# POPULATION STUDY OF GREATER SNOW GEESE ON BYLOT ISLAND (NUNAVUT) IN 2000: A PROGRESS REPORT

by

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## INTRODUCTION

In 2000, we continued our long-term study of the population dynamics of greater snow geese (*Chen caerulescens atlantica*) and of the interactions between geese, plants and their predators on Bylot Island. Like most goose populations worldwide, the greater snow goose has increased considerably over the past 20 years. During this period, the average annual growth rate was almost 10%. In the near future, arctic-breeding habitats could potentially become a limiting factor for goose populations as extensive use of agriculture lands now provides an unlimited source of food during winter and migratory stopovers. Our long-term objectives are to study the population dynamics of this expanding species, the effect of this population increase on the Arctic habitat, and the effect of recent management actions such as the spring conservation hunt on the population dynamics.

## OBJECTIVES

Specific goals for 2000 were as follows:

1) Monitor the productivity (egg laying date, clutch size and nesting success) and nesting distribution of greater snow geese on Bylot Island.
2) Study the movements of geese during their reproductive cycle on Bylot Island, and determine reproductive performance of radio-marked geese.
3) Collect female geese at the time of laying to examine the contribution of body reserves accumulated during spring staging to egg-formation.
4) Assess the growth and pre-fledging survival of goslings using goslings marked in the nest.
5) Collect live goose eggs to continue experiments on metabolism and thermoregulation of growing goslings in the laboratory.
6) Band a large number of goslings and adults, and neck-collar adult females at the end of the summer, to continue the long-term study of demographic parameters such as survival and breeding propensity.
7) Monitor the level of intestinal parasite infestations and the impact of these parasites on growth and survival of goslings.
8) Monitor lemming abundance and activity at fox dens to examine the relationship between predator abundance, lemming cycles and nesting success of geese.
9) Band and monitor nesting success of small birds (Lapland Longspurs) and Snowy Owls.
10) Sample plants in exclosures to assess annual plant production and the impact of goose grazing on plant abundance.
11) Study the past and present evolution of wetlands (polygons) and associated landforms on Bylot Island, and evaluate how goose grazing may affect these processes.
12) Characterize the vegetation in upland habitats used by geese.

# FIELD ACTIVITIES

***Field camps.*** — In 2000, we operated three field camps on Bylot Island: the main camp, located at 6 km from the coast in the largest glacial valley on the island ('*Base-camp Valley*', 73° 08' N, 80° 00' W), was occupied from 29 May to 21 August. A secondary camp, located in a narrow valley 30 km south of the Base-camp and 5 km from the coast ('*Camp-2 area*', 72° 53' N, 79° 54' W) was occupied from 10 June to 18 July. Finally, a third camp located 1 km from the coast half-way between the previous 2 camps (73° 03' N, 80° 06' W) was occupied for the first time from 16 to 21 July.

***Field party.*** — The total number of people in the three camps ranged from 6 to 13 depending on the period. Members of our field party included project leaders Gilles Gauthier, Austin Reed, and Jean-François Giroux. There were also graduate and undergraduate students whose thesis projects addressed several of the objectives laid out above. Students were: Joël Bêty (PhD, objective 8), Eric Reed (PhD, objectives 1 and 6), Chistopher Ellis (Post-doc, objective 11), Isabelle Duclos (MSc, objective 12), Pascale Otis (MSc, objective 5), Mathieu Dumas (MSc, objective 12), Mohamed Righi (Post-doc, objectives 7 and 9), Julien Mainguy (BSc, objectives 2, 3 and 4), Marie-Christine Cadieux (BSc, objective 10), and Daniel Munro (BSc, objectives 2 and 9). Other members of our field party included Gérald Picard and Bernard Maktar, Joasie Ootovak and Amos Ootovak from Pond Inlet. The new Sirmilik Park chief warden, M. Carey Elverum, visited our camp in June, whereas the park's warden Jason Aliqatuqtuq and James Enook assisted us during part of the goose banding in August. One board member of the Pond Inlet HTO also visited the camp during goose banding.

***Weather stations.*** — Weather data continued to be recorded at our two automated stations. Air and ground temperature, air humidity, solar radiation, wind speed and direction were recorded on an hourly basis without interruption throughout the year. Daily precipitation was recorded manually during the summer. Snowmelt was monitored by measuring snow depth at 50 stations along two 250-m transects at 2-day intervals.

***Monitoring of goose nesting.*** — Nest searches were carried out within walking distance (~6 km) of both the Base-camp Valley and the Camp-2 area between 5 and 18 June. We attempted to find the nests of as many neck-collared females as possible. During the hatching period, we visited a sample of nests almost every day to record hatch dates and to web-tag goslings at the two study areas. We captured some females with nest traps during incubation and marked them with conventional radio transmitters. These radios were glued on green neck-collars and the total package weighed 60g.

***Tracking of geese fitted with radio-transmitters.*** — We regularly scanned from one receiving station located at each study area to detect the presence of geese marked with radio transmitters. Scans were done every day during the pre-laying and laying periods and every 1 to 3 days during incubation to detect geese that had been radio-marked last year. We also used a snowmobile to track geese around the Base-camp (30 May to 9 June) and the Camp 2 (10-20 June). We searched for nests of geese with radio-transmitters on foot using a portable antenna. At regular intervals, we also did aerial tracking with the helicopter over most of the south plain of Bylot Island (on 9 and 25-29 June; 3, 16, 18 and 20 July and 7 and 15 August).

***Collection of birds and eggs.*** — During laying, we shot some adult females and collected eggs to examine their body condition and to conduct isotopic analyses. We removed the abdominal fat, breast muscles and reproductive tract to assess their condition and reproductive status. In a related project, geese were also collected with cannon-nets and autopsied in southern Québec in spring. Thus, the condition of birds during laying could be compared with that of geese in southern Québec before departure for the Arctic in spring. We further removed 16 live eggs from goose nests and sent them to the university laboratory in a portable incubator, where they hatched. Young geese were used for laboratory studies on metabolism and thermoregulation.

***Study of intestinal parasites***. — We removed some goslings from nests at hatch, separated them in 2 groups and reared them by hand in the field. One group was treated with piperazine and droncit, two helminthicid drugs, and the other group was used as a control. The growth and behavior of these goslings was monitored until 35 days of age. Goslings were then sacrificed and their intestines examined for parasite load. Wild goslings and adults were sacrificed during banding, and their intestines was also removed and examined for parasite loads.

***Goose banding.*** — From 8 to 14 August, we banded geese with the assistance of local Inuit people and a helicopter. All geese captured were sexed and leg banded. A sample of young and adults was measured (mass and length of culmen, head, tarsus and 9th primary). Young were fitted with coded red plastic leg bands and adult females were fitted with coded yellow plastic neck-collars. We also obtained samples of pulp from growing feathers in 100 goslings as requested by Dr Kim Scribner from Michigan State University for his genetic studies.

***Small mammals, predators and other birds monitoring.*** — We participated again in the small-mammal survey coordinated across the NWT and Nunavut by the Renewable Resources office in Yellowknife. The methods and detailed results are given in a separate report. The breeding activity of foxes was monitored by regularly visiting dens. We also monitored the nesting activity of Lapland Longspurs (*Calcarius lapponicus*) and Snowy Owls (*Nyctea scandiaca*), and banded some longspurs.

***Monitoring of plant growth and goose grazing.*** — The annual impact of goose grazing was evaluated in wet meadows dominated by graminoid plants at 3 sites: the Base-camp Valley and Dufour Point (two brood-rearing areas), and the Camp-2 area (nesting area). At each site, 12 exclosures (1 x 1 m) were installed in late June, and plant biomass was sampled in ungrazed and grazed areas (i.e. inside and outside exclosures) at the end of the plant-growing season on 14 August. Plants were sorted out into sedges (*Eriophorum scheuchzeri* and *Carex aquatilis*) and grasses (*Dupontia fisheri*). Use of the area by geese was monitored by counting faeces on 1x10 m transects located near each exclosure every 2-weeks in the Base-camp Valley and once at the end of the season at the other sites.

This year we continued our study of the vegetation used by geese in upland mesic and dry habitats. Prior to field sampling, we mapped the major vegetation zones of the main valley and its surroundings using the results of the 1999 survey, aerial photos and topographic maps. We paid particular attention to areas more intensively used by geese. In a representative section of each of the 10 major vegetation zones, we positioned 3 to 9 plots (5m x 20m each) for a total of 64 plots. Within these plots, we sampled 10 random 50cm x 50cm quadrats. For each quadrat, we evaluated plant cover, diversity, grazing (direct marks of grazing and faeces counts), and environmental parameters. Plant communities dominant in each zone and a grazing index for each plant community will be determined.

## PRELIMINARY RESULTS

***Weather conditions.*** — The spring of 2000 was characterized by a thick snow-pack: snow depth on 1 June was 45 cm compared to a long-term average of 34 cm (Fig. 1). Temperature in spring was cold with an average air temperature of -3.0 $^{o}$C between 20 May-20 June compared to a long-term average of -0.3 $^{o}$C. This resulted in a delayed snowmelt (Fig. 1) even though conditions were exceptionally sunny and dry in June (0 mm of precipitation). In contrast, temperature in late June and July were much warmer than normal and precipitation near average (55 mm in July and 9 mm up to 21 August). These conditions, combined with a good spring run-off, resulted in an excellent growing environment for plants this year.

***Goose nesting activity.*** — Even though departure of geese from spring staging areas in Québec occurred at the usual dates, arrival of geese on Bylot Island was delayed for a second year in a row. Virtually no geese were present upon our arrival on 29 May and daily counts of geese on the hills surrounding the Base-camp Valley were low until 10 June (<200 pairs). There was then a large influx of birds with a peak count of 400 pairs on 19 June, which was about 10 days later than usual.

Median egg laying date was 16 June, which is relatively late (Table 1). For the second consecutive year, reproductive effort of geese was low at the main breeding colony (Camp-2), but relatively good at the Base-camp Valley thanks to the presence of several Snowy Owls around which many geese established their nest. Nest density was nonetheless low as most nests were widely dispersed in the hills rather than in the lowlands in the Base-camp Valley. Clutch size was 3.65, which is near the long-term average (Table 1).

***Monitoring of radio-marked geese during nesting.*** — For a fourth year, the population contained a large number of radio-marked geese that had been tracked on spring staging grounds in southern Québec until their departure for the Arctic. These birds had been originally marked on Bylot Island in 1999 or earlier. The signal of only 23 of these birds (34%) was detected on Bylot Island, which is more than last year but still much fewer than in 1997 or 1998 when >77% of all radio-marked geese tracked in spring were detected on Bylot Island (Table 2). Last year, many of the marked geese that were not detected at Bylot Island were located in the fall along the St-Lawrence River, indicating that they were alive and with operating radios during the summer. We believe that this is again the case this year even if it is too early to confirm that.

Only two of the radio-marked geese were found nesting in 2000 (9%), which is slightly better than in 1999 but much lower than in 1997 or 1998 (Table 3). This confirms that reproductive effort was low this year on Bylot Island, with several birds not even completing their spring migration all the way to their usual breeding site. As in the previous years, most radio-marked birds that did not nest (or lost their nests very early) disappeared from the Island by 25 June (90%, n = 21). These birds must have molted away from Bylot Island, at a yet unknown area.

During incubation, 12 females were captured on the nest and marked with radio-transmitters at the Camp-2 colony. The nests of two of these females were preyed upon before hatch, as was the nest of one of the two females marked with a radio in the previous year. Therefore, 11 radio-marked females hatched out broods.

***Collection of geese and body condition.*** — For the second year in a row, geese departing southern Quebec for the Arctic in mid-May had a reduced body condition. Birds leaving the Upper Estuary of the St. Lawrence River had slightly more abdominal fat than in 1999, but their reserves were still 30% lower than values recorded in previous years (Fig. 2). Birds departing from the Lower Estuary had abdominal fat reserves similar to 1999, which was 40% lower than in previous years. The reduced condition in 1999 and 2000 corresponds to the implementation of the spring conservation hunt in Québec. As participation by hunters was massive, the high rate of disturbance suffered by geese feeding in farmlands may partly account for the reduced fattening. In 1999, a sample of 21 females collected during laying on Bylot Island showed a reduced body condition compared to geese collected at the same time in 1989 and 1990. A sample of 20 females collected at laying in 2000 showed that condition was intermediate between values recorded in 1999 and in 1989-1990.

***Nesting success, hatching and brood density.*** — Nesting success was excellent this year with 83% of the nests hatching at least one egg, the second highest value recorded (Table 1). Activity of predators at goose nests was much reduced due to the abundance of alternative preys (high lemming density) and the abundance of snowy owls with which many geese nested in association. During nesting and brood-rearing, 267 neck-collared birds were sighted, a relatively low number.

Peak hatch was on 13 July, the second latest on record (Table 1). We tagged 1797 goslings in nests at hatch, 546 in the Base-camp Valley and 1251 in the Camp-2 area. Of the 11 radio-marked females with young, 5 moved all the way to the Base-camp Valley with their brood, 3 dispersed half-way in that direction and stopped around the Camp-3, 1 moved in the opposite direction toward Dufour Point, 1 moved inland toward the glacier, and 1 signal was lost. No females stayed in the Camp-2 area to rear their brood contrary to 1999 when most broods stayed there. However, in 1999 brood density was much lower and predation higher than in 2000.

Despite the low reproductive effort observed this year, goose faeces density in wet meadows of the Base-camp Valley was fairly high at the end of the summer (83.6 faeces/$m^2$), but variable as shown by the large standard error (Fig. 3). Faeces density was close to 0 until mid-July, which was expected based on the late hatching this year, but increased rapidly thereafter. Accumulation of faeces in August increased steeply in 2000 in contrast to other years where it tended to level off at that time. We believe that this reflects a sustained use of the wet meadows by broods until the end of the summer and the absence of movement toward upland habitats in August as occurs typically. The absence of late summer movement may be a consequence of the very high plant production in wet meadows this year. Faeces density was moderate in the wet meadows of Dufour Point, another brood-rearing area (36.7 faeces/$m^2$ vs 5.2 and 66.6 faeces/$m^2$ in 1999 and 1998, respectively), and also in those of the nesting colony at Camp-2 (36.2 faeces/$m^2$ vs 22.4 and 32.4 faeces/$m^2$ in 1999 and 1998, respectively).

***Study of intestinal parasites***. — During the summer, we examined the intestine of 106 geese for intestinal parasites. This sample includes the 20 adult females collected during laying, 30 adults (15 of each sex) collected during banding and 56 goslings also collected during banding. Preliminary analyses indicated a high infestation by helminths in almost 100% of goslings, but a much lower incidence in adults, a pattern similar to the one seen in previous years. In the experiment with captive goslings, there was no difference in growth between goslings treated for intestinal parasites and control goslings (n = 11 and 14, respectively), but the parasite loads of goslings in the control group at the end of the experiment was lower than in wild goslings.

***Goose banding.*** — The banding operation was successful with 12 drives conducted in the lowlands and hills bordering the Base-camp Valley to the south. All captures were within 8 km of our base camp, in sharp contrast to last year when the extremely low brood density forced us to go much farther afield to find geese to band. We banded a total of 4269 geese, including 815 adult females marked with neck-collars and 1567 young with plastic tarsal bands. In addition, there were 139 recaptures of web-tagged young and 293 recaptures of adult females banded in previous years. No females were marked with radio-collars during banding but the 10 radio-marked females that had hatched young were recaptured at banding. The gosling:adult ratio among geese captured at banding (1.08:1; Table 1) was close to the long-term average, and mean brood size (2.78 young, SD = 1.10, n = 180; counts conducted between 2-6 August) was slightly higher (Table 1). By combining information on brood size and young:adult ratio at banding, we estimate that 78% of the adults captured were accompanied by young. This suggests that brood survival was good in 2000 and that predation rate was relatively low.

***Small mammal and predator monitoring.*** — For our small-mammal survey, we accumulated 1050 trap-nights in the Base-camp Valley equally split between 2 trapping sites (one lowland and one upland) and 500 trap-nights in the upland habitat at Camp-2. In the Base-camp sites, we captured 39 brown lemming (*Lemmus sibiricus*) and 5 collared lemmings (*Dicrostonyx groenlandicus*), for an index of abundance of 4.39 lemmings/100TTN, the highest value recorded since the beginning of the small mammal monitoring in 1994. Five collared lemmings were captured at the Camp-2 site, which yielded a moderate index of abundance (1.03 lemmings/100TTN). This suggests that overall lemming abundance in 2000 was very high and that populations were at the peak of their cycle.

We found signs of fox activity (digging or fresh prey remains) at 18 of 39 known denning sites (46%), compared to 38% in 1999 and 56% in 1998. We confirmed the presence of pups at 7 dens, compared to 3 in 1999 and 9 in 1998. Five dens were occupied by Arctic foxes and two by Red foxes (*Vulpes vulpes*). Litter size was a minimum of 1 to 5 pups. This suggests that fox breeding activity was high, presumably a consequence of the high lemming abundance. After 3 years of nesting absence, we found 1 Snowy Owl nest in the Camp-2 area and 12 in the Base-camp Valley, a high value. In previous lemming peaks, 7 owl nests were found in the Base-camp Valley in 1996 and 12 in 1993. The average clutch size and hatch date of the first egg were 6.2 eggs (range: 4 to 9) and 30 June (range: 24 June to 7 July), respectively. Only two owl nests failed (one in the Base-camp Valley and the sole nest of the Camp-2 area). One Rough-legged Hawk (*Buteo lagopus*) pair nested in the Base-camp Valley.

***Plant growth and grazing impact.*** — Plant production of wet meadows was extremely good this year as above-ground biomass of graminoid plants reached a record level of 71.7 ± 9.9 [SE] $g/m^2$ in ungrazed areas in mid-August (Fig. 4). The increase in plant production was entirely due to *Eriophorum*, the preferred plant of geese, which showed a remarkable 2.6-fold increase in biomass (33.5 ± 8.0 vs 12.7 ± 2.9 $g/m^2$ in 1999). Plant production was also high at Dufour Point (brood-rearing area; 65.5 ± 16.4 vs 43.0 ± 7.2 g/$m^2$ in 1999) but not at the Camp-2 area (nesting area; 28.9 ± 5.5 vs 38.7 ± 4.0 g/$m^2$ in 1999). It is interesting to note that Camp-2 was the only area with a significant grazing impact in 1999.

Goose grazing was moderately high in the wet meadows of the Base-camp Valley where geese had removed 44% of the above-ground biomass (difference between paired grazed and ungrazed plots) by mid-August (Fig. 4). The impact was higher on *Eriophorum* (51% of biomass removed) than on *Dupontia* (30% of biomass removed). At Dufour Point, another brood-rearing area, geese removed 31% of the total biomass, but 50% of the biomass of *Eriophorum*. Dufour Point is characterized by a high proportion of *Carex* (42% of total biomass vs 8% in the Base-camp Valley), a plant that is not grazed very much by geese due to its low forage quality. Grazing impact at Camp-2 (nesting area) was negligible (a non-significant 4% difference in biomass between grazed and ungrazed sites), again suggesting that most broods dispersed away from the nesting area this year.

We recorded abundant signs of grazing by geese and lemmings in the upland vegetation. Ten major vegetation zones were sampled and an area of approximately 100 $km^2$ was surveyed by foot and helicopter. Leaves and inflorescences of graminoids (*Arctagrostis latifolia*, *Alopecurus alpinus*, *Poa arctica*, *Luzula nivalis*, *L. confusa*), mountain sorrel (*Oxyria digyna*), alpine milk-vetch (*Astragalus alpinus*) and arctic willow (*Salix arctica*) were grazed preferencially in summer. Signs of grubbing were visible in spring and late season, they were associated with the grazing of the tap root of the legume, *Oxytropis maydelliana*, and of the starchy rhizome of knotweed, *Polygonum viviparum*. Faeces from geese and lemmings were also recorded in plots from all vegetation zones. We are currently analyzing the vegetation data in order to quantify the grazing impact and to define dominant plant communities in each zone.

## CONCLUSIONS

Based on our observations, we anticipate that the proportion of young in the fall flock of Greater Snow Geese should be in the range of 15 to 20%. This will be much higher than last year (2%, the worst breeding failure in over 30 years) but still below the long-term average (25%). In 2000, geese experienced a high nesting success due to the very high peak in lemming abundance, and good feeding conditions during brood-rearing due to a record plant production. However, these positive factors were probably not sufficient to offset the late nesting and, more importantly, the reduced reproductive effort as shown by the telemetry data. Even though the youg:adult ratio at banding was relatively good, this indicator does not account for the low reproductive effort as non-breeders do not stay on Bylot Island to molt, and thus are not included in this ratio. For the second year in a row, we believe that a reduced accumulation of fat reserves during staging in southern Québec and the resulting poor body condition of geese upon departure for the Arctic contributed to the late nesting and reduced reproductive effort. However, contrary to last year, a delayed snowmelt on Bylot Island also had a negative impact on laying date and reproductive effort in 2000.

This year, plant production in wet meadows of Bylot Island was surprisingly high, especially for *Eriophorum* the preferred food plant of geese. The good plant production in 2000 may be explained by 1) the virtual absence of grazing in 1999 due to the massive breeding failure of geese, as shown by the record biomass measured in grazed areas last year (Fig. 4), and 2) the good growing conditions for plants in 2000 (good spring run-off, lots of sunshine and very mild temperature). Even though geese consume a significant proportion of the plant biomass every year on Bylot Island, we have not detected any decreasing trend in annual plant production despite the increase in the population. Plant production in recent years was among the highest values recorded over the last decade.

It appears that the recommendation of the Arctic Goose Joint Venture special report on Greater Snow Goose to stabilize the population between 800,000 and 1 million geese by 2002 will be achieved sooner than anticipated. This is due to a combination of factors, including a greater participation than expected by hunters to the spring conservation hunt in Québec, an increase in the harvest during the regular season in Canada and the US, and an apparent negative impact of the spring hunt on reproduction, a factor that was not taken into account in the original population model of Gauthier and Brault (1998). The most recent spring inventory shows a decline in population size of at least 15% between 1999 and 2000. Based on the reproductive output of this year and assuming the same hunting pressure as in the previous 2 years, the population model anticipates a further 10% decline in population size in spring 2001.

## PLANS FOR 2001

The long-term objective of our work is to study the population dynamics of the Greater Snow Goose population, and the interactions between geese, plants and their predators on Bylot Island. A major focus of the project is to monitor changes in population dynamics (population size, survival and reproduction) and habitat in response to the new spring conservation hunt and other management actions aimed at doubling the sport harvest in order to stop population growth (B. Batt ed., 1998, AGJV special report on the Greater Snow Goose). Other focuses of the project include *i*) improving estimates of annual variation in survival and especially breeding propensity, a poorly known parameter; *ii*) a better understanding of movements of geese on the island, especially between nesting and brood-rearing areas; *iii*) expanding our estimate of the carrying capacity of the Island for geese to the upland habitats; and *iv*) determining long-term effects of geese on the landscape of Bylot Island. In 2001, we anticipate to:

1) Monitor productivity (egg laying date, clutch size and nesting success) and nesting distribution of greater snow geese on Bylot Island.
2) Mark goslings in the nest to provide a sample of known-age individuals to be used to assess the growth and pre-fledging survival of goslings by their recapture in late summer.
3) Collect goose eggs to continue experiments on metabolism and thermoregulation of growing goslings in the laboratory.
4) Capture adult females on the nest and mark them with conventional radio-transmitters to study the post-hatch dispersal of families.
5) Band a large number of goslings and adults, and neck-collar adult females at the end of the summer, to continue the long-term monitoring of several demographic parameters (e.g. survival, breeding propensity).
6) Evaluate the level of intestinal parasite infestations in goslings.
7) Monitor the abundance of lemmings, the breeding activity of snowy owls and foxes, and examine their influence on goose nesting success.
8) Sample plants in exclosures to assess annual impact of goose grazing on plant abundance.
9) Evaluate the diet of geese grazing in upland habitats.

10) Continue our study of goose/plant interaction in the upland habitat to eventually estimate the carrying capacity of this habitat for geese.

In 2001, at least 2 graduate students will be involved in the Bylot Island snow goose project. **Julien Mainguy** (MSc) will study the dispersal pattern of geese between the hatching and brood-rearing site, and the effect on dispersal distance on gosling growth and survival. **Isabelle Duclos** (MSc) will continue her study of the vegetation used by geese in the mesic, upland habitat of Bylot Island.

Table 1. Productivity data on Greater Snow Geese nesting on Bylot Island over the past decade

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | **2000** | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of nest monitored | 239 | 199 | 367 | 846 | 312 | 367 | 326 | 349 | 185 | **329** | -- |
| Median date of egg-laying | 11 June | 20 June | 6 June | 11 June | 10 June | 14 June | 10 June | 7 June | 17 June | **16 June** | 12 June |
| Clutch size | 3.59 | 3.21 | 4.41 | 3.55 | 3.64 | 3.99 | 4.27 | 4.06 | 3.12 | **3.65** | 3.74 |
| Nesting success[1] | 72% | 70% | 89% | 40% | 14% | 65% | 83% | 79% | 14% | **83%** | 63% |
| Median date of hatching | 8 July | 15 July | 3 July | 7 July | 7 July | 11 July | 7 July | 4 July | 12 July | **13 July** | 9 July |
| Number of geese banded | 1859 | 2004 | 3134 | 3531 | 3985 | 3824 | 3956 | 3998 | 1717 | **4269** | -- |
| Ratio young:adult at banding | 1.46:1 | 0.81:1 | 1.55:1 | 0.79:1 | 1.10:1 | 0.83:1 | 1.06:1 | 1.09:1 | 0.54:1 | **1.08:1** | 1.04:1 |
| Brood size at banding | 2.83 | 2.20 | 3.12 | 2.66 | 2.50 | 2.34 | 2.47 | 2.70 | 1.67 | **2.78** | 2.55 |
| Proportion of adults with young at banding | 100% | 74% | 99% | 60% | 88% | 71% | 86% | 81% | 65% | **78%** | 81% |

[1] Mayfield estimate

**Table 2.** Number of radio-marked geese detected at departure from spring staging areas in southern Québec and during the summer on Bylot Island.

| Year | Number leaving Southern Québec | Number detected on Bylot Island | % |
|---|---|---|---|
| 1997 | 37 | 35 | 95% |
| 1998 | 70 | 54 | 77% |
| 1999 | 57 | 11 | 19% |
| **2000** | **67** | **23** | **34%** |

**Table 3.** Number of radio-marked geese present on Bylot Island and known to have nested.

| Year | Number detected on Bylot Island | Number of nests found | % |
|---|---|---|---|
| 1997 | 35 | 20 | 57% |
| 1998 | 54 | 29 | 54% |
| 1999 | 11 | 0 | 0% |
| **2000** | **23** | **2** | **9%** |

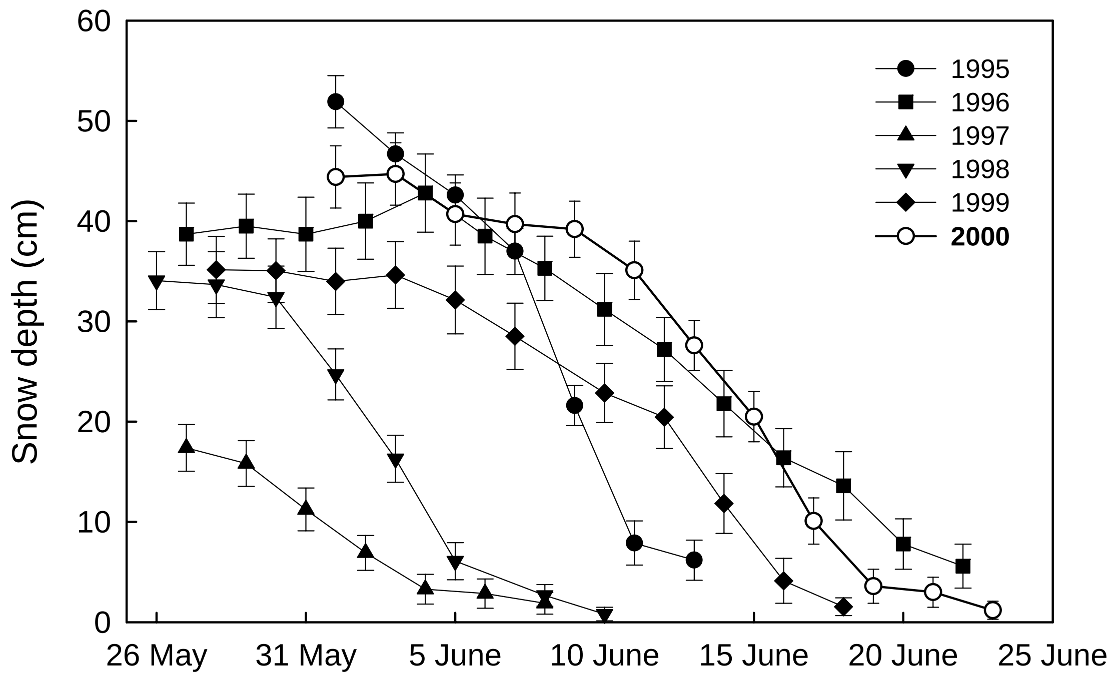


**Figure 1.** Depth of snow (mean ± SE) along 2 transects showing the rate of snowmelt in Bylot Island lowlands (*n* = 50 stations).

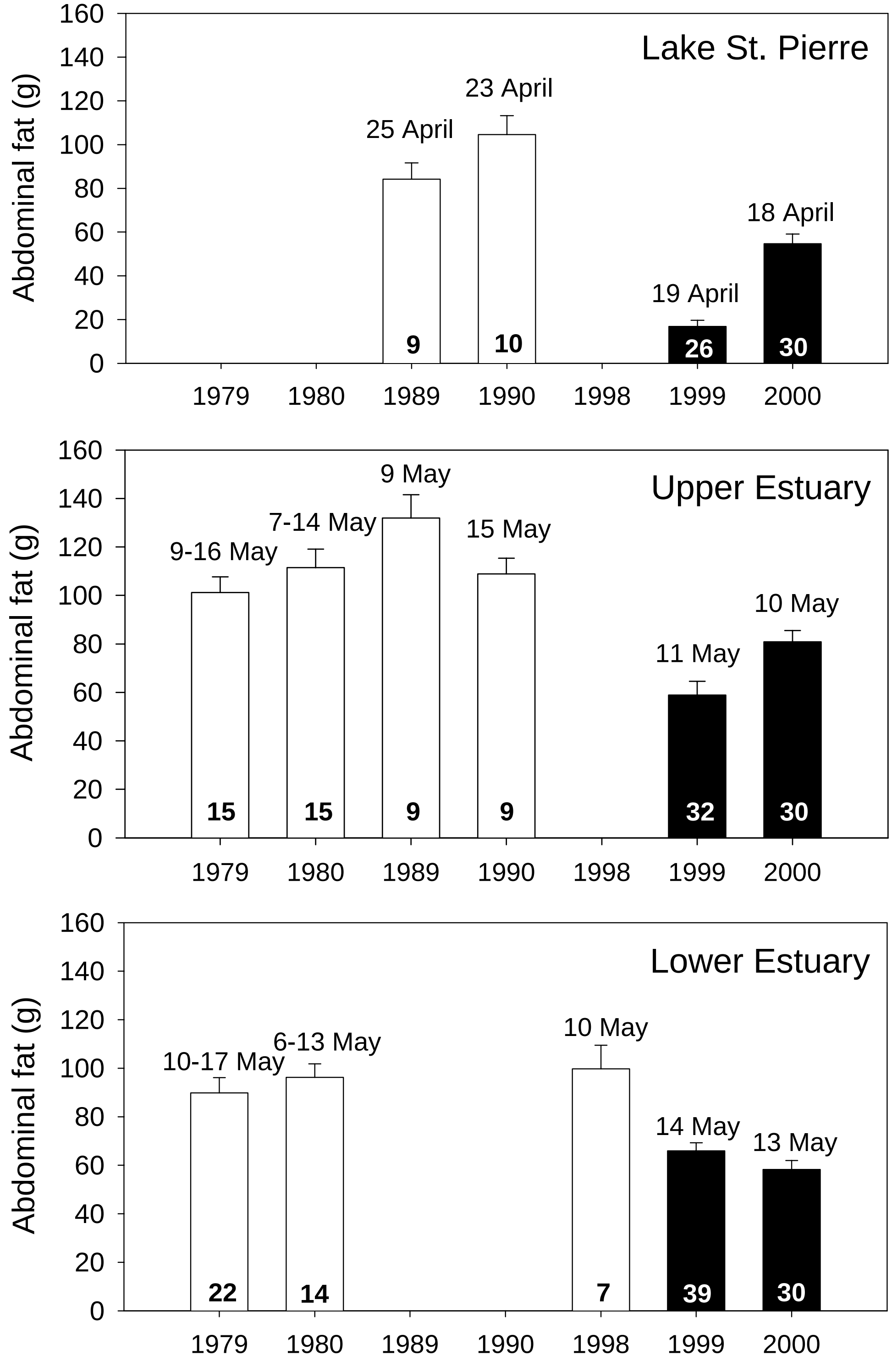


**Figure 2.** Abdominal fat mass of female greater snow geese upon departure from various spring staging areas along the St. Lawrence River. Geese were collected only in some years during the period 1979 to 1999. Numbers within bars are sample sizes and dates are sampling dates. Geese leaving Lake St. Pierre continue their fattening in the estuary area but geese leaving from the two estuary sites depart for the Arctic. In 1999, the sample of birds from Lake St. Pierre was possibly biased because it was collected after most birds had already moved to the estuary area.

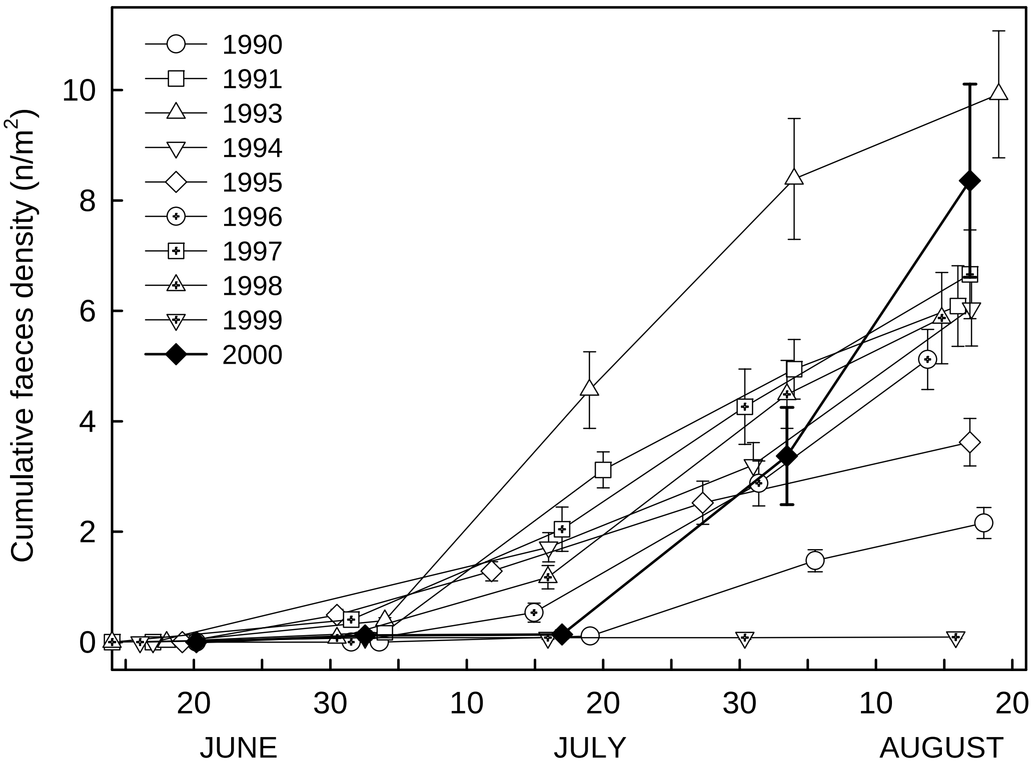


**Figure 3**. Cumulative faeces density (mean ± SE) showing the use of Base-camp Valley by Greater Snow Goose families on Bylot Island throughout the summer ($n$ = 12 transects of 1x10m).

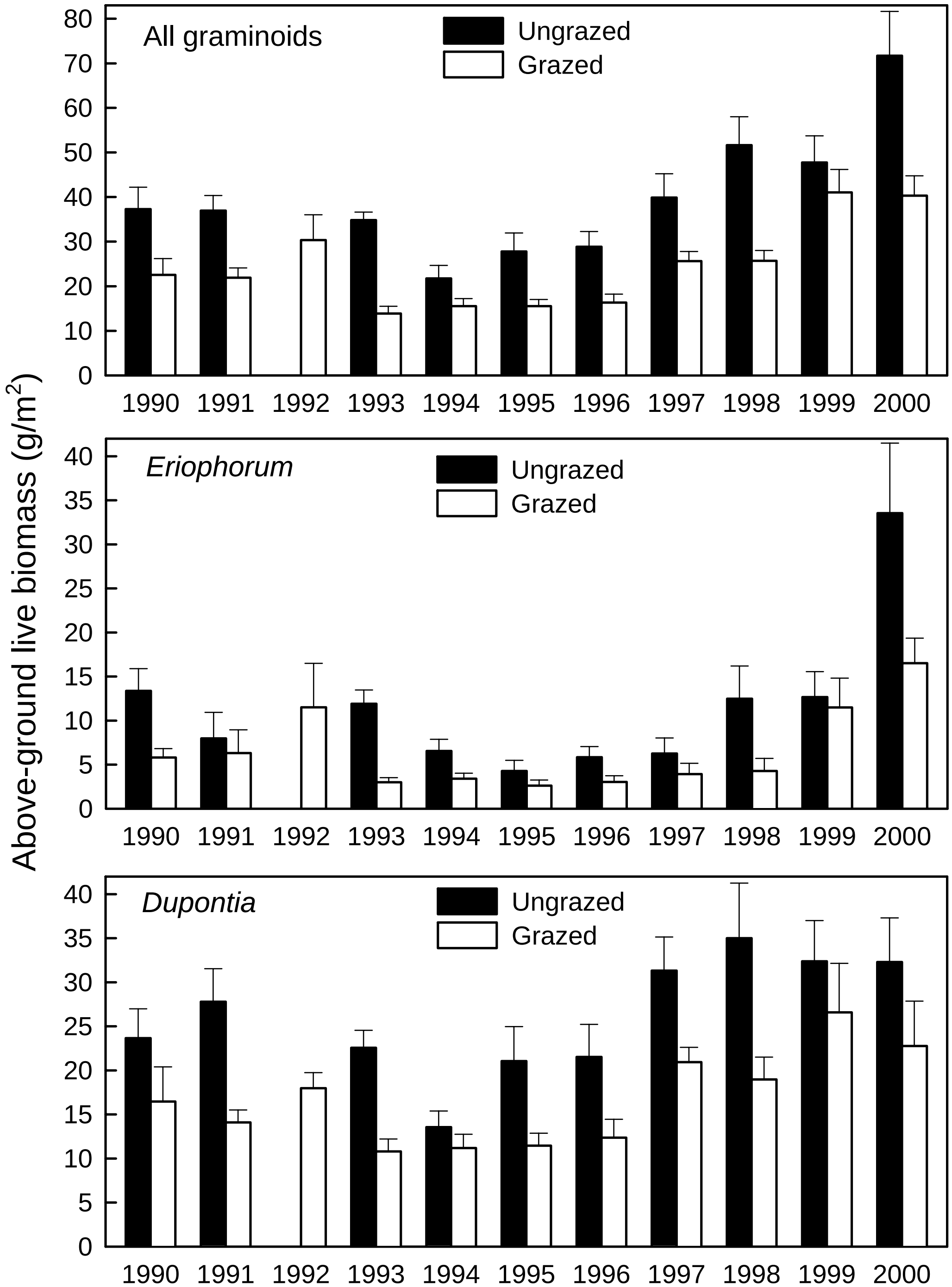


**Figure 4.** Live above-ground biomass (mean ± SE, dry mass) of graminoids around 15 August in grazed and ungrazed wet meadows of the Base-camp Valley, Bylot Island (*n* = 12). Total graminoids include *Eriophorum scheuchzeri*, *Dupontia fisheri* and *Carex aquatilis*. There is no data from ungrazed area in 1992.