent years (Clausen *et al.* 2014, P. Clausen pers. comm.).

In spring and summer of 2008 and 2009 baseline data on bird and mammal distribution and abundance were collected from aircraft throughout most of Northeast and eastern North Greenland. This commissioned work was undertaken in response to the opening up of the Greenland Sea for hydrocarbon exploration (Boertmann & Mosbech 2012) and to the proposed development of a molybdenum mine in Jameson Land. This latter task included identifying candidates for new Ramsar sites to replace the proposed reduction in area of the existing Ramsar site in Jameson Land (Glahder *et al*. 2010). The surveys included areas surveyed 20 years earlier in 1988 (Boertmann 1991), as well as new areas, and provided a unique opportunity to update knowledge about the goose populations breeding and moulting in Northeast and North Greenland.

Material and methods

All surveys were carried out from aircraft, which have proved efficient platforms for goose surveys in Greenland (Boertmann 1991, Fox & Glahder 2010).

The pilot and the senior observer (the first author) in 2008 and 2009 were the same as in 1988, as was the aircraft, a Partenavia P-68 Observer (twin-engined and high-winged) specially equipped with a Perspex nose cone and bubble windows next to the seats behind the pilot seats.

The surveys were carried out as 'total counts' (cf. Laursen *et al.* 2008) i.e. all observed birds and mammals were recorded in the habitats that were selected and surveyed. The two observers occupied the co-pilot seat and the seat behind the pilot. The second author was observer in 2008 and the third author in 2009. The surveys took place in the period 16 July to 2 August both years, at a time when non-breeding geese are flightless due to wing moult and breeders move around with still flightless chicks. However, broods of Barnacle Geese and Pink-footed Geese were rarely encountered during these surveys and were potentially easily to miss. For this reason, only moulting birds are considered to have been surveyed efficiently, and moulting birds only of these two species are reported here. By contrast, several Brent Goose broods were recorded, particularly in 2008.

Distance sampling using surveys along fixed and straight transects was tried in 2009 in the Hold With Hope area, because this extensive lowland area permitted such an approach and was considered as a potential candidate for the replacement Ramsar site. However, most other areas were not amenable to this type of survey, and the number of geese actually observed along the Hold With Hope transect lines has been included here for the purpose of comparison.

Navigation on total counts was visual and guided by GPS. Flying altitude and speed were maintained at 250 feet (85 m) and 90 knots (160 km/h), respectively, during surveys. In Jameson Land, more or less the same survey routes as in the survey years 1985-1989 (Mosbech *et al*. 1989) were used in order to obtain comparable results.

The surveys in 2008 and 2009 covered the region from Kap Dalton (69° N) on the Blosseville Kyst in the south to Nansen Land at 82° 45′ N; 43° 00′W in the northwest, including the world's northernmost land areas at 83° 40′ N. However, the region between 77° and 80° N (Figs 1 and 2) was excluded because of the endurance limitations of the aircraft – the area was too far away from the two airfields to be surveyed safely.The surveys relating to hydrocarbon exploration in the Greenland Sea were mainly directed at coastal and offshore areas, although some potentially important inland areas were included. The surveys relating to the molybdenum project covered exclusively inland areas including Jameson Land, Hold With Hope and Wollaston Forland.

Potential new (compared to 1988) goose habitats were selected based on knowledge from the surveys in 1988 and from Landsat satellite images showing Normalized Difference Vegetation Index (NDVI) values. This index is an indicator of the level of greenness of the vegetation (Rouse *et al*. 1973).

All observations were recorded on tape recorder, and each observation was dictated together with the observation time. A GPS (Trimple GeoXT) recorded the flown track lines, and each observation was geo-referenced by combining the observation time and GPS time. All clocks were synchronised with the GPS clock (UTC-time).

The airfields of Constable Pynt (BGCP) and Station Nord (BGNO) were used as land bases during the surveys.

Results from areas covered more than once both within years and between 2008 and 2009 were corrected for double registrations by selecting the highest number recorded at the specific sites.

The number of Brent Goose broods in larger aggregations of chicks was calculated using 3.44 as conversion factor, as this was the average clutch size reported from Kilen in 1985 (Hjort *et al.* 1987).

There was a marked difference in the survey results of both Pink-footed Goose and Barnacle Goose numbers in Jameson Land between the two observation years. General linear models (GLM) were applied to test if this difference could be explained by observer bias. A quasi-

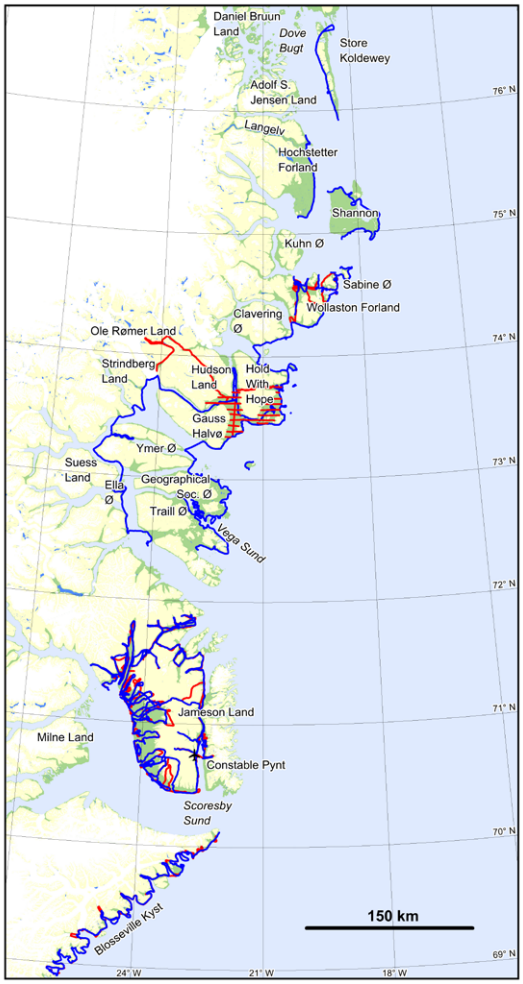

Fig. 1. Map showing the survey aircraft tracks in the southern part of covered area in 2008 (blue) and 2009 (red). Surveys were also conducted in the off shore area, but these are omitted here. The closely spaced, parallel tracks in the Hold With Hope area were flown to test the Distance Sampling method, but only actual observations are reported here.
Flyruter i den sydlige del af undersøgelsesområdet under optællingerne i 2008 (blå) og 2009 (rød). Kun ruter hvor der kunne observeres gæs er vist. De tætliggende og parallelle ruter i Hold With Hope-området var et forsøg på at afprøve en særlig optællingsmetode (Distance sampling). *Her rapporteres kun de aktuelle observationer.*

Fig. 2. Map showing the survey aircraft tracks in the northern part of covered area flown in 2008 (blue) and 2009 (red). Surveys were also conducted in the off shore areas, but these are omitted here.
Flyruter i den nordlige del af undersøgelsesområdet under optællingerne i 2008 (blå) og 2009 (rød). Kun ruter hvor der kunne observeres gæs er vist.

Poisson error structure was assumed because preliminary analyses showed over-dispersed data with regard to a Poisson error structure. Model factors were goose species, observers and their interaction. The analyses were carried out for the two years separately, except in the case of the senior observer who participated in both years. The statistical trend analyses were performed using the software R version 3.01 (R Core Team 2013).

Data on snow conditions in Jameson Land and in Kilen in springs 2008 and 2009 are not available. Therefore use was made of information on snow cover from the research station at Zackenberg which is sutuated 400 km north of Jameson Land and 760 km south of Kilen (Sigsgaard *et al*. 2009, 2010) combined with Landsat 7 satellite images showing snow cover and available on the internet (U.S. Geological Survey).

Details on the surveys can be found in three reports from the National Environmental Research Institute, Denmark (now Danish Centre for Environment and Energy – DCE; Boertmann *et al*. 2009, Boertmann & Nielsen 2010, Glahder *et al*. 2010).

Tab. 1. Survey coverage and regional results of counts of Pink-footed and Barnacle Geese in Northeast and North Greenland in 2008 and 2009 compared with survey results from 1988. Numbers in brackets indicate no. of flocks.
Dækning og resultater af optællinger af Kortnæbbet Gås og Bramgås i Nordøst- og Nordgrønland i 2008 og 2009 sammenlignet med tilsvarende resultater i 1988. Tal i parentes angiver antal flokke.

Region *Region*	**Effort (km)** *Dækning (km)*			**Pink-footed Goose** *Kortnæbbet Gås*			**Barnacle Goose** *Bramgås*		
	1988	2008	2009	1988	2008	2009	1988	2008	2009
Blosseville Kyst	-	608	493	-	65 (8)	108 (9)	-	326 (17)	411 (31)
Jameson Land	c. 1800	1919	1756	5560	19068 (384)	11860 (304)	6035	16603 (431)	12349 (349)
Traill Ø	150	87	-	47 (7)	34 (5)	-	132(15)	89 (3)	-
Vega Sund	-	211	-	-	480 (33)	-	-	465 (34)	-
Geo. Soc. Ø	108	96	-	16 (2)	77 (4)	-	135 (10)	28 (3)	-
Suess Land	-	24	-	-	45 (2)	-	-	20 (1)	-
Ella Ø	5	47	-	0	45 (3)	-	21 (2)	35 (1)	-
Ymer Ø, west	41	115	-	11 (3)	223 (11)	-	49 (4)	577 (5)	-
Ymer Ø, east	-	23	-	-	0	-	-	138 (8)	-
Strindberg Land	-	50	-	-	36 (2)	-	-	20 (1)	-
Gauss Halvø	119	178	109	243 (15)	768 (19)	435 (12)	226 (13)	777 (27)	614 (19)
Hold With Hope	115	94	144	1257 (36)	1882 (47)	2738 (63)	567 (16)	1173 (31)	1768 (38)
Ole Rømer Land	-	-	109	-	-	692 (15)	-	-	212 (7)
Hudson Land	87	-	62	13 (1)	-	52 (2)	121 (6)	-	328 (8)
Clavering Ø	51	47	-	60 (1)	39 (2)	-	0	65 (5)	-
Sabine Ø	15	113	76	0	25 (1)	122 (5)	0	54 (5)	95 (2)
Wollaston Forland	115	149	205	1763 (31)	2357 (38)	2032 (29)	306 (6)	1906 (33)	1229 (22)
A.P. Olsen Land	39	-	-	20 (2)	-	-	232 (5)	-	-
Shannon	107	141	-	210 (10)	213 (11)	-	169 (6)	165 (7)	-
Hochstetter Forland	364	94	-	6479 (132)	1569 (20)	-	226 (23)	124 (5)	-
Langelv valley	85	-	-	308 (21)	-	-	37 (6)	-	-
Store Koldewey	93	121	-	0	0	-	0	43 (1)	-
Aldolf S. Jensen Land	112	-	-	94 (6)	-	-	67 (6)	-	-
Dove Bugt	132	-	-	94 (6)	-	-	67 (6)	-	-
Daniel Bruun Land	170	-	-	2417 (96)	-	-	253 (13)	-	-
Nordmarken	162	-	-	2288 (112)	-	-	401 (20)	-	-
Dr. Louise Land	80	-	-	336 (12)	-	-	11 (3)	-	-
Germania Land	312	-	-	4415 (167)	-	-	265 (17)	-	-
Kr. Christian Land	-	890	646	-	345 (2)	30 (1)	-	0	0
Skjoldungeelv	-	156	-	-	2199 (112)	-	-	0	-
Mylius Erichsen Land	-	-	133	-	-	1376 (35)	-	-	0
Herluf Trolle Land	-	203	316	-	1506 (56)	10142 (197)	-	0	0
Frigg Fjord	-	-	70	-	-	1027 (40)	-	-	0
Johs. V. Jensen Land	-	132	317	-	3220 (71)	2977 (60)	-	0	0
Nansen Land	-	-	144	-	-	8517 (22)	-	-	0

Results

Survey coverage and count results for Pink-footed and Barnacle Geese in the different land areas are listed in Tab. 1 and compared to the results from the 1988 surveys.

Pink-footed Goose

In total, 34196 birds were observed during the survey in 2008, and out of this total 19068 were recorded in Jameson Land. Outside Jameson Land, high numbers were found in Hold With Hope (1882), in Wollaston Forland (2357), in the Skjoldungeelv-area (2199) and along the north coast of Johannes V. Jensen Land (3220) (Tab. 1, Fig. 3).

In 2009, a total of 42108 Pink-footed Geese were recorded. Of these, 11860 were counted in Jameson Land, 3917 in Hold With Hope, Gauss Halvø, Hudson Land, Ole

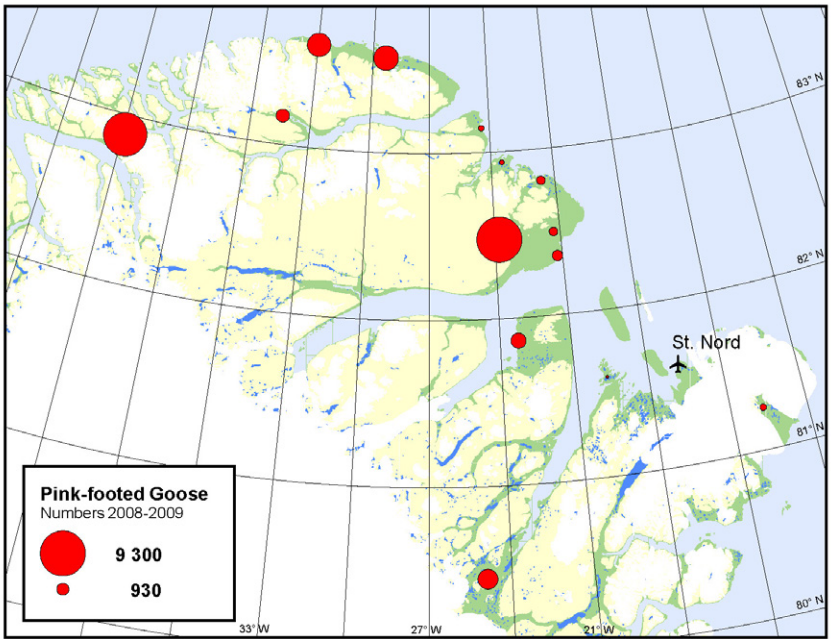

Fig. 3. Distribution of moulting Pink-footed Geese in 2008 and 2009 in eastern North Greenland north of 80° N. Where there were records for both years at specific sites, the higher number is shown.
Fordelingen af fældende Kortnæbbede Gæs i den østlige del af Nordgrønland (nord for 80° N) i 2008 og 2009. Fra områder dækket begge år er højeste antal vist.

Rømer Land area combined, and 2032 in Wollaston Forland. In North Greenland (north of 80° N), a total of 24069 were found with very high numbers in Nansen Land and in Herluf Trolle Land (Vitskøl Elv) (Tab. 1, Fig. 3). Only 108 were located on the Blosseville Kyst.

When the results from the two years were combined and corrected for overlapping routes, the total numbers recorded in North Greenland (to the north of 80° N) were 30653 Pink-footed Geese. These geese were obviously moulting as only few were able to fly, particularly in 2009 (43% of the individuals recorded in 2008 and 1.5% in 2009) and no signs of breeding Pink-footed Geese were recorded there.

In Jameson Land, 7200 fewer individuals and 80 fewer flocks were counted in 2009 compared to 2008 (Tab. 1).

Barnacle Goose

In 2008 a total of 22608 Barnacle Geese were counted. Of these, 16603 were found in Jameson Land, and the rest mainly in coastal habitats as far north as Store Koldewey (76° 45′ N).

In 2009, 17006 Barnacle Geese were counted, with 12349 in Jameson Land, 2929 in the combined Hold With Hope, Gauss Halvø, Hudson Land and Ole Rømer Land area, 1229 in the Wollaston Forland area, and 411 along the northern part of Blosseville Kyst (Tab. 1).

No Barnacle Geese were observed in North Greenland (to the north of 80° N).

Similar to Pink-footed Goose, fewer individuals (4,200) and flocks (82) were found in Jameson Land in 2009 compared to 2008.

Light-bellied Brent Goose

A total of 1075 Brent Geese were recorded in 2008. Excluding a single moulting flock of 14 on the coast of Wollaston Forland (74° 30′ N), all were seen along the coasts north of 80° N which constitute the stronghold for this species in Greenland. More than half of the geese (n = 530) were observed in Kilen (Fig. 4).

Broods of large but still downy chicks were observed at twelve sites (Fig. 4). In Kilen, 44 chicks (*c.* 13 broods) were seen, and on the islands northwest of Station Nord (Prinsesse Margrethe Ø and Prinsesse Thyra Ø) 42 chicks (*c.* 12 broods) were recorded. The most remarkable observation was a brood of three chicks a few kilometres east of Kap Morris Jesup, which was 400 km west of the hitherto known breeding sites. About 930 of the observed Brent Geese were either non-breeders or failed breeders.

In 2009, far fewer Brent Geese were observed even though the areas surveyed were nearly identical to those areas surveyed in 2008. In total, only 403 geese in 25 flocks were encountered. In Kilen, only 91 individuals were recorded and in total only three broods were recorded (two in Kilen and one in Amdrup Land) (Fig. 4).

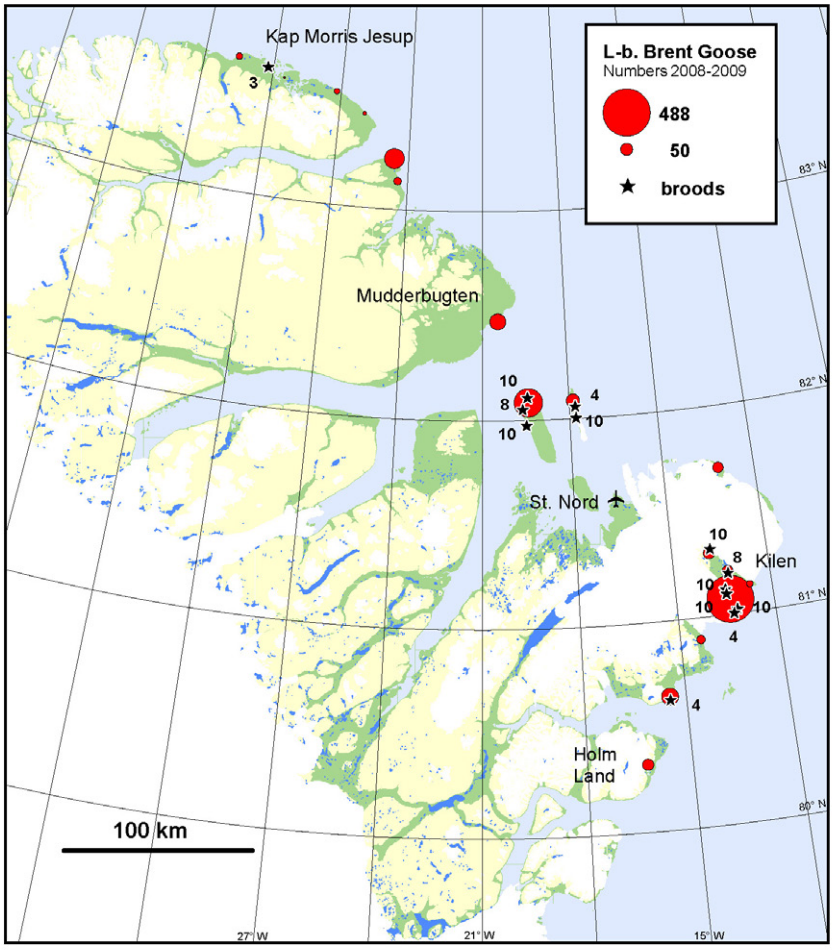

Fig. 4. Distribution of Light-bellied Brent Geese observed during the surveys in 2008 and 2009. Where there were records for both years at specific sites, the higher number is shown. Total numbers observed in the area illustrated were 1060 in 2008 and 403 in 2009. Figures at brood symbols indicate number of chicks recorded. *Fordelingen af observerede Lysbugede Knortegæs i 2008 og 2009. Fra områder dækket begge år er højeste antal vist. Totalt blev der optalt 1060 i 2008 og 403 i 2009. Tal ved kuld-symboler (stjerner) angiver antal gæslinger.*

Inter-annual variation

The GLM analyses show that the first author recorded a significantly higher mean flock size than the second author (in 2008) and the third author (in 2009) (GLM, $p < 0.01$ and $p = 0.02$). However, the mean flock size recorded by the first author did not differ between years (GLM, $p = 0.07$). Moreover, there were no significant interactions between goose species and observers in the two years (GLM, $p = 0.29$, $p = 0.99$). This indicates that although observer bias did play a role, this was restricted to the same side of the aircraft and occurred to the same degree in both years. These results suggest that the difference between 2008 and 2009 in observed numbers of geese was most likely real and not solely due to observer bias.

Other geese

A few non-breeding Snow Geese *Chen caerulescens* were observed among the Pink-footed and Barnacle Geese. In 2008, a total of four single observations of two white phase birds and two blue phase birds were recorded in Strindberg Land, Ymer Ø, Hold With Hope and Herluf Trolle Land. In 2009, a total of four white Snow Geese were observed in Jameson Land, Wollaston Forland and Herluf Trolle Land.

Two Canada Geese *Branta canadensis* were observed; both were seen in a flock of moulting Pink-footed Geese in Jameson Land in 2008.

Discussion

Pink-footed Goose

In 1983/84 it was concluded that the carrying capacity of the habitats in Jameson Land had almost been reached for moulting Pink-footed Geese (Madsen & Mortensen 1987). It was therefore quite remarkable to find that the population in 2008 and 2009 had increased

considerably; i.e. more than three times as many were found in 2008 compared to 1988. Concomittant new studies at the same moulting sites in Jameson Land in 2008 revealed that the density of geese had almost doubled since 1983/84, probably facilitated by a climate change-induced increase in productivity of the graminoid vegetation (Madsen *et al*. 2011).

Another factor contributing to the same areas supporting higher numbers could also be that moulting Pink-footed Geese now utilise suboptimal habitats to a higher degree than in earlier years. For example, we observed several flocks along rocky coasts, where they previously were not expected to occur. Moulting Pink-footed Geese were also found in habitats at higher altitudes (compared to 1988), e.g. in Hudson Land and Ole Rømer Land, where moulting geese were observed at lakes at more than 200 m a.s.l. This also could suggest that the optimal habitats have now been saturated by moulting Pink-footed Geese.

The survey in 1988 confirmed a northward range expansion by moulting Pink-footed Geese observed as early as in 1969-71 (Meltofte 1975). This expansion has continued, with large concentrations found up to 550 km north of the northern distribution limit found in 1988 (Boertmann 1991). In 1988, Pink-footed Geese were only recorded north of 80° N as accidental stragglers (Boertmann 1994), despite relatively high ornithological activity in the areas associated mainly with geological research (Meltofte 1976, Håkansson *et al.* 1981, Hjort *et al.* 1983, 1987, 1988, Bennike & Kelly 1986, Hjort 1986, Bennike & Higgins 1989). The first reports of large aggregations of moulting Pink-footed Geese in North Greenland were from 1998 when Ko de Korte (pers. comm.) found several thousand moulting birds in the Constable Bugt area of Johannes V. Jensen Land. Since then, reports of moulting Pink-footed Geese have been frequent and increasing from this part of Greenland (e.g. Glahder 1998, Clausen & Laubæk 1999). In 2008 and 2009, high numbers were located in all the major lowland areas surveyed and, surprisingly, also along the almost barren north coast of Johannes V. Jensen Land (Figs 3 and 5).

The surveys in 1988 could account for a total of 30 000 moulting Pink-footed Geese in Northeast Greenland (Boertmann 1991). A similar approach (by adding the most recent and highest numbers recorded in the different areas) 20 years later resulted in 75 000 moulting Pink-footed Geese distributed over a much wider area, including eastern North Greenland. This figure is certainly considerably below the actual numbers present. Many geese moult in unsurveyed areas (e.g. in the uncovered region between 77° and 80° N, most of interior Northeast Greenland and most of Hochstetter Forland), and Pink-footed Geese most probably also occur further to the west in North Greenland, as suggested by the very high densities located in Nansen Land – the westernmost area surveyed. This increase mirrors the development in the winter habitats (Mitchell 2010).

Moulting Pink-footed Geese have been recorded as far south as 63° N on the southeast coast of Greenland (Boertmann 1994). Hence significant numbers may also occur on the 1100 km long coastal strip of land between 63° N and Scoresby Sund, although only a few were found on the Blosseville Kyst during the surveys.

The habitat requirements of moulting Pink-footed Geese are primarily relatively lush wetlands, such as salt marshes or marshes fringing ponds, lakes and rivers, where the production of graminoids is high (e.g. Madsen *et al.* 2011). However, in some of the areas where large numbers of moulting Pink-footed Geese were found, the habitats looked barren and almost devoid of vegetation (at least when observed from the aircraft). Such an area is eastern Germania Land, where more than 4000 geese were seen in a moraine terrain dominated by barren gravel hills and ponds without marginal vegetation in 1988. Along the north coast of Johannes V. Jensen Land almost 3000 geese were moulting on a barren coastal plain with dispersed vegetation dominated by purple saxifrage *Saxifraga oppositifolia* and Arctic poppy *Papaver radicatum*.

Barnacle Goose

In the most important moulting area for Barnacle Geese – Jameson Land – the numbers had more than doubled since 1988. Numbers had also increased considerably in Hold With Hope and in Wollaston Forland, but here the increase could not be quantified because of very different survey routes between years.

The surveys in 1988 accounted for a total of 11 000 moulting Barnacle Geese in Northeast Greenland (Boertmann 1991). A similar coarse approach (by adding the most recent and highest numbers) 20 years later gives a figure of 25 500 moulting Barnacle Geese. This increase is in line with the doubling of the total population in the wintering sites in the same period (Mitchell & Hall 2013).

In contrast to the Pink-footed Geese, no moulting Barnacle Geese were observed in North Greenland, and there are very few reports of stragglers from this region. However, in 2006 a flock of moulting Barnacle Geese was observed in Danmark Fjord (P. Clausen pers. comm.), which indicates that further increases in population size may push more moulting bird into these northern habitats. Another indication of a range expansion was a flock of moulting birds observed at Umiivik south of Tasiilaq in Southeast Greenland (64° 25′ N) in July 2014 (Boertmann & Rosing-Asvid 2014).

Light-bellied Brent Goose

The surveys confirmed that the Brent Geese in eastern North Greenland are confined to the narrow polar desert zone adjacent to the Arctic Ocean (Hjort 1995) where they were observed between Kap Morris Jesup and Holm Land in 2008 and 2009. The surveys also confirmed Kilen as the most important area for the population, having about 50% of the birds recorded in 2008 and about half of the recorded broods. Moreover, Mudderbugten was confirmed to be an important site for moulting Brent Geese (cf. Denny *et al*. 2004).

The islands to the northwest of Station Nord proved to be an important breeding area. It is promising that breeding was confirmed as far west as Kap Morris Jesup. This indicates that the coasts from Kap Morris Jesup and south to Amdrup Land and Holm Land remain potential breeding sites.

The total number of observed Brent Geese in 2008 agrees with previous estimates of the Greenland component of the population at *c*. 1000 birds (Hjort 1995, Denny *et al*. 2004), and there were no signs of a local population increase. The geese on the other hand were much more dispersed along the coasts between Kap Morris Jesup and Holm Land, whereas almost all previously were found in Kilen, e.g. in 1998 when about 1000 geese were observed there (P. Clausen pers. comm.). The decrease in Kilen and the colonization of habitats west of Kronprins Christian Land could be a response to the immigration of Great Skuas *Stercorarius skua* to Kilen where there were three pairs in 2006 (P. Clausen pers. comm.) and at least two birds were seen from the aircraft in 2009 (Boertmann & Nielsen 2010).

Inter-annual variation

The reduction in numbers of both Pink-footed Geese (38%) and Barnacle Geese (26%) in Jameson Land from 2008 to 2009 is remarkable and much larger than the variation observed during the survey years 1985 to 1989 (Mosbech *et al.* 1989). Observer bias seems to have been the same in the two years, and given that survey effort and weather conditions were almost identical in the two years, the difference is most likely real. On Svalbard, extensive snow cover has been shown to restrict many Pink-footed Geese from breed-

Fig. 5. A flock of 131 moulting Pink-footed Geese on the north coast of Johannes V. Jensen Land 40 km east of Kap Morris Jesup. They had retreated to the narrow strip of open water due to the approach of the survey aircraft. Note the shadow from the aircraft and the barren coast almost devoid of vegetation.
Flok med 131 fældende Kortnæbbede Gæs på nordkysten af Johannes V. Jensen Land. De er flygtet ud på den smalle stribe af åbent vand, da optællingsflyet nærmede sig. Bemærk flyets skygge og den sparsomme vegetation på kysten.

More than 1000 Light-bellied Brent Geese were recorded in North Greenland in 2008. Here moulting birds on Kilen, juli 1998. Photo: Preben Clausen.
Mere end 1000 Lysbugede Knortegæs blev talt i Nordgrønland i 2008. Foto: Preben Clausen, Kilen, juli 1998.

ing (Anderson *et al*. 2015). Since May/June 2008 was exceptionally snow rich in Jameson Land compared to 2009 (based on our own observations), as was also evident from satellite images, failed breeders may have contributed to the elevated numbers of moulting birds in 2008. At Zackenberg, snow cover was close to average on 10 June 2008, while 2009 had the lowest snow cover recorded since snow cover was initiated in 1996 (Sigsgaard *et al*. 2009, 2010), therefore the 2008 snow conditions in Jameson Land was apparently a local phenomenon.

The breeding success of the total population (including the Icelandic part) in the winter habitats was estimated as being high in 2008 and considerably lower in 2009 (Mitchell 2009, 2010). This suggests that poor breeding conditions in 2008 also may have been restricted to Jameson Land.

The much reduced numbers of both breeding and moulting Brent Geese observed in 2009 compared to 2008 indicate that a large fraction of the Greenland Brent Goose population did not attempt to breed/moult at this marginal part of the breeding range in 2009 and possibly returned to Svalbard, since the populations in these two areas are closely linked (Clausen & Bustnes 1998, Clausen *et al*. 2003). The reason for this difference is unknown, but satellite images indicate that snow melt in Kilen was greatly delayed in 2009 compared to 2008 and that the southeastern lowland part of Kilen was still covered by snow on 20 June 2009, whereas it has been completely free of snow on the same date in 2008. Moreover, numbers of juveniles among the flocks recorded in Denmark the following autumn were very low (2.5%, P. Clausen pers. comm.) which supports the hypothesis that 2009 was, in general, a very poor breeding year for Light-bellied Brent Geese of this population (Denny *et al*. 2004).

Other geese

Single individuals and small flocks of Canada Geese are reported almost annually from Northeast Greenland (e.g. Hansen *et al.* 2010, Meltofte & Dinensen 2010). Breeding must be expected soon because the West Greenland breeding population of this species is still increasing and expanding its breeding range (Fox *et al*. 2012). For instance, breeding was proven for the first time in Southeast Greenland in 2014 (Boertmann & Rosing-Asvid 2014).

Tab. 2. New sites which fulfil the 1% IBA criterion for sites of international importance.
Nye lokaliteter i Nordøst- og Nordgrønland, som opfylder 1 % IBA-kriteriet for fuglelokaliteter af international betydning.

Area	**Region**	**Geographical coordinates**	**Distance from center to border (km)**	**Species**	**No.**	**Year**	**Habitat**
Område	Region	Koordinater	Afstand fra centrum *til rand (km)*	Art	Antal	År	Habitat
Siriuspasset	Nansen Land	82° 52′ 04″ N 42° 03′ 29″ W	12	Pink-footed	8517	2009	Wetlands in valley
Vitskøl Elv	Herluf Trolle Land	82° 31′ 14″ N 23° 13′ 35″ W	40	Pink-footed	9452	2009	Wetlands in valley and coastal delta
Mudderbugt	Herluf Trolle Land	82° 27′ 55″ N 20° 53′ 48″ W	10	Brent	75	2008	Marine coast and delta
Kap Johan Flagler	Herluf Trolle Land	83° 12′ 19″ N 24° 26′ 23″ W	10	Brent	110	2008	Marine coast
Albrechtslette, NW corner	Wollaston Forland	74° 35′ 10″ N 19° 56′ 59″ W	5	Barnacle	1724	2009	Wetlands on plain
Pr. Margrethe & Pr. Thyra Ø	Kr. Christian Land	82° 00′ 11 N 18° 34′ 16″ W	26	Brent	248	2008	Marine coast
Sommer-terrassen	Amdrup Land	80° 40′ 02″ N 15° 34′ 32″ W	8	Brent	87	2008	Marine coast

Conservation

All surveyed regions, except for Jameson Land and Blosseville Kyst, are situated within the National Park of North and East Greenland. This does not mean that the habitats are protected from changes, because mineral and hydrocarbon exploration and exploitation are possible within the National Park. Background information on the extent and nature of the goose habitats and their use is therefore crucial in order to protect important and critical sites. The results from the 1988 survey contributed data for the designation of three Ramsar sites (two within the National Park) and for the identification of 14 BirdLife International *Important Bird Areas* (IBA) (eight within the National Park) in Northeast and eastern North Greenland (Boertmann 2000). The 2008/09 surveys revealed a number of new sites that fulfil the 1% IBA A4/B1 criteria (habitat of international importance to the species; Heath & Evans 2000) for the three species of geese and confirmed one site which was identified in 2004 (Denny *et al*. 2004). Since the populations of Pink-footed and Barnacle Geese have doubled over the 20 years covered, the 1% criterion has increased consequently and in 2009 was equivalent to 3600 Pink-footed Geese, 740 Barnacle Geese and 72 Brent Geese (Tab. 2).

Future research

Three issues related to the increasing goose populations are relevant as a focus for further research in Northeast Greenland:

Habitat deterioration. It is well documented that expanding goose populations in Arctic Canada and Svalbard locally have caused severe adverse impacts on the vegetation of their feeding habitats (Jeffries *et al.* 2006, Pedersen *et al*. 2013). In 2008 signs of reduced vegetation cover due to goose grazing were found in Jameson Land (Madsen *et al.* 2011).

Performance of moulting Pink-footed Geese in habitats devoid of vegetation. It is relevant to study how the large flocks of moulting Pink-footed Geese balance their energy and nutrient demands in the apparently barren habitats described above. Does the use of such habitats have adverse fitness consequences for the individuals involved?

Performance of the breeding Pink-footed Geese in Northeast Greenland. An increase in both breeding density and breeding range is expected in Northeast Greenland. However, so far there is information only from Jameson Land where nest densities in 2009 had increased up to 10 fold since the early 1980s (Meltofte & Dinesen 2010, Madsen *et al.* 2011). This could be studied by land based surveys in potential high quality breeding areas dispersed over the moulting range.

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Resumé

Gæs i Nordøst- og Nordgrønland optalt fra fly i 2008 og 2009
I 2008 og 2009 gennemførtes flybaserede optællinger af gæs i Nordøst- og Nordgrønland (Fig. 1 og 2). Optællingerne dækkede bl.a. Jameson Land, som blev talt op på samme måde i 1988, og resultaterne herfra er derfor sammenlignelige.

Kortnæbbet Gås: Tællingerne viste, at antallet af fældende fugle er øget markant siden 1988. I 2008 var der tre gange så mange i Jameson Land som i 1988; i 2009 dog noget færre. Der var desuden fældende Kortnæbbede Gæs i det meste af det undersøgte Nordgrønland (Fig. 3), i alt mindst 30 000. De blev først konstateret i Nordgrønland i 1998, så der er sket en voldsom fremgang i bestanden her.

Bramgås: Bestanden af fældende Bramgæs var også gået markant frem siden 1988; i Jameson Land således en fordobling, mens der ikke kunne konstateres ændringer i udbredelsen.

Fremgangen i disse to gåsebestande i Grønland kan ikke overraske, da overvågning i vinterkvartererne på De Britiske Øer har vist tilsvarende fremgange.

Knortegås: Der blev i 2008 optalt ca. 1000 fugle, heraf ca. 25 par med unger, mens antallet i 2009 var væsentligt lavere. De ca. 1000 fugle svarer til tidligere opgørelser af den grønlandske del af bestanden, men de var markant mere spredt end tidligere set, hvor næsten hele bestanden opholdt sig på det begrænsede landområde Kilen. Her var der i 2006 og 2009 Storkjover og måske har deres prædation forårsaget dels et lavere antal på Kilen og dels den spredning til andre områder, der blev observeret.

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