

## Molt Migration in Relation to Breeding Success in Greater Snow Geese

ERIC T. REED,<sup>1,2</sup> JOËL BÊTY,<sup>1,3</sup> JULIEN MAINGUY,<sup>1</sup> GILLES GAUTHIER<sup>1</sup> and JEAN-FRANÇOIS GIROUX<sup>4</sup>

(Received 23 January 2002; accepted in revised form 25 June 2002)

**ABSTRACT.** We describe summer migratory movements by female greater snow geese (*Chen caerulescens atlantica*) breeding on Bylot Island, Nunavut. We followed 121 radio-collared females between 1997 and 2001 to determine the frequency and timing of their departure from the colony in relation to breeding status, nesting success, and molting chronology. We found that 90% (n = 51) of non-breeders (no nest found) and 97% (n = 29) of failed nesters (nest destroyed or abandoned before hatch) departed the island before molting. The few non-breeders that remained on Bylot Island all summer molted earlier than adults with young, and they appeared to initiate the fall migration before breeding geese. In contrast, only 2% of successful nesters (n = 41) left Bylot Island to molt, and those that did presumably had lost their offspring in the early stages of brood rearing. Thus, the occurrence of a molt migration in greater snow geese appears to be strongly dependent on reproductive status and nesting success. The area used by molt migrants and their habitat requirements during molt remain unknown. We suggest that the paucity of predator-safe areas (such as large water bodies) on Bylot Island may be an important factor that drives the geese to molt elsewhere.

**Key words:** breeding effort, greater snow goose, *Chen caerulescens atlantica*, migration, molt, nesting success, Nunavut, telemetry

**RÉSUMÉ.** Nous décrivons les mouvements migratoires estivaux de la grande oie des neiges (*Chen caerulescens atlantica*) nichant à l'île Bylot (Nunavut). De 1997 à 2001, 121 femelles munies de radio-émetteurs ont été suivies afin de déterminer la fréquence et le moment de leur départ de la colonie relativement à leur statut reproducteur, leur succès de nidification et la chronologie de la mue. Nous avons trouvé que 90 p. cent (n = 51) des non-reproducteurs (pas de nid trouvé) et 97 p. cent (n = 29) des femelles dont le nid a été détruit ou abandonné avant l'éclosion ont entrepris leur migration avant la mue. Les quelques non-reproducteurs ayant demeuré à l'île Bylot tout l'été ont mué et apparemment entrepris la migration automnale plus tôt que les adultes accompagnés de jeunes. Par contraste, seulement 2 p. cent (n = 41) de femelles ayant niché avec succès ont quitté l'île Bylot pour la mue, après avoir probablement perdu leurs jeunes au début de l'élevage. La migration de mue chez la grande oie des neiges semble donc fortement dépendante du statut reproducteur et du succès de nidification. Nous ne connaissons pas les sites utilisés ni les conditions d'habitat requises pour la mue de ces individus. Nous suggérons que la rareté de refuges contre les prédateurs à l'île Bylot, tels que de grandes étendues d'eau, pourrait être un facteur important qui incite les oies à muer ailleurs.

**Mots clés:** effort reproducteur, grande oie des neiges, *Chen caerulescens atlantica*, migration, mue, Nunavut, succès de nidification, télémétrie

### INTRODUCTION

Migratory behavior of animals is believed to have evolved in seasonal environments to take advantage of ephemeral resources and conditions optimal for the different stages of the life cycle (Gauthreaux, 1982). In many species of water birds, the flight and tail feathers are shed simultaneously once a year, rendering the birds flightless during the molting period (Bellrose, 1980). If feeding conditions or refuges from predators are not optimal for molting on the breeding areas, failed breeders and non-breeders may undertake a pre-molt migration to distant and more favorable areas (Salomonsen, 1968).

Most goose populations of the Palearctic and Nearctic regions undertake long migrations from their wintering area to their breeding grounds in temperate or Arctic regions. These long-distance migrations are well documented (e.g., Bellrose, 1980), but movements on and around the breeding grounds are poorly known. Salomonsen (1968) described different types of migratory movements from the breeding areas, such as dispersal to other breeding areas, molt migration, and the return fall migration. In North America, molt migrations have been described for Canada geese (*Branta canadensis*), emperor geese (*Chen canagica*), black brant (*Branta bernicla nigricans*), and lesser snow geese (*Chen caerulescens caerulescens*)

<sup>1</sup> Département de Biologie and Centre d'Études Nordiques, Université Laval, Sainte-Foy, Québec G1K 7P4, Canada

<sup>2</sup> Present address: Canadian Wildlife Service, Migratory Birds Conservation Division, Place Vincent Massey, 351 St. Joseph Blvd., Hull, Québec K1A 0H3, Canada; eric.reed@ec.gc.ca

<sup>3</sup> Present address: Atlantic Cooperative Wildlife Ecology Research Network, Department of Biology, University of New Brunswick, P.O. Box 45111, Fredericton, New Brunswick E3B 6C2, Canada

<sup>4</sup> Département des Sciences Biologiques, Université du Québec à Montréal, Succursale Centre ville, C.P. 8888, Montréal, Québec H3C 3P8, Canada

(Blurton Jones, 1972; Krohn and Bizeau, 1979; Abraham, 1980; Bollinger and Derksen, 1996; Abraham et al., 1999). Field studies on molting areas indicate that flocks are mostly composed of non-breeders and failed nesters of both sexes (Bollinger and Derksen, 1996). However, the frequency and timing of departure from the breeding grounds for a molt migration in relation to the breeding status or nesting success of individuals are poorly documented.

In this study, we describe the summer migratory movements by adult female greater snow geese (*C. c. atlantica*) from a large breeding colony in the Canadian Arctic. We used radio-marked birds to determine the frequency and timing of departure from the colony for the molt migration in relation to breeding status and success.

## METHODS

The breeding ecology of greater snow geese has been studied since 1988 at a colony located on the south plain of Bylot Island, Nunavut (73°08' N, 80°00' W; see Lepage et al., 1996 for details of the study area). This colony is the largest known concentration of breeding greater snow geese and accounts for approximately 15% of the world population (Reed et al., 1998). Geese typically arrive on Bylot Island in early June (Bêty, 2001), and the peak in nest initiation is generally around 12 June (range: 6 to 20 June; Lepage et al., 1996, 2000). As in other goose species, flight feathers are shed simultaneously once a year in greater snow geese, rendering the birds flightless for some time.

We captured 305 adult female greater snow geese during the molting period in August 1996 to 1999 and marked them with radio transmitters fastened to neck bands (see Menu et al., 2001 and Demers et al., in press for details). In addition, we affixed radio transmitters on another 32 adult females that were captured on their nests in June 2000 and 2001. The radios had a minimum life expectancy of 16 months, but many were still functioning after 24 months. This allowed us to track individuals returning to Bylot Island to breed during the summer following their initial marking and, in 2000–01, to track birds marked at the end of incubation for the rest of the summer.

We radio-tracked geese several times each summer from 1997 to 2001, using two four-element Yagi antennas fixed on each side of a helicopter. Most aerial surveys covered all areas used by geese on Bylot Island's south plain (ca. 1600 km<sup>2</sup>). We also conducted ground-based tracking every one to two days during the pre-laying, laying, and incubation periods, either using antennas mounted on a snowmobile or from fixed towers located near the two main nesting areas (Mainguy et al., 2002). Detection range of radios was approximately 5–10 km from the ground and 10–20 km from the air (Bêty, 2001).

We performed three to eight tracking flights per year at various intervals throughout the breeding cycle of geese.

These were grouped into four main periods: laying/early incubation, incubation, early brood rearing, and molt. The dates of these four periods varied from year to year because of differences in nesting phenology and aircraft availability (Table 1). The egg laying/early incubation period began when the first radio-marked female was detected on Bylot Island. Coverage was most extensive during this early period, in part because of additional ground tracking. Despite this extensive coverage, some females were missed in this early period, either because they were not yet present on the island when we conducted our tracking flights or because they staged there only briefly. In the subsequent periods, we are confident that we did not miss any previously detected females, since their movements were reduced to small nesting or molting territories, allowing us to concentrate our searches in areas where birds were known to be. We considered a female present in the first period if she was detected on the island either during that period or later. Thus, the first period always included all females subsequently detected in a given year.

To determine breeding status of radio-marked females, we conducted extensive nest searches at all locations where females had been detected more than once either during the aerial survey or from the ground during incubation. Females were categorized as either breeders (nest found) or non-breeders (no nest found). We are confident that we did not miss nests of incubating radio-marked females, although some females that we categorized as non-breeders could have initiated a nest but lost it very early (e.g., during laying). Successful nests were defined as those from which at least one egg hatched (Bêty et al., 2001). In 2000 and 2001, an emphasis was placed on observing or capturing radio-marked females still present during the molt period to determine whether they were still accompanied by young.

Some females were followed in more than one season. To avoid pseudoreplication (Hurlbert, 1984), we used only the first summer in which a female was detected on Bylot Island in all analyses. Radio failures occurring during the summer would appear as emigration. Thus, we computed the proportion of females that were detected in at least one season after the summer in which they were followed on Bylot Island. We then tested, using a two-tailed Fisher's exact test, whether radio failure (i.e., lack of detection in any subsequent season) was similar for (1) females that were detected on Bylot Island for the whole summer and (2) those for which we lost the signal during the summer. This was possible for the summers 1997–99 because intensive radio tracking was conducted in those years during the subsequent fall and spring on the staging grounds in southern Quebec (Demers et al., in press). Two females known to have died during the summer were excluded from the analyses.

There was a high incidence of non-breeding in 1999 (Mainguy et al., 2002) so we conducted an extensive aerial survey at the end of the hatching period (15 July) to

TABLE 1. Dates and periods of radio tracking in relation to the breeding cycle of greater snow geese on Bylot Island's south plain in 1997–2001.

Year	Egg Laying/Early Incubation	Incubation	Early Brood Rearing	Molt
1997	28 May–14 June	30 June	15 July	9–15 August
1998	30 May–13 June	28 June	13–16 July	8 August
1999	10–25 June	28 June	15 July	– <sup>1</sup>
2000	9–26 June	3 July	16 July	7 August
2001	11–19 June	1–9 July	17 July	8 August

<sup>1</sup> No surveys were conducted during molt in 1999 because no radio-marked geese had been detected in the study area during early brood rearing.

determine the number of non-breeders and failed nesters that were molting on Bylot Island. We covered all significant water bodies where molting geese might occur. For all molting flocks with 50 or more individuals, we landed to make total counts and compute age ratios (goslings, yearlings, and birds more than one year old could be identified by plumage coloration). For smaller groups, we made total counts from the helicopter.

## RESULTS

We followed 121 radio-marked females during the nesting season from 1997 to 2001. Of these, 89 had been marked during the molting period before the summer that they were followed, and the remaining 32 were captured and marked on their nests during the summer that they were followed. Seventy of the 121 females were categorized as breeders and 51 as non-breeders. We did not find any nests of radio-marked females in 1999, which was a year with a very low proportion of geese attempting to breed (Mainguy et al., 2002). Forty-one of the females that were classified as breeders successfully hatched at least one young, whereas the remaining 29 females were failed nesters (Table 2).

Of the 51 radio-marked females that we categorized as non-breeders, 86% were present on the island during incubation, but only 10% of these birds were still present shortly after hatch (Table 2). Thus, most non-breeding females (90%) left Bylot Island during the late nesting period to molt elsewhere. Of the 29 females that lost their nest before hatch (failed nesters), 27 (93%) had disappeared shortly after hatch (Table 2). Thus, these females also left the island to molt elsewhere. In contrast, 98% of the 41 successful nesters were detected during the early brood-rearing period, and 83% were still present on Bylot Island during molt (Table 2). Two of the seven successful nesters that emigrated before the molt period were last detected on 14 and 20 July (i.e., before wing molt of parents), whereas the other five nesting females were last detected between 4 and 6 August (during wing molt). We observed no goslings that were capable of flight at any of these dates. All 9 successful nesters that were present during the molt period in 2000 were still accompanied by

their goslings, whereas 5 of the 13 successful nesters present during the molt period in 2001 had lost their offspring by then.

Although most non-breeders and failed nesters left the breeding colony to molt, small flocks of molting adults and subadults without young were seen on Bylot Island every year. During the 15 July survey in 1999, we observed 704 molting geese distributed in 15 flocks (group size range: 10–138). We estimated that 18.5% of these molting geese were yearlings, and we found no goslings in these groups ( $n = 504$  individuals aged). We observed no females with young that had started to shed their flight feathers at that time. The molting pattern of these birds strongly suggests that the five non-breeding females detected on Bylot Island after hatch also molted on the island, as they were last detected there between 31 July and 8 August.

The proportion of females that were never detected again after the summer in which they were followed was low and did not differ significantly between those that disappeared before the molt period and those that did not (Fisher's exact test  $p = 0.33$ ). Only 5 (8.3%) of the 60 females for which we lost the radio signal from Bylot Island before the molt period in 1997 to 1999 were never detected after the summer, compared to 2 (16.7%) of the 12 females that were still present during the molt period. This illustrates that radio failure was low during the summer and caused very few females still present on the island to be misclassified as having departed.

## DISCUSSION

This study showed that breeding performance of greater snow geese nesting on Bylot Island had a strong influence on migratory patterns of this population: the majority of successful nesters molted on the island, whereas most non-breeding and failed-nesting birds left the island to molt elsewhere. Non-breeding and failed-nesting female greater snow geese departed Bylot Island and initiated a molt migration after a residency period of four to six weeks in early summer. Although only adult females were marked in this study, molt migration patterns are likely to be identical in males because greater snow geese, like other geese, form long-lasting pair bonds (Demers et al., in press).

TABLE 2. Number of radio-marked greater snow goose females detected during egg laying, incubation, brood rearing, and molting periods on Bylot Island's south plain in 1997–2001. Birds are split according to breeding status. Females that were detected, but for which no nest was found, were considered non-breeders. Failed nesters were females that had a nest in which no eggs hatched. A female was considered present in a period if she was detected during that period or any subsequent period in that summer.

Year	Egg Laying/ Early Incubation	Incubation	Early Brood Rearing	Molt
<b>Non-breeders</b>				
1997	14	13	2	0
1998	15	15	0	0
1999	7	4	0	- <sup>1</sup>
2000	15	12	3	3
2001	0	0	0	0
Total	51	44	5	3
<b>Failed nesters</b>				
1997	10	10	0	0
1998	9	9	0	0
1999 <sup>2</sup>	0	0	0	- <sup>1</sup>
2000	3	3	0	0
2001	7	6	2	1
Total	29	28	2	1
<b>Successful nesters</b>				
1997	9	9	9	7
1998	8	8	8	5
1999 <sup>2</sup>	0	0	0	- <sup>1</sup>
2000	10	10	10	9
2001	14	14	13	13
Total	41	41	40	34

<sup>1</sup> No aerial surveys were conducted during molt in 1999 because no radio-marked geese had been detected in the study area during the brood-rearing period.

<sup>2</sup> No nests of radio-marked females were found in 1999.

The timing of departure for molting areas is similar to that of lesser snow geese at La Pérouse Bay, a Subarctic colony (Abraham, 1980). The disappearance of some non-breeders in early August may represent an early departure for the southward fall migration, which normally starts during the last days of August in parental birds (Blouin, 1996; for similar evidence in brant, see O'Briain et al., 1998). The few non-breeders that stayed on Bylot Island during the summer molted earlier than parental birds and thus regained flight capabilities earlier. In contrast, molt migration was largely absent in successful nesters, as only one (2%) of them disappeared in mid July, presumably after having lost her goslings, to molt elsewhere. Although six other successful nesters disappeared in early August when parental birds were still molting, it is highly unlikely that this was a molt migration so late in the summer. These birds probably molted on Bylot Island but at an earlier date, presumably after having lost their goslings after hatch, and, like some non-breeders, they initiated their fall migration early.

The occurrence of a molt migration in adult greater snow geese appears to be strongly dependent on reproduc-

tive status and nesting success. The number of molt migrants may therefore vary greatly from year to year, and it should be especially high in years with high incidence of non-breeding or failed nesting (McLaren and Alliston, 1985), which occur periodically in Arctic-nesting geese (Reed et al., 1998). For instance, 1999 was the year with the highest incidence of non-breeding and failed nesting on Bylot Island in 30 years (Bêty et al., 2002; Mainguy et al., 2002), and the number of geese molting on the south plain was estimated at less than 2000 adults (non-breeders, failed nesters, and successful nesters) (G. Gauthier, unpubl. data). In contrast, colony surveys conducted every five years between 1983 and 1998 showed that in good breeding years, the number of adults present on Bylot Island during molt ranged from 25 500 to 69 475 adults, of which 62% to 83% were successful nesters (Reed et al., 1992, 1998; A. Reed, Canadian Wildlife Service, unpubl. data). Thus, the number of adult geese molting on the breeding colony or elsewhere may vary dramatically among years according to overall breeding success of colonies.

This is the first study that shows a major molt migration in mature adult greater snow geese, a species breeding in the High Arctic. The direction of molt migrations of ducks and geese breeding in temperate and Subarctic areas is often northward (Salomonson, 1968; Abraham, 1980; Abraham et al., 1999), although molt migrations in other directions have also been documented (Bollinger and Derksen, 1996; Nilsson et al., 2001). Few concentrations of molting greater snow geese are known, but we suspect that a major destination may have been an area approximately 200 km to the south on Baffin Island, where surveys conducted in 1993, a year of very good breeding success, revealed the presence of 20 280 adults, including 19 127 (94.3%) non-breeders or failed nesters (A. Reed, Canadian Wildlife Service, unpubl. data). The 7200 km<sup>2</sup> area surveyed covered several large lakes, including Erichsen Lake (ca. 70°40' N, 80°41' W) and Quartz Lake (ca. 70°57' N, 80°42' W). However, it remains unknown whether geese from Bylot Island and other colonies molt together in a few restricted areas such as this one, or in several flocks scattered over a broad expanse.

Because wing molt does not represent a severe nutritional stress in geese (Ankney, 1979, 1984), it is likely that food supply is not the only factor involved in the selection of molting areas by adults without young. Since non-parental geese almost entirely avoid dry upland habitats on Bylot Island (Hughes et al., 1994), the presence of predator-safe areas such as large bodies of water, which are generally rare on Bylot Island, may be an important factor that drives the geese to molt elsewhere. In contrast, the abundance of small ponds on the island may provide more adequate refuge from predators for small goslings, which are unable to swim in the presence of large waves (Hughes et al., 1994).

Molting areas are potentially of great importance in the dynamics and structure of populations, as mixing of breeding populations on molting areas has been described for

other species of geese (Abraham, 1980; Bollinger and Derksen, 1996; Abraham et al., 1999). Mixing of birds from different breeding populations increases the likelihood of genetic exchange among populations. Geese are also known to be faithful to specific molting areas (Bollinger and Derksen, 1996).

Although greater snow geese have been intensively studied in the past 20 years, resulting in a comprehensive knowledge of their ecology and habitat use during breeding, wintering, and fall and spring staging (summarized in Batt, 1998), the area used by molt migrants and their precise habitat requirements remain unknown. With the dramatic increase in the greater snow goose population over the past 30 years (Reed et al., 1998), either molting areas have seen an increase in the number of geese using them, or the number of sites used has increased. A shift in molting area of greylag geese (*Anser anser*) in southern Sweden was linked to an increase in population size, possibly because the carrying capacity of the traditional molting site had been reached (Nilsson et al., 2001). Therefore, increase in goose use in some molting areas may have important ecological implications. Our findings of a large segment of molt migrants in greater snow geese and the lack of information about the molting areas underscore the need for further studies of this question.

#### ACKNOWLEDGEMENTS

Funding was provided by a Natural Sciences and Engineering Research Council of Canada (NSERC) grant to G. Gauthier; the Arctic Goose Joint Venture (Canadian Wildlife Service); the Fonds pour la Formation des Chercheurs et l'Aide à la Recherche (FCAR), Ministère de l'Éducation du Québec; the Institute for Wetland and Waterfowl Research; and the Department of Indian and Northern Affairs Canada. The FCAR, the Fondation de l'Université Laval, the Centre d'Études Nordiques, the Dennis Raveling Scholarship Fund, and the Fonds Richard Bernard provided financial assistance to E.T. Reed. Logistical support was generously provided by the Polar Continental Shelf Project (Natural Resources Canada). The Hunters and Trappers Association of Pond Inlet, Nunavut Territory, kindly provided assistance and support. Thanks to the many people who participated in the field work, particularly Arnaud Béchet, Frederic Demers, Diane Leclerc, Jonathan Olson, and Joassie Ootoovak. Gustaf Samelius, Stephen R. Johnson, and Austin Reed provided valuable comments on an earlier draft of this manuscript. Austin Reed kindly provided some unpublished survey data. This is contribution no. 005-02 of the Polar Continental Shelf Project.

#### REFERENCES

ABRAHAM, K.F. 1980. Molt migration of lesser snow geese. *Wildfowl* 31:89–93.

ABRAHAM, K.F., LEAFLOOR, J.O., and RUSCH, D.H. 1999. Molt migrant Canada geese in northern Ontario and western James Bay. *Journal of Wildlife Management* 63:649–655.

ANKNEY, C.D. 1979. Does the wing molt cause nutritional stress in lesser snow geese? *Auk* 96:68–72.

———. 1984. Nutrient reserve dynamics of breeding and molting brant. *Auk* 101:361–370.

BATT, B.D.J., ed. 1998. The greater snow goose: Report of the Arctic Goose Habitat Working Group. Arctic Goose Joint Venture Special Publication. Washington, D.C.: U.S. Fish and Wildlife Service and Ottawa: Canadian Wildlife Service. 88 p.

BELLROSE, F.C. 1980. Ducks, geese and swans of North America. Harrisburg, Pennsylvania: Stackpole Books. 544 p.

BÊTY, J. 2001. Interactions trophiques indirectes, prédation et stratégies de reproduction chez l'oie des neiges nichant dans le Haut-Arctique. Ph.D. Thesis, Université Laval, Québec, Québec, Canada.

BÊTY, J., GAUTHIER, G., GIROUX, J.-F., and KORPIMÄKI, E. 2001. Are goose nesting success and lemming cycles linked? Interplay between nest density and predators. *Oikos* 93: 388–400.

BÊTY J., GAUTHIER, G., KORPIMÄKI, E., and GIROUX, J.-F. 2002. Shared predators and indirect trophic interactions: Lemming cycles and Arctic-nesting geese. *Journal of Animal Ecology* 71:88–98.

BLOUIN, F. 1996. Suivi de la migration automnale de la grande oie blanche à l'aide de la télémétrie par satellite. M.Sc. thesis. Université du Québec à Montréal, Montréal, Québec, Canada.

BLURTON JONES, N.G. 1972. Molt migration of emperor geese. *Wildfowl* 23:92–93.

BOLLINGER, K.S., and DERKSEN, D.V. 1996. Demographic characteristics of molting black brant near Teshekpuk Lake, Alaska. *Journal of Field Ornithology* 67:141–158.

DEMERS, F., GIROUX, J.-F., GAUTHIER, G., and BÊTY, J. In press. Effects of collar-attached transmitters on behavior, pair bond, and breeding success of snow geese. *Wildlife Biology* (2003).

GAUTHREAUX, S.A. 1982. The ecology and evolution of avian migration systems. In: Farner, D.S., and King, J.R., eds. *Avian biology*, Vol. 6. New York: Academic Press, Inc. 93–168.

HUGHES, R.J., GAUTHIER, G., and REED, A. 1994. Summer habitat use and behaviour of greater snow geese *Anser caerulescens*. *Wildfowl* 45:49–64.

HURLBERT, S.H. 1984. Pseudoreplication and the design of ecological field experiments. *Ecological Monographs* 54:187–211.

KROHN, W.B., and BIZEAU, E.G. 1979. Molt migration of the Rocky Mountain population of the western Canada goose. In: Jarvis, R.L., and Bartonek, J.C., eds. *Management and biology of Pacific Flyway geese*. Corvallis, Oregon: Oregon State University Book Stores, Inc. 130–140.

LEPAGE, D., GAUTHIER, G., and REED, A. 1996. Breeding-site infidelity in greater snow geese: A consequence of constraints on laying date? *Canadian Journal of Zoology* 74:1866–1875.

LEPAGE, D., GAUTHIER, G., and MENU, S. 2000. Reproductive consequences of egg-laying decisions in snow geese. *Journal of Animal Ecology* 69:414–427.

MAINGUY, J., BÊTY, J., GAUTHIER, G., and GIROUX, J.-F. 2002. Is the body condition of laying greater snow geese and their reproduction affected by the spring conservation hunt? *Condor* 104:156–162.

- McLAREN, M.A., and ALLISTON, W.G. 1985. Effects of snow and ice on waterfowl distribution in the central Canadian Arctic Islands. *Arctic* 38:43–52.
- MENU, S., GAUTHIER, G., and REED, A. 2001. Survival of juvenile greater snow geese immediately after banding. *Journal of Field Ornithology* 72:282–290.
- NILSSON, L., KAHLERT, J., and PERSSON, H. 2001. Moults and moult migration of greylag geese *Anser anser* from a population in Scania, south Sweden. *Bird Study* 48:129–138.
- O'BRIAIN, M., REED, A., and MACDONALD, S.D. 1998. Breeding, moulting, and site fidelity of brant (*Branta bernicla*) on Bathurst and Seymour Islands in the Canadian High Arctic. *Arctic* 51:350–360.
- REED, A., BOYD, H., CHAGNON, P., and HAWKINGS, J. 1992. The numbers and distribution of greater snow geese on Bylot Island and near Jungersen Bay, Baffin Island, in 1988 and 1983. *Arctic* 45:115–119.
- REED, A., GIROUX, J.-F., and GAUTHIER, G. 1998. Population size, productivity, harvest and distribution. In: Batt, B.D.J., ed. *The greater snow goose: Report of the Arctic Goose Habitat Working Group*. Arctic Goose Joint Venture Special Publication. Washington, D.C.: U.S. Fish and Wildlife Service and Ottawa: Canadian Wildlife Service. 5–31.
- SALOMONSEN, F. 1968. The moult migration. *Wildfowl* 19: 5–24.