

Low Abundance of King Eider Nests during Low Lemming Years in Northeast Greenland

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ABSTRACT. Long-term surveys on Traill Island (Northeast Greenland) show that numbers of king eider (*Somateria spectabilis*) nests are correlated with high densities of collared lemming (*Dicrostonyx groenlandicus*). These observations match other zoological records from this region and agree with similar observations recorded elsewhere for arctic geese. Processes at work may be related to the fact that mammalian predators focus on lemmings when lemming numbers are high, but exert higher predation pressure on other prey at low lemming densities. Predators seem to increase their search effort during such low lemming years, thus increasing the likelihood that they will discover eider nests. This study highlights the importance of studying patterns at the community level in any attempt to interpret cyclic fluctuations in northern ecosystems.

Key words: arctic fox, *Alopex lagopus*, collared lemming, *Dicrostonyx groenlandicus*, Greenland, king eider, *Somateria spectabilis*, population cycles, predation

RÉSUMÉ. Une étude à long terme menée sur l'île de Traill (nord-est du Groenland) a mis en évidence que le nombre de nids d'eiders à tête grise (*Somateria spectabilis*) est corrélé à de fortes densités de lemming à collier (*Dicrostonyx groenlandicus*). Ces observations sont identiques à celles des autres relevés fauniques réalisés dans cette région et confortent des constats similaires sur le succès de reproduction des oies arctiques. Le déterminisme de ces phénomènes semble être lié au fait que les mammifères prédateurs se concentrent sur les lemmings lorsque ces derniers sont abondants, mais exercent une pression de prédation plus forte sur les autres espèces lorsque les lemmings se font plus rares. L'effort de recherche des prédateurs semble augmenter durant les années de creux, ce qui accroît la probabilité de découvrir les nids d'eiders. Cette étude souligne l'importance d'examiner les phénomènes dans l'ensemble de la communauté animale pour tenter d'expliquer les fluctuations cycliques dans les écosystèmes nordiques.

Mots clés: eider à tête grise, *Somateria spectabilis*, lemming à collier, *Dicrostonyx groenlandicus*, renard polaire, *Alopex lagopus*, prédation, cycles des populations, Groenland

INTRODUCTION

Cyclic fluctuations of rodents such as lemmings are a common feature of northern ecosystems (Stenseth and Ims, 1993). Associated with these phenomena are the cyclic dynamics of predators such as arctic foxes (*Alopex lagopus*) and snowy owls (*Nyctea scandiaca*) (Portenko, 1972; Summers et al., 1998). The mechanisms behind these fluctuations are still largely unknown (Stenseth and Ims, 1993). Recent findings have highlighted the role that specialist predators play in these phenomena, generating a delayed density dependence (Hanski et al., 1993; Norrdahl, 1995; Reid et al., 1995), while the role of food availability and intrinsic factors (i.e., parental care) remains yet to be resolved (Boonstra et al., 1998).

Knowledge of the population dynamics displayed by other species in the community can aid in understanding cyclic population dynamics. If coexisting species competing for the same food resource display fully departing

dynamics, then food limitation could not account for cyclic patterns in one species and not in the other. On the other hand, similar population dynamics in species that have different diets but share the same predators could suggest that direct or indirect effects of predator-prey interactions might be involved.

Observations suggest that the breeding success of brent geese (*Branta bernicla*) is related to the lemming cycles (Summers, 1986; Greenwood, 1987; Underhill et al., 1993; Summers et al., 1998). However, these herbivores share some of the same food resources as microtine rodents. Observations on non-herbivorous species are scarce (Pehrsson, 1986; Martin and Baird, 1988; Spiekman and Groen, 1993; Summers et al., 1998). Our goal is to examine the population dynamics of a non-herbivorous species with respect to lemming population cycles.

Such a candidate species is the king eider, a typical tundra breeder whose diet is almost entirely marine animals (Uspenski, 1972). In summer, females nest on the

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tundra and hence share the same habitats and predators as lemmings (Uspenski, 1972). The rest of the year, this species uses marine habitat. By determining whether there is a correlation between lemming densities and the breeding of the king eider (a potential alternative prey for predators), one could see whether predator pressure may at times reduce breeding success in king eiders.

To compare the number of king eider nests with lemming abundance in Northeast Greenland, we used two different data sets: observations gathered as part of a long-term study devoted to lemmings on Traill Island and data compiled from the literature.

STUDY AREA

Investigations reported here were conducted within a study site of about 10 km² in the Karupelv Valley (75 km²), Traill Island (72°30'N, 24°00'W), Northeast Greenland (Fig. 1). This area is part of the High Arctic breeding range of the collared lemming as well as the king eider and snowy owl. It consists of a wide-open valley on the southern part of Traill Island, facing Kong Oscars Fjord. Numerous raised beaches parallel the present shoreline. Inland elevations do not exceed 100 m a.s.l. Lakes are less numerous and relatively smaller (< 1 ha) than in other tundra areas. At the beginning of the breeding season, open water is limited to shore leads or ice-free areas that result from meltwater discharges. These are generally the places where small groups of king eider first gather in June. This region has polar semidesert vegetation that is discontinuous. The collared lemming is the only small rodent. Its population dynamics display typical cyclic patterns that are also illustrated by the densities of its main predators, arctic fox, stoat (*Mustela erminea*), long-tailed skua (*Stercorarius longicaudus*), and snowy owl (Pedersen, 1942; de Korte, 1988; Sittler, 1995).

METHODS

This study, part of a long-term monitoring of a lemming population initiated in 1988, is based on a systematic survey of winter nests revealed at snowmelt at the end of June (Sittler, 1995). For this purpose, the area is screened by walking strip transects (25 m wide) during the king eider incubation period from the end of June until the beginning of August. The transects, which are walked once, vary in length; therefore, they cover all parts of the study area. Distances of at least 500 km per field season are covered, with every effort to ensure that the census effort is the same every year. While walking these transects, observers mark king eider nests on air photos and destroy lemming winter nests after counting them. These transects also allow us to census breeding birds and larger mammals. Breeding king eider females are more difficult to detect than lemming winter nests and most of the bird nests

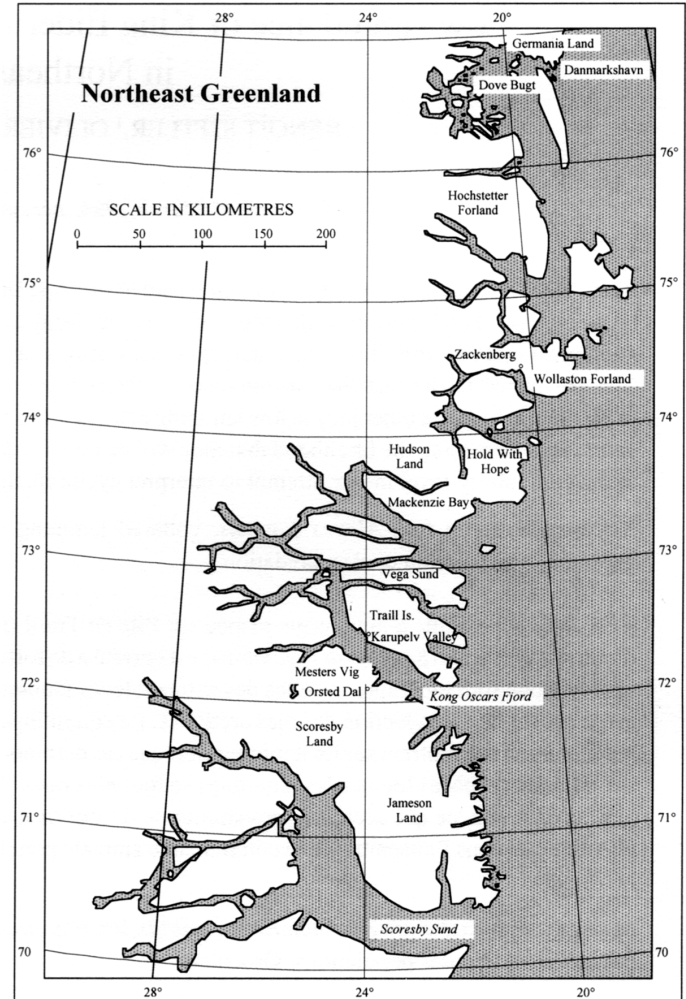


FIG. 1. Map of Northeast Greenland showing our study area and other locations referred to in this paper.

recorded on these transects because of their silent, secretive behaviour and their reluctance to leave the nest unless closely approached by the observer. Data may therefore be biased because we cannot be sure that all the breeding king eiders were recorded. As the sampling methods remained constant over the 12 years of the study, this bias should be the same in all years. Since snowy owls have larger territories than king eiders, snowy owl nests were censused over the whole Karupelv Valley (7500 ha).

In addition, to get a comparative and larger overview, we compiled all available zoological records from Northeast Greenland that provide information on lemmings and king eiders. In contrast to systematic surveys like the one reported above (same study area over years and same census effort), these data are from various sites and without consistency in sampling procedures. Direct surveys were usually not available to estimate the lemming densities. Authors generally describe the lemming situation either as “bad” or “low” when lemmings were not observed, or as “abundant” or “common” during an increase or peak phase. Therefore, we also included snowy owl

TABLE 1. Numbers of king eider and snowy owl nests compared to numbers of lemming winter nests in the lower Karupelv Valley, Traill Island, Northeast Greenland.

| Year | Lemming winter nests ¹ | King eider nests ¹ | Snowy owl nests ^{1,2} |
|------|-----------------------------------|-------------------------------|--------------------------------|
| 1979 | n.d. (increase/peak) | 2 | 1 (2) |
| 1985 | n.d. (low) ³ | 0 | 0 |
| 1988 | 149 | 0 | 0 |
| 1989 | 1270 | 1 | 1 (6) |
| 1990 | 3687 | 2 (+1 family outside) | 2 (12) |
| 1991 | 282 | 0 | 0 |
| 1992 | 105 | 0 | 0 |
| 1993 | 145 | 0 | 0 |
| 1994 | 2938 | 3 (+1 nest on islet) | 1 (5) |
| 1995 | 1007 ⁴ | 0 | 0 |
| 1996 | 195 | 0 | 0 |
| 1997 | 311 | 0 | 0 |
| 1998 | 3521 | 3 (+1 family on islet) | 1 (13) |
| 1999 | 1596 | 1 | 1 (3) |

¹ in the restricted study area (1000 ha).

² Figures in parentheses are for the Karupelv Valley (7500 ha).

³ data from Newton (pers. comm. 1998).

⁴ rapid lemming decline in spring before king eider breeding.

breeding records, which are known to be reliable indicators of lemming abundance (Portenko, 1972).

Because of the small sample size ($n = 12$ years), we used the Spearman rank correlation coefficient (r_s) to compare lemming winter nests with king eider and snowy owl nests in our study area. For the other Northeast Greenland sources presented in Table 2, we used the Pearson's correlation coefficient to compare lemming abundance (0 for low, 0.5 for intermediate, or 1 for high) and king eider breeding (0 when no evidence of breeding and 1 if breeding).

RESULTS

The first pattern that emerged from our 12-year monitoring in the Karupelv Valley (Table 1) was that king eiders in this part of their range may breed only in low numbers, since the maximum number of nests discovered per season was three. King eider nests were discovered only during high lemming years (indicated by lemming winter nests), i.e., when lemmings were either in an intermediate phase (1989 and 1999) or in a peak year (1990, 1994, and 1998), and are significantly correlated with lemming winter nests ($r_s = 0.88$; $p < 0.01$). This correlation is as strong as that between lemming winter nests and snowy owl nests ($r_s = 0.87$; $p < 0.01$). A similar pattern was recorded in the study area in 1979, when two king eider nests were found during an exploratory survey in a high lemming year (GREA, 1982). Not a single nest was found in all other years.

The other available sources from Northeast Greenland, presented in Table 2, give a similar result. King eider nests are not found when lemmings are at a low, but only when lemming numbers are high. Pearson's correlation coefficient is highly significant ($r = 0.75$; $p < 0.001$) when

comparing lemming abundance (0 for low, 0.5 for intermediate, or 1 for high) and king eider breeding (0 when no evidence of breeding and 1 if breeding). Only 5 out of 55 references did not match this general pattern. In one instance in 1964, breeding occurred on an islet (Rosenberg et al., 1970; but see Discussion), in another case in 1966, data on lemming densities were not clearly documented (Marris and Webbe, 1969), and in two instances, in 1980 (Sellar et al., 1981) and 1998 (author's observation), no breeding was observed despite high lemming densities. Clear evidence for king eider breeding during a lemming low was provided only by Meltofte (1975), on Germania Land, close to Danmarkshavn, in 1969.

DISCUSSION

The failure to detect any king eider nests in our study area in the eight years when lemmings were either at a low or in a pronounced decline, together with positive recordings in all high lemming years (Table 1), suggests that breeding success of king eider in this region is related to processes that also act on lemmings. This assumption is supported by the comparative data presented in Table 2. Available data for the rest of the Arctic suggest similar trends, even if breeding is annual. On southern Victoria Island (Northwest Territories, Canada) for example, Parmelee et al. (1967) found by far more king eider nests in 1960 (25 nests), when lemmings were abundant, than in 1962 (only four nests), during a lemming low. On the same site, O. Gilg, G. Ritter, E. Buchel and R. Sané (unpubl. data) found 16 king eider nests in 1996 during a lemming peak (plus several dozen pomarine skua and snowy owl nests), but only 1–3 nests during lemming lows (two in 1997, one in 1998, and three in 1999, plus one failed snowy owl nest in 1997, but no pomarine skua nests). Similar trends were also reported from Siberia (Stishov et al., 1991; Kondratyev and Sokolov, 1993).

It is unclear whether the failure to detect any nests in Northeast Greenland in low lemming years is due to non-breeding or to nest predation before detection by the observer (since pairs are generally present on open waters in the sea from June until they migrate south). Reasons for non-breeding or low breeding success among Arctic birds include poor weather and delayed snowmelt (Bertram et al., 1934; Sdobnikov, 1971), but there are others (Pehrsson, 1986; Syroechkovskiy et al., 1991; Dickson et al., 1997). In 1994, a summer with an exceptionally late snowmelt in our study area, king eider egg laying was postponed by more than two weeks, but not prevented (three nests were recorded). Hence, predation-related processes may be regarded as the major factors affecting the breeding success of king eider in our study area and in Northeast Greenland. Studies documenting nest predation rates, are rare but Lamothe's (1973) study showed that they can be very high. Of the 25 king eider nests he found on Bathurst Island (Canada), 18 were preyed upon by arctic foxes.

TABLE 2. Breeding records of king eiders in Northeast Greenland obtained from various reports. Information is compared to population density of lemmings and to breeding records of snowy owls.

| Year | Area | Lemming ¹ | King eider ² | Snowy owl ² | Source ³ |
|------|----------------------------|----------------------|-------------------------|------------------------|--|
| 1900 | Mackenzie Bay | +++ | B | B | Kohltoff (1903) |
| 1900 | NE Greenland | 0 | 0 | 0 | Deichmann (1909) |
| 1906 | Danmarkshavn | ++ | B | B (?) | Manniche (1910) |
| 1907 | Danmarkshavn | 0 | 0 | 0 | Manniche (1910) |
| 1908 | Danmarkshavn | 0 | 0 | 0 | Manniche (1910) |
| 1924 | Scoresby Sund | 0 | 0 | 0 | Pedersen (1926) |
| 1925 | Scoresby Sund | 0 | 0 | 0 | Pedersen (1926) |
| 1927 | Jameson Land | + | B (n = 3) | B | Pedersen (1930) |
| 1928 | Jameson Land | ++ | B (n = 40) | B | Pedersen (1930) |
| 1929 | Jameson Land | 0 | 0 | 0 | Pedersen (1930) |
| 1930 | NE Greenland 73–75°30N | 0 | 0 | 0 | Loppenthin (1932) |
| 1933 | Hochstetter Forland | +/+++ | B | B | Pedersen (1934) |
| 1933 | Jameson Land | 0 | 0 | 0 | Bertram et al. (1934) |
| 1936 | Mackenzie Bay | ++ | B | B | Bird and Bird (1940, 1941) |
| 1937 | Mackenzie Bay | ++ | B | B | Bird and Bird (1940, 1941) |
| 1938 | Mackenzie Bay | 0 | 0 | 0 | Bird and Bird (1940) |
| 1938 | Dovebugt | 0 | 0 | 0 | Pedersen (1942) |
| 1939 | Germania Land | 0 | 0 | 0 | Pedersen (1942) |
| 1961 | Orsted Dal | 0 | 0 | 0 | Marris and Ogilvie (1962) |
| 1962 | Jameson Land | + | B (n = 1) | 0 ⁴ | Hall (1966) |
| 1963 | Orsted Dal | ++ | B | B | Hall and Waddingham, (1966) |
| 1964 | Wollaston Forland | 0 | B (n = 1, on islet) | 0 | Rosenberg et al. (1970) |
| 1966 | NE Greenland 71–75°N | ? | B (n = 1) | 0 | Marris and Webbe (1969) |
| 1969 | Scoresby Sund | 0 | 0 | 0 | Vranes (1971); Smart (1969) |
| 1969 | NE Greenland 76–78°N | 0 | B | 0 | Meltofte (1975) |
| 1970 | NE Greenland 76–78°N | + | B | B | Meltofte (1975) |
| 1970 | Scoresby Land | + | B | 0 | Smart and O'Brien (1971) |
| 1972 | Mestersvig | 0 | 0 | 0 | O'Brien and Greenwood (1972) |
| 1973 | Hold with Hope | 0 | 0 | 0 | Hjort (1976) |
| 1974 | Scoresby Sund | 0 | 0 | 0 | Meltofte (1976b) |
| 1974 | Orsted Dal | 0 | 0 | 0 | Ferns and Mudge (1976) |
| 1974 | Mestersvig & Traill Island | + | B (n = 1) | 0 | Green and Greenwood (1978) |
| 1975 | Germania Land | +/+++ | B (n = 8) | B | Meltofte (1977) |
| 1976 | Hochstetter Forland | ++ | B (n = 18) | 0 ⁴ | Meltofte et al. (1981) |
| 1979 | Mackenzie Bay | ++ | B (n = 10) | B | Elander and Blomquist (1986) |
| 1980 | NE Greenland | ++ | 0 | B | Sellar et al. (1981) |
| 1982 | Vega Sund | 0 | 0 | 0 | B. Sittler (1997, unpubl. data) |
| 1984 | Vega Sund | 0 | 0 | 0 | B. Sittler (1997, unpubl. data) |
| 1984 | Orsted Dal | + | B (n = 1) | 0 | Cabot (1984) |
| 1985 | Traill Island | 0 | 0 | 0 | Newton (pers. comm. 1998) |
| 1987 | Germania Land | 0 | 0 | 0 | Cabot et al. (1988) |
| 1988 | Jameson Land | 0 | 0 | 0 | de Korte (1988) |
| 1988 | Ile de France | 0 | 0 | 0 | Andersen and Berg (1991) |
| 1989 | Ile de France | 0 | 0 | 0 | Andersen and Berg (1991) |
| 1989 | Germania Land | + | B | n.d. | Boertmann et al. (1991) |
| 1990 | Mackenzie Bay | ++ | B | B | Dörnbach (pers. comm. 1990) |
| 1990 | Kong Oscars Fjord | ++ | B (n = 4) | B | O. Gilg and B. Sabard (1999, unpubl. data) |
| 1992 | Kong Oscars Fjord | 0 | 0 | 0 | O. Gilg and B. Sabard (1999, unpubl. data) |
| 1995 | Kong Oscars Fjord | 0 | 0 | 0 | O. Gilg and B. Sabard (1999, unpubl. data) |
| 1995 | Zackenber | 0 | 0 | 0 | Berg (1996a, b) |
| 1996 | Zackenber | +? | B (n = 1) | 0 | Berg (1997); Meltofte and Berg (1997) |
| 1997 | Zackenber | + | B (n = 1) | B | Berg (1998); Meltofte and Berg (1998) |
| 1998 | Zackenber | ++ | 0 | 0 ⁴ | T. Berg (1999, unpubl. data) |
| 1998 | Kong Oscars Fjord | ++ | B (n = 2) | B | O. Gilg and B. Sabard (1999, unpubl. data) |
| 1999 | NE Greenland 72–74°30N | + | B (n = 1) | B | O. Gilg and B. Sabard (1999, unpubl. data) |

¹ 0 = low year; + = intermediate or increase; ++ = peak or very abundant.

² 0 = no breeding record; B = breeding record (either nest or chicks).

³ sources are completed from de Korte and Wattel (1988) and Boertmann (1994).

⁴ no breeding recorded but several birds seen.

Breeding association (commensalism) with long-tailed jaegers (Blomquist and Elander, 1988), gulls (D. Solovieva, pers. comm. 1997), snowy owls (Litvin et al., 1985; Dorogoi, 1990; Summers et al., 1994; Cotter et al., 1997), and chained dogs (Kaliakin, 1992) also suggests that

successful nesting of king eiders is indirectly linked to predation-related processes. Similar nesting associations are known for the three other eider species (Ahlen and Andersson, 1970; Uspenski, 1972; Kistchinski and Flint, 1974; Meltofte, 1978). Such associations, thought to offer

protection against mammalian predators, were obvious in our study area (i.e., two king eider nests were found less than 100 m from a jaeger nest). But they are not a prerequisite for king eiders to breed in the tundra, as several lone nests were also discovered.

The results from our study area at Karupelv show that eiders actually bred during a lemming increase (1989) or high situation (1990, 1994, 1998) while mammalian predator densities were still low (see delay in response of stoats in Sittler, 1995). According to Ovsyanikov (1993), during such lemming peaks, foxes take lemmings to the den at least four or five times a day (with records of up to three times per hour), and the hunting range represents only 40% of the whole territory. To get the same result in low years, foxes probably increase time spent in the field and distances covered, thereby also increasing their probability of discovering secretive breeding species. In these low years following the decline of the lemming population, high numbers of predators (foxes and stoats) have to share poor food resources, forcing each predator to increase searching activity and range (Ovsyanikov, 1993), which may increase their probability of detecting breeding eiders. Sparse fox data from our study area support this explanation. In June 1998, during a lemming peak, we counted a mean of only 0.12 fox track/km (snow tracks) in our study area, while in June 1993, during a lemming low, more than 1 track/km was recorded from the same area.

Viewed in a broader context, the unexplained gaps in the distribution range of some arctic shorebirds and wildfowl (i.e., in west and south Greenland) have sometimes been attributed to the lack of rodents and to the increased fox predation pressure faced by these species (Larson, 1960).

If king eider nest abundance is related to fox predation pressure, small islets, supposedly less exposed to fox predation, should host king eider nests even during low lemming years. Reports of breeding records on islets during such low years support this assumption (Salomonsen, 1950; Johnsen, 1953; and Rosenberg et al., 1970). Similarly, in North Greenland, king eiders regularly breed on islets and vegetationless stony sea-slopes and reproduce successfully even in low lemming years (Johnsen, 1953; Just, 1967; Andersen, 1970; Meltofte, 1976a).

Similar effects of fox predation on tundra breeding birds have been reported from several places, mainly in Siberia. Ovsyanikov (1993) reported that on Wrangel Island, in low lemming years, up to 100% of the snow geese (*Chen caerulescens*) nests may be preyed upon, resulting in losses of 100 000 eggs in these seasons. Syroechkovski and Krechmar (1981) likewise noticed that during high lemming years, nearly all snow geese were breeding, in contrast to low lemming years, when up to 86% of the pairs were reported to refrain from breeding. During a lemming low in 1984 on Vaygach Island (north-western Siberia), Kaliakin (1992) recorded only one instance of successful breeding among 14 pairs of barnacle geese (*Branta leucopsis*). In 1988, during a lemming high, the same area supported 114 breeding pairs, and only six

nests were taken by foxes. Sdobnikov (1959) earlier noticed intensive reproduction among tundra species, such as hares, geese, ptarmigans and other birds, only in years when lemmings were abundant. Uspenski (1972) and Summers et al. (1998) also noticed that on Novaya Zemlya and the Taimyr Peninsula, breeding abundance of birds was correlated with lemming densities and number of predators. Lastly, in Canada (Toker Point, Tuktoyaktuk Peninsula), Dickson (1992) found an obvious relationship between vole abundance and hatched eggs of red-throated loon (*Gavia stellata*) during a five-year study. The number of eggs that hatched was also negatively correlated with fox abundance.

Our study provides an example of the long-term effort needed to detect population patterns. It also highlights the importance of approaching patterns at the community level when attempting to unravel underlying processes such as cyclic fluctuations in northern ecosystems.

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