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Incidents of neckband icing and consequences for body condition and survival of pink-footed geese *Anser brachyrhynchus*

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During cold spells in Denmark and The Netherlands in January-February 1996, and in Belgium in January 1997, ice buildup on plastic neckbands on pink-footed geese *Anser brachyrhynchus* was observed, affecting 15-31% of the marked geese in the areas. Ice started to form at effective temperatures of approximately -5°C, but broke off after 1-6 days, despite temperatures remaining below the freezing point. During the subsequent months, there was no detectable difference in body condition, assessed by an abdominal profile index, of geese which had experienced no, light or heavy icing of neckbands, respectively. Furthermore, during the subsequent spring and autumn there was no significant difference in resighting rates of geese with and without neckband icing.

Key words: body condition, goose, mortality, neck collar, waterfowl

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Neckbands are widely applied as individual markers in studies of geese in North America and Europe. In Europe, more than 20 studies using neckbands have been initiated since the early 1970s (Madsen 1995) and the method has proved to be valuable in studies of behaviour, dispersal, migration and population dynamics of geese. It is generally assumed that neckbands do not affect the behaviour or fecundity/survival of marked individuals. However, from North America incidents of icing of neckbands have been reported, causing casu-

alties among especially Canada geese *Branta canadensis* during late fall (Greenwood & Bair 1974, Zicus, Schultz & Cooper 1983). To our knowledge, no cases of goose neckband icing have been reported from Europe.

In this paper we describe two incidents of icing of neckbands on pink-footed geese *Anser brachyrhynchus* wintering in Denmark, The Netherlands and Belgium. We evaluate the impacts on subsequent body condition, assessed by an abdominal profile index, and survival.

Study population

The Svalbard breeding population of the pink-footed goose migrates via Norway to wintering grounds in Denmark, The Netherlands and Belgium (Madsen, Kuijken, Meire, Cottaar, Haitjema, Nicolaisen, Bønes & Mehlum 1999). The geese used to winter south of the 0°C isotherm and quickly migrated southwards from Denmark in case of cold spells (Madsen 1980). Since the late 1980s, an increasing number of geese have wintered in Denmark despite cold spells, which is a result of an increased area of winter cereals providing the geese with a reliable and high-quality food supply even during periods of sub-zero temperatures (Therkildsen & Madsen 2000). Only in case of thick snow coverage of the ground, will the geese migrate south.

Material and methods

Since 1990, a total of 976 individuals have been marked with blue plastic neckbands engraved with three-digit codes. Intensive reading of neckbands has been carried out throughout the winter range, providing resighting probabilities above 95% in most springs (April-May) and autumns (October-November) since 1991 (Madsen & Noer 1996, Madsen, Frederiksen & Ganter in press).

To visually assess body condition of individually marked geese in the field, an abdominal profile index (API) was developed (Madsen, Hansen, Kristensen & Boyd 1997). The API ranges from 1 (lowest) to 7 (highest). During spring, APIs of individuals were scored repeatedly.

Weather information was obtained from local weather stations from the Danish Meteorological Institute, the Dutch Meteorological Institute and the Royal Meteorological Institute of Belgium.

Results

Case 1

During January 1996, approximately 10,000 pink-

footed geese wintered in Ballum Enge, southwest Denmark (55°07'N, 08°42'E), a polder area next to the Wadden Sea. Observations of geese were carried out on a daily basis. The geese foraged on pastures and winter cereal fields and roosted in a canal outside the sea dikes. The geese arrived during 10-14 January when daily mean temperatures were around the freezing point. From mid January to early February daily mean temperatures decreased to -7°C (maximum range: -1 to -3°C and minimum range: -4 to -10°C). During late January to early February, temperatures temporarily increased (5 February: max. 0, min. -5°C), only to decrease again (9 February: max. -8, min. -13°C). From mid-February onwards, daily mean temperatures approached the freezing point, and there was a snow fall covering the fields with a 10-20 cm layer of snow. All geese then abandoned the area and flew southwards to The Netherlands and Belgium, to return to Denmark during early March when daily temperatures were around the freezing point and the snow had disappeared (Madsen et al. 1999). During the cold spell in January-February, the wind speed was on average 6 m sec⁻¹, adding a wind chill factor to the sub-freezing temperatures.

From 21 January, ice formation on neckbands was observed. Icing varied from a thin ice cover on the front of the neckband to a thick layer (approximately 5 cm) all around the neckband, forming a heavy clump of ice on the front of the neckband (up to 5-10 cm thick). Because geese were observed on a daily basis, it was possible to maintain a record of neckband codes despite partial ice coverage of the neckbands. Two categories were distinguished: light icing (no clump in front of neckband) and heavy icing (clump of ice in front of neckband). A total of 164 neckbanded individuals were observed in the area during January-February, of which 51 (31%) were recorded with some degree of icing (Table 1). The majority of geese were observed from day-to-day and the icing did not last more than 4-6 days at a maximum, and all geese appeared to lose the ice during the last days of January. Five geese were observed to form ice again during 8-11 February, but the icing only lasted 2-3 days.

Geese with iced neckbands were observed feeding

Table 1. Number of neckbanded pink-footed geese observed with and without icing in Ballum Enge during January-February 1996, and subsequent resightings during April (spring) and September-October (autumn) 1996. Percentages give the proportion of the birds observed in January-February subsequently resighted.

	No observed during January-February	No resighted during spring	%	No resighted during autumn	%
No ice	113	109	96.5	90	79.7
Light icing	26	26	100.0	21	80.8
Heavy icing	25	24	96.0	22	88.0
Total	164	159	97.0	133	81.1

in the fields, 0.5-2 kilometres from the roost site. Geese with light icing were foraging by walking, whereas geese with heavy icing were sitting while feeding, and only walked when changing their foraging position. All geese flew outside the sea dikes to roost.

During the same cold spell, approximately 7,000 pink-footed geese stayed in Friesland in The Netherlands (approximately 52°58'N, 05°34'E). Out of a total of 41 neckbands observed during four observation days between 15 January and 3 February, eight neckbands with some degree of icing (20%) were noticed on 22 and 29 January, when daytime temperatures were -3 and -5°C, respectively, and the wind speed 5-8 m sec⁻¹. On 3 February, when the daytime temperature was -3°C and the wind was calm, icing of neckbands was not observed.

Case 2

During late December 1996, approximately 21,000 pink-footed geese stayed in the Flemish polders between Oostend, Bruges and Knokke in Belgium (approximately 51°15'N, 03°03'E), where geese feed on permanent grassland and usually roost in the fields at night. They drink and bathe in ditches and small ponds (Meire & Kuijken 1991). A cold spell started on 21 December and lasted until 12 January. Especially during 1-3 January 1997, temperatures reached extremes of -10 to -13°C, and the wind was northeasterly with a speed of up to 14 m sec⁻¹.

Observations of geese were carried out almost daily from 26 December to 11 January. Icing of neckbands was observed during 1-8 January. In total 123 neckbanded geese were observed, of which five had light icing and legible codes, six had heavy icing and legible codes and seven had heavy icing and illegible codes. Thus, approximately 18 neckbanded birds had icing (15%), but possibly the percentage was slightly lower because some of the birds with illegible codes may have been some of the ones seen with a smaller degree of icing during previous days. Most birds lost the ice after 1-3 days; one bird lost the ice after three days but was seen with ice again four days later. Geese with icing on neckbands continued to feed but at a reduced rate.

Consequences for body condition

Average APIs of male and female pink-footed geese with and without icing in 1996 are shown in Figure 1. Mean values are from the middle of the month ± 5 days in February, March and April, respectively. In none of the three months, was there a significant difference in APIs of birds with no ice formation and birds with light and heavy ice formation, respectively (Kruskal-Wallis

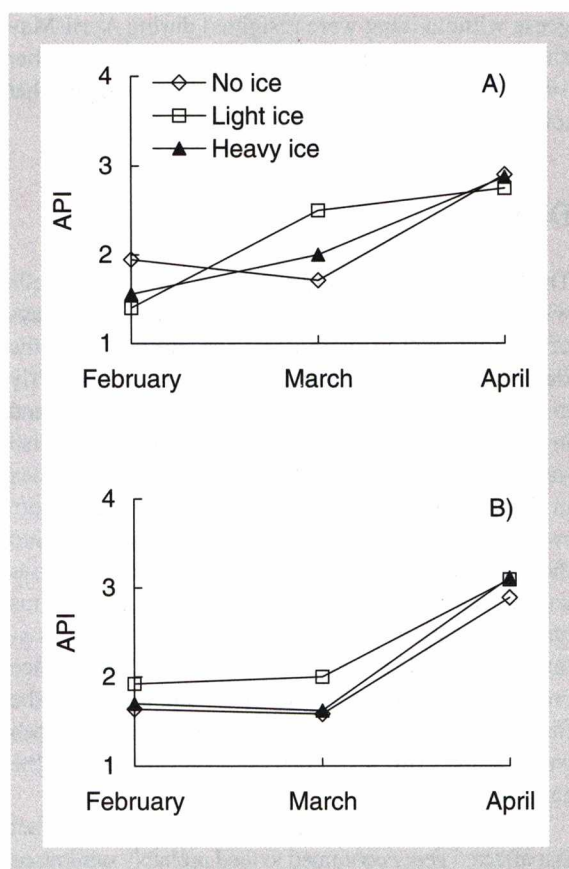


Figure 1. Mean abdominal profile index (API) of male (A) and female (B) pink-footed geese during mid-February, mid-March and mid-April 1996, divided into individuals experiencing no, light and heavy neckband icing during January-February, respectively. In males, sample sizes range within 4-37, in females within 4-27.

one-way analysis of variation of ranks: $P > 0.1$ in all cases).

Consequences for survival

Of all geese previously observed in Ballum Enge in January-February 1996, 97 and 81% were resighted during April-May and September-November, respectively (see Table 1). There was no significant difference in frequency distribution of the number of resighted versus non-resighted individuals with and without icing (April: $\chi^2 = 0.296$, $df = 1$, $P > 0.05$; October: $\chi^2 = 0.499$, $df = 1$, $P > 0.05$).

Of the six geese with legible iced neckbands in The Netherlands in January 1996, five and four were resighted during April-May and September-November 1996, respectively.

Of the 11 birds with icing in Belgium in January 1997, 10 were resighted during April-May and nine during September-November 1997. In comparison, 89 of 105

geese without icing were resighted during April-May and 84 were resighted during September-November 1997. Hence, this small material does not suggest that icing of neckbands caused additional mortality.

Discussion

The two incidents of icing happened during cold spells with relatively strong wind forces. During the first days of the cold spells, freshwater pools and ditches in the fields froze over. In Ballum Enge the geese had to fly to the canals outside the sea dike to drink and roost, and in Flanders they flew to icefree canals and a brackish sandpit to drink and bathe. The icing probably happened in these open water bodies, because the geese were swimming in the open water where water sprayed onto the neckbands. We cannot explain why some individuals did, and others did not, experience icing. It seems that icing started at effective temperatures of approximately -5°C . The icing lasted 1-6 days, and the ice broke off despite temperatures remaining below the freezing point. It is possible that the use of brackish open water with a sub-zero freezing point facilitated the early break-off.

The relatively quick break-off of the ice and the fact that affected geese continued to feed probably minimised the effects of icing and, fortunately, it did not have a detectable impact on body condition and subsequent survival. The more fatal instances reported from North America happened in late fall as winter sets in with a complete freeze up lasting for months, which is in contrast to the North Sea situation where weather conditions usually ameliorate after relatively short periods of cold spells.

Because of the icing incident in 1996, marking was stopped until the consequences became known. In North America, cone-shaped rubber neckbands have been developed on which ice forms less easily than on plastic neckbands (Hestbeck, Rusch & Malecki 1990). However, we were reluctant to change to another type of neckband because the plastic neckbands have very good properties apart from the icing problem. Hence, the neckband loss rate is very low (approximately 1% per year; Madsen & Noer 1996, Madsen et al. in press), and neckbands are highly legible in the field. Because we found no serious impact of the icing, it was therefore decided to continue marking with the plastic neckbands and marking was resumed in the spring of 1998.

So far, icing has happened in two severe winters in nine years of neckband marking. In the southern part of the winter range (Belgium, The Netherlands), which

has the mildest winter climate, the occurrence of icing is likely to remain infrequent and last for short periods only. In Denmark, where more wintering pink-footed geese stay during cold spells because of the change to winter cereals, the frequency of icing is likely to increase. Both from an animal welfare point of view and a scientific perspective, it is imperative to monitor and evaluate the consequences when icing occurs.

Based on our experience and those obtained in North America, we recommend that researchers planning to use neckbands in studies of waterfowl carefully assess the risks of icing which may occur during various parts of the annual cycle.

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