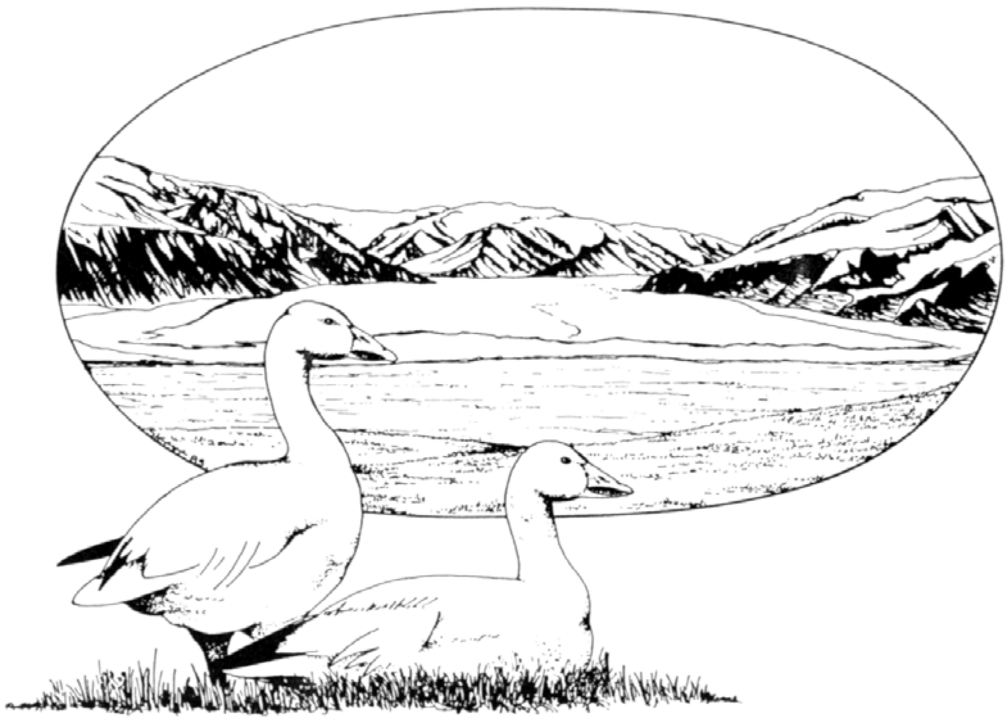
POPULATION STUDY OF GREATER SNOW GEESE ON BYLOT ISLAND (NUNAVUT) IN 2002: A PROGRESS REPORT



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INTRODUCTION

In 2002, 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. The long-term objectives of this project are to (1) study changes in the demographic parameters of the snow goose population, and especially the effects of the spring conservation hunt, (2) determine the role of food availability and fox predation in limiting annual production of geese, and (3) monitor the impact of grazing on the vegetation of Bylot Island.

OBJECTIVES

Specific goals for 2002 were as follows:

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 live goose eggs to continue experiments on metabolism, thermoregulation and nutrition of growing goslings in the laboratory.
4) 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.
5) Monitor the level of intestinal parasite infestations in goslings and the effects of parasites on survival.
6) Evaluate the diet of geese grazing in upland habitats.
7) Monitor the abundance of lemmings, the breeding activity of owls and foxes, and examine their influence on goose nesting success.
8) Sample plants in exclosures to assess annual plant production and the impact of goose grazing on plant abundance.
9) Determine the use of different types of habitats by broods during their movement between the nesting and brood-rearing areas, and their subsequent use of upland habitats during the summer.
10) Maintain and upgrade our automated environmental and weather monitoring system.

FIELD ACTIVITIES

Field camps. — In 2002, 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 30 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 8 June to 17 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 from 15 to 22 July.

Field party. — The total number of people from our group in the three camps ranged from 5 to 9 depending on the period. Members of our field party included project leaders Gilles Gauthier, Austin Reed, and Dominique Berteaux (a new member from UQAR). There were also graduate and undergraduate students whose thesis projects addressed several of the objectives laid out above. Students were: Julien Mainguy (MSc, objectives 1 and 3), Anna Calvert (MSc, objectives 1 and 4), Nicolas Lecomte (PhD, objectives 2 and 7), Vincent Préfontaine (objectives 6 and 8), and Olivier Mathieu (objective 9). Other people in the field included Denis Sarrazin, a research professional responsible of the weather stations; Gérald Picard and Gaétan Rochette, two technicians from Université Laval; and Kelly Akpaleapik and Philip Awa from Pond Inlet.

Other people that shared our camp for part of the summer include the field party of Esther Lévesque (Catherine Gagnon, Marie-Claire Bédard, Claudia St-Arnaud and James Inootik) who studied plant ecology and Michel Allard (Daniel Fortier and Olivier Piraux) who studied the geomorphology of tundra polygons. Our camp was also visited by two journalists from *L'Express* (Françoise Monière and Jean-Paul Guilloteau) and one from the *Canadian Geographic* (Larry Pynn). Furthermore, Carey Elverum, the chief warden of *Sirmilik Park* and Vicki Sahanatien, ecosystem secretariat manager, both from Parks Canada, also visited our camp.

Environmental and weather data. — Environmental and weather data continued to be recorded at our three automated stations. Our network includes 2 full stations, one at low and one at high elevation (20 m and 370m ASL, respectively) where air and ground temperature, air humidity, solar radiation, wind speed and direction are recorded on an hourly basis throughout the year. A third station monitors soil surface temperature in areas grazed and ungrazed by geese (i.e. exclosures). All automated stations were visited during the summer to download data and were found to be operating normally. A battery, a charging regulator, and a few damaged sensors (especially those recording ground temperature) were replaced. Some new sensors were also added (soil humidity at both low and high elevation, an additional snow depth sensor at high elevation, a PAR radiation sensor and a new full spectrum radiometer). Finally, daily precipitation was recorded manually during the summer and snowmelt was monitored by measuring snow depth at 50 stations along two 250-m transects at 2-day intervals.

Monitoring of goose arrival and nesting. — We monitored goose arrival in the Base-camp Valley by counting goose pairs every two to three days from our arrival on the island until the end of snowmelt on sample plots. Nest searches were carried out within walking distance (~6 km) of both the Base-camp Valley and the Camp-2 area between 10and 21 June. Nests were found in 2 ways: 1) through systematic searches at the Base-camp and Camp-2 (limited to a high-density area in the colony centre in the latter case) or 2) searches of randomly located 4-ha plots at Camp-2. We also attempted to find the nests of as many neck-collared females as possible throughout both study areas. During the hatching period, we visited a sample of nests almost every day to record hatch dates and to web-tag goslings.

Marking and tracking of geese with radio-transmitters. — We regularly scanned from one receiving station located at each study area to detect the presence of geese that had been marked with radio transmitters last year. Scans were done during the pre-laying, laying and incubation periods every 1 to 3 days. We also used a snowmobile to track geese around the Base-camp and the Camp 2. We did a complete aerial tracking of Bylot Island on 9 and 25 June and searched for the nests of radio-marked females that we detected with the helicopter.

Collection of eggs and birds. — During laying, we removed 19 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 thermoregulation, energetic cost of locomotion and nutrition. During brood rearing, we also collected 22 grazing goslings by shooting to examine their diet in upland habitats.

Behavioural observations. — Observations were carried out daily during the whole brood-rearing period at the Base-camp Valley (from 17 July to 9 August) and at the Camp-3 (16 July to 21 July) when broods are in movement from the nesting to the brood-rearing areas. Every day, we scanned each study area from 2 blinds located on vantage points. All goose families were positioned, the behaviour was recorded and the habitat used was identified using a detailed map. In the Base-Camp Valley, observations focused on the mesic (i.e. upland habitat) because use of this habitat is still poorly known.

Goose banding. — From 6 to 14 August, we banded geese with the assistance of local Inuit people and a helicopter. All geese captured were sexed and leg banded, and all recaptures (web-tagged or leg-banded birds) were recorded. A sample of young and adults was measured (mass and length of culmen, head, tarsus and 9th primary). Young were fitted with coded white plastic leg bands and a sample of adult females were fitted with coded yellow plastic neck-collars.

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 13 and

17 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.

PRELIMINARY RESULTS

Weather conditions. — The spring 2002 was characterized by an early snowmelt, mostly due to a relatively thin snow-pack. Snow depth on 2 June was 26 cm compared to a long-term average of 35 cm (Fig. 1). Temperature in spring was also relatively mild with an average air temperature of -0.94 ^{o}C between 20 May-20 June compared to a long-term average of -0.32 ^{o}C. Consequently, the rate of snow-melt was rapid and comparable to years with early spring such as 1997 and 1998 (Fig. 1). Precipitation was low in June (10 mm), including a few light snowfalls (4 cm). However, summer temperatures were generally cool with little sunshine and frequent precipitations (38 mm in July; no data for August).

Goose arrival and nesting activity. — Despite the early snow-melt, the arrival of geese on Bylot Island was much later than in most years and similar to 2000, a year with a relatively late snow-melt (Fig. 2). Our first pair count on 1 June on the hills surrounding the Base-camp Valley was 28 pairs, and up until the complete snowmelt counts remained low (i.e. <200 pairs), which is unusual.

Median egg-laying date was 16 June, which is later than normal (Table 1). This is very surprising given the favourable conditions in early June (i.e. early snow-melt). It is noteworthy that since the instauration of the spring hunt in 1999, nest initiation has been later than the long-term average in three years and near normal in the fourth (Table 1). Our field observations suggest that the reproductive effort of geese was low at the main breeding colony (Camp-2) and no nest were found at the Base-camp Valley (even though the latter site is mostly a brood-rearing area, a low density of nesting geese is found there in most years). Average clutch size was 3.43, which is below the long-term average (Table 1). Again, it is noteworthy that since the instauration of the spring hunt, clutch size has been lower than the long-term average in all four years.

Nesting activity of radio-marked geese. — We still had some geese with radio-transmitters present in the population at the beginning of the season but this number was reduced because few birds were marked with radios on Bylot Island in 2000 and 2001. Even though no tracking was done in spring 2002 in southern Québec, we estimated that up to 30 birds still had potentially functioning radios. This number, however, is a maximum and may have been lower in reality. The signal of only 3 of these birds (10%) was detected on Bylot Island, a much lower proportion than last year but comparable to 1999 (Table 2). We presume that most birds not detected on Bylot Island were still alive, as we found in previous years.

Similar to 1999, none of the radio-marked geese detected on Bylot Island in 2002 nested, again a situation similar to 1999 (Table 3). However, we must be cautious about this conclusion due to the very small number of radio-marked geese present on the island. This nonetheless provides additional evidence that the reproductive effort was low on Bylot Island this year.

Nesting success of geese. — Nesting success (proportion of nests hatching at least one egg) was similar to last year (53% in 2002 compared to 57% last year), which is below the long-term average (Table 1). Activity of predators at goose nests, especially Arctic foxes (*Alopex lagopus*), was moderately high this year possibly because the abundance of lemmings (the main prey of predators) was very low on Bylot Island following the peak of 2000 (see below). During nesting and brood-rearing, 79 birds with neck-collars were sighted, a very low number. Peak hatch was on 11 July, slightly later than normal (Table 1). We tagged 1977 goslings in nests at hatch, all of them in the Camp-2 area since no geese attempted to nest in the Base-camp Valley.

Density of broods. — The low reproductive effort observed this year was confirmed by goose faeces density at the end of the summer in wet meadows of the Base-camp Valley, which was among the lowest values recorded (4.4 ± 1.2 [SE] faeces/m^2, Fig. 3). Accumulation of faeces was also delayed this year and only started at the end of July, which suggests that arrival of broods on the brood-rearing areas was delayed. Faeces density at the end of the summer was also low in the wet meadows of the nesting colony at Camp-2 (3.1 faeces/m^2 vs. 4.9 in 2001) and at Point Dufour, the other brood-rearing area (4.6 faeces/m^2 vs. 3.6 in 2000). When the reproductive effort of geese is low, as we observed this year, non-breeders leave Bylot Island to moult elsewhere in the Arctic (Reed et al. in press), thus reducing the summer goose density on the Island.

Behavioural observations. — Behavioural observations confirmed that the number of broods present in the Base-camp Valley was relatively low in 2002 and it increased gradually during the summer, thus also suggesting a late arrival of geese on the brood-rearing area. Wet polygons were the most heavily used habitat and uplands received very little use with no tendency for an increase in late summer as usually observed. The absence of late summer movement to upland habitats may be related to the light grazing pressure observed in wetland habitats (see below) where feeding conditions may have remained good until the end of the season for geese this year. However, bad weather conditions at the end of the summer, especially fog, forced us to stop observations early and this may partly explain why we did not detect late summer movements toward upland habitats.

Goose banding. — The banding operation was difficult this year and only moderately successful due to a low density of brood, bad weather and unavailability of the helicopter on some days. We conducted 6 drives in the lowlands and hills bordering the Base-camp Valley to the south (<8 km) and 6 drive near the Camp-2 (30 km to the south). We banded a total of 2650 geese, including 490 adult females marked with neck-collars and 1131 young with plastic tarsal bands. In addition, there were 143 recaptures of web-tagged young and 133 recaptures of adults banded in previous years. No geese were marked with radio-transmitters during banding. The gosling:adult ratio among geese captured at banding (0.81:1) and mean brood size (1.67 young, SD = 0.78, n = 43; counts conducted between 7 and 13 August) were both well below the long-term average and among the lowest values ever recorded (Table 1). By combining information on brood size and young:adult ratio at banding, we estimated that 97% of the adults captured were accompanied by young, a rather high value.

Small mammal and predator monitoring. — For our small-mammal survey, we accumulated 1400 trap-nights in the Base-camp Valley split between 2 trapping sites (one lowland and one upland) and 550 trap-nights in the upland habitat at Camp-2. In the Base-camp sites, we captured only 1 collared lemming (*Dicrostonyx groenlandicus*), for an index of abundance of 0.07 lemmings/100 trap-nights, the lowest number since 1995 (Fig. 4). Lemming abundance at the Camp-2 was also very low (0.19 lemmings/100 trap-nights with only 1 collared lemming captured). Therefore, lemmings continued the decline started in 2001 at the Base-camp Valley following the peak of 2000, and declined dramatically at Camp-2 following a very high density in 2001. Thus, even though the last peak in lemming abundance was not synchronized at our two study sites, lemming populations had crashed at both sites in 2002 (Fig. 4).

We found signs of fox activity (digging or fresh prey remains) at 6% of known denning sites (n = 48) compared to 47% in 2001 and 46% in 2000. No litters were seen this year compared to 8 in 2001 and 7 in 2000. This suggests that fox breeding activity had declined drastically and was very low in 2002. Again this year, no Snowy owl nests were found at either study area compared to 13 nests in 2000. This further confirms that lemming numbers were very low this year on Bylot Island.

Plant growth and grazing impact. **—** This year, plant production in wet meadows was good although it was lower than in the two previous years. Above-ground biomass of graminoid plants reached 53.1 ± 8.1 [SE] g/m^2 in ungrazed areas in mid-August compared to 68.2 ± 12.6 in 2001 (Fig. 5). Again this year, the proportion of *Eriophorum*, the preferred plant of geese, remained high compared to the Gramineae *Dupontia*. Indeed, since 2000, *Eriophorum* accounted for 45% to 47% of the total graminoid biomass (45% in 2002) whereas for the period 1990 to 1999, *Eriophorum* accounted for 15% to 36%. This year, total plant production was also reduced at the Camp-2 area (nesting area: 26.1 ± 2.6 g/m^2 vs. 48.7 ± 10.2 g/m^2 in 2001 and 28.9 ± 5.5 in 2000) and Dufour Point (another brood-rearing area: 42.6 ± 8.2 g/m^2 vs. 65.5 ± 16.4 g/m^2 in 2000).

Goose grazing was very low in the wet meadows of the Base-camp Valley where geese removed only 17% of the above-ground biomass (difference between paired grazed and ungrazed plots) by mid-August. This grazing impact is comparable to the year of reproductive failure of 1999 (14%) and much lower than in the two previous years (43% in 2001 and 44% in 2000, Fig. 5). The impact was again higher on *Eriophorum* (20% of biomass removed) than on *Dupontia* (14% of biomass removed). Grazing impact at Camp-2 (nesting area) was also low with 17% of the graminoid biomass removed by geese (15% for *Eriophorum*) compared to 40% in 2001. However, at Dufour Point, another brood-rearing area, geese removed 33% of the total biomass, but 54% of the biomass of *Eriophorum* (comparable values in 2000 were 31% and 50%, respectively). Dufour Point is characterized by a higher proportion of *Carex* (16% of the total biomass vs 1% in the Base-camp Valley).

CONCLUSIONS

The breeding season of Greater Snow Geese yielded some surprising results in 2002. Most noteworthy is that, despite an early snow-melt in 2002, geese arrived late and nested late, and their reproductive effort was considerably reduced. This is the first time in 14 years of monitoring that an early spring (e.g. similar to 1993, 1997 and 1998) did not result in a good breeding performance by geese. Nest predation was moderately high, but not as high as in previous years of lemming crashes (e.g. 1995 and 1999), which is also surprising given the low nest density. The combination of low reproductive effort, late nesting, and moderate nest predation lead to a low young:adult ratio during our banding operation. Based on this statistic, we anticipated a proportion of young in the fall flock around 14%, a low value. However, this prediction was only partially upheld as juvenile counts conducted in Québec this fall indicated an even lower proportion of young (6%, n = 18,930). It should be noted that our young:adult ratio at banding does not take into account non-breeding adults that do not stay on Bylot Island to molt, a number that was likely high this year due to the low reproductive effort. Therefore, with a proportion of young in the fall flock of 6%, the year 2002 can be classified as a year of breeding failure for Greater Snow Geese (defined as years where this proportion is <10%), comparable to 1999 (2%, the worst breeding failure in over 30 years).

This year, plant production in wet meadows of Bylot Island was good, though lower than in the two previous years, possibly because relatively dry conditions prevailed at the onset of plant growth in June, and temperature was cool in July and August. However, grazing impact was very light due to the low brood density. Therefore, goslings probably experienced good feeding conditions during brood-rearing for a third year in a row. The high plant production in recent years on Bylot Island may be explained by the virtual absence of grazing in 1999 due to a massive breeding failure of geese that year, and moderate grazing combined with very good growing conditions for plants in 2000 and 2001 (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 in recent years.

The poor reproduction of geese on Bylot Island in 2002 is clearly not due to conditions prevailing there in spring. We suggest that a reduction in the body condition of geese due to the spring hunt, in combination to harsh climatic conditions encountered during the spring migration may explain the late arrival of geese in the Arctic and the ensuing poor reproduction. Even though we did not measure the body condition of geese in Québec this spring, we have shown before that disturbance induced by the spring hunt reduced the accumulation of fat and protein (Féret et al. in press, Gauthier unpubl. data). In 2002, the spring hunt was again intense with a record number of geese killed (CWS, unpubl. data). Furthermore, the spring was late throughout Québec, and especially along the migratory route of geese in northern Québec. Thus, geese probably had little opportunity to feed during the migration through northern Québec and could not make up for any deficit in body reserves that may have occurred during their staging in southern Québec. Hence, this may have contributed as well to the late arrival of geese in the High Arctic this year.

We have previously suggested that the reduction in body condition caused by the spring hunt had a negative impact on goose fecundity (Mainguy et al. 2002). After 4 years of spring hunt, we are now in a better position to evaluate this hypothesis. During those years, egg-laying has been late in 3 years and clutch size reduced in all years. Bêty et al (in press) recently showed that laying date was significantly later than anticipated in years with a spring hunt after controlling for the effect of climatic condition. In addition, proportion of young in the fall flock was very low in two years and below average in the third. On average, production of young during the 4 years with a spring hunt was 15%, well below the value during the preceding period (27% during 1984-1998, Menu et al. 2002). These results thus provide additional support for the hypothesis that the spring hunt negatively affects the reproduction of geese, a factor that was not taken into account in the original population model of Gauthier and Brault (1998). The most recent survey (640,000 geese in spring 2002; CWS, unpubl. data) shows a marked decline in the spring population following the peak of 1999 (938,000 including a telemetry correction). Despite uncertainties associated with the most recent survey figure, population trend over the last 4 years shows an average decline of at least 13%/yr, which matches well the decline of 10-15%/yr predicted by a revised population model including both a reduction in survival and fecundity due to the spring hunt (Gauthier, unpubl. data). This concordance suggests that the most recent survey data are probably reasonable. Based on the very low production observed this year, further population decline are anticipated for spring 2003. Therefore, the objective of stabilizing the Greater Snow Goose population proposed in the Arctic Goose Joint Venture report of 1998 has been attained.

PLANS FOR 2003

The long-term objectives of our work are to study the population dynamics of the Greater Snow Goose, and the interactions between geese, plants and their predators on Bylot Island. A major focus of the project is to monitor changes in demographic parameters (such as survival rate, hunting mortality, breeding propensity, reproductive success and recruitment) and habitat in response to the spring conservation hunt and other special management actions implemented since 1999 in Québec. Other focuses of the project include *i*) improving estimates of annual variation in survival and breeding propensity (a poorly known parameter); *ii*) a better understanding of the spatial structure of colonies and goose movements on Bylot Island; *iii*) expanding our estimate of the carrying capacity of the Island for geese to the upland habitats; *iv*) determining long-term effects of geese on the arctic landscape; and *v*) study indirect interactions between snow geese and lemmings via shared predators, especially arctic foxes. In 2003, 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 live goose eggs to continue experiments on metabolism, thermoregulation and nutrition of growing goslings in the laboratory.
4) Band 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.
5) Monitor the level of intestinal parasite infestations in goslings and the effects of parasites on survival.
6) Carry out the aerial survey of snow geese on Bylot Island during brood-rearing (conducted every 5 years since 1983).

7) Monitor the abundance of lemmings, the breeding activity of snowy owls and foxes, and examine their influence on goose nesting success.
8) Capture and radio-mark arctic foxes to study their foraging activity around goose colonies.
9) Sample plants in exclosures to assess annual production and the impact of goose grazing on plant abundance in wet meadow habitats.
10) Monitor plant abundance in long-term goose and lemming exclosures in both wet meadows and upland (mesic) habitats.
11) Evaluate the diet, food selection and variation in plant quality of geese grazing in upland habitats.
12) Maintain and upgrade our automated environmental and weather monitoring system.

In 2003, at least 5 graduate students will be involved in the Bylot Island snow goose project. **Nicolas Lecomte** (PhD) will start a project on the spatial structure of snow goose colonies and movements between colonies based on marked females and genetic markers. **Benoît Audet** (MSc) will study the diet, food selection and plant quality of geese in upland habitats. **Nicolas Ouellet** (MSc) will participate to the monitoring of geese nesting activity and collect eggs for laboratory studies on gosling growth and metabolism. **Ilya Klvana** (PhD) will start a project on the population dynamics and movements of arctic foxes. Finally, **Guillaume Szor** (MSc) will complete the fox den survey of Bylot Island and study the activity and diet of foxes at their dens around the snow goose colony. We are also planning to recruit another PhD student to study egg caching by foxes.

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

	1993	1994	1995	1996	1997	1998	1999	2000	2001	**2002**	Average
Number of nest monitored	367	846	312	367	326	350	266	386	296	**470**	--
Median date of egg-laying	6 June	11 June	10 June	14 June	10 June	7 June	17 June	16 June	13 June	**16 June**	13 June
Clutch size	4.41	3.55	3.64	3.99	4.27	4.00	3.09	3.51	3.43	**3.43**	3.69
Nesting success[1]	89%	40%	14%	65%	83%	79%	12%	83%	57%	**53%**	62%
Median date of hatching	3 July	7 July	7 July	11 July	7 July	4 July	13 July	13 July	9 July	**11 July**	9 July
Number of geese banded	3134	3531	3985	3824	3956	3998	1717	4269	3430	**2650**	--
Ratio young:adult at banding	1.55:1	0.79:1	1.10:1	0.83:1	1.06:1	1.09:1	0.54:1	1.08:1	1.03:1	**0.81:1**	1.02:1
Brood size at banding	3.12	2.66	2.50	2.34	2.47	2.70	1.67	2.78	2.37	**1.67**	2.47
Proportion of adults with young at banding	99%	60%	88%	71%	86%	81%	65%	78%	87%	**97%**	82%

[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%
2001	19	9	47%
2002	**(20-30)***	**3**	**(10-15%)**

* The exact number of radio-marked geese leaving southern Quebec is unknown in 2002 because no tracking was conducted there in spring. The maximum potential number is 30 but the true value is probably lower due to mortality

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%
2001	9	2	22%
2002	**3**	**0**	**0%**

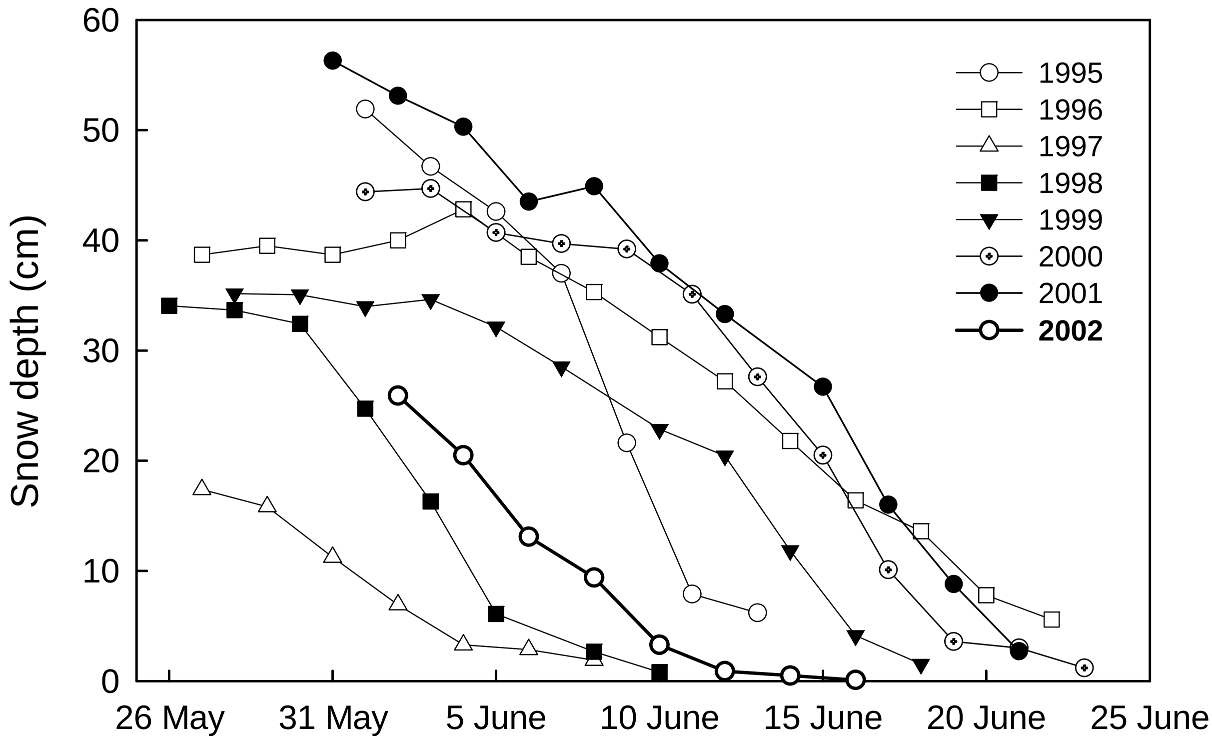

Figure 1. Depth of snow (mean $\pm$ SE) along 2 transects showing the rate of snowmelt in Bylot Island lowlands (n = 50 stations).

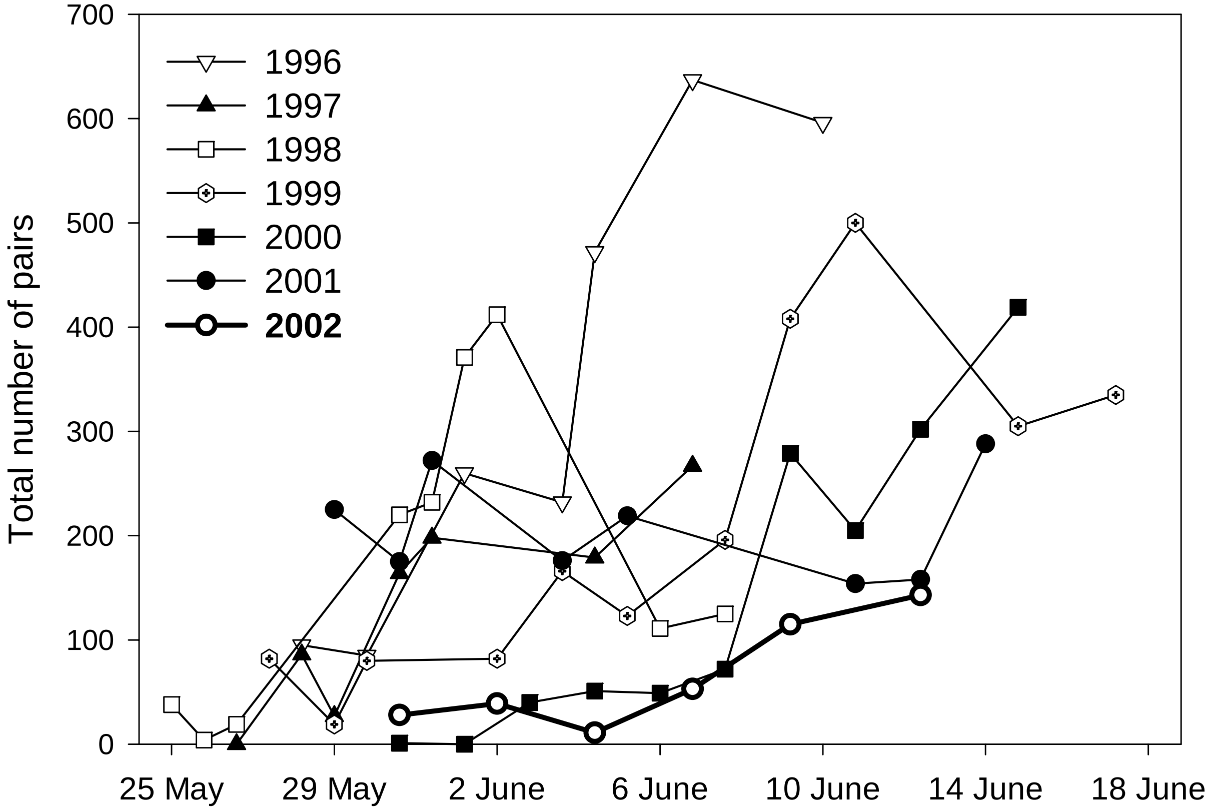

Figure 2. Total number of goose pairs counted in the Base-camp Valley from arrival of our crew on Bylot Island until the end of snowmelt.

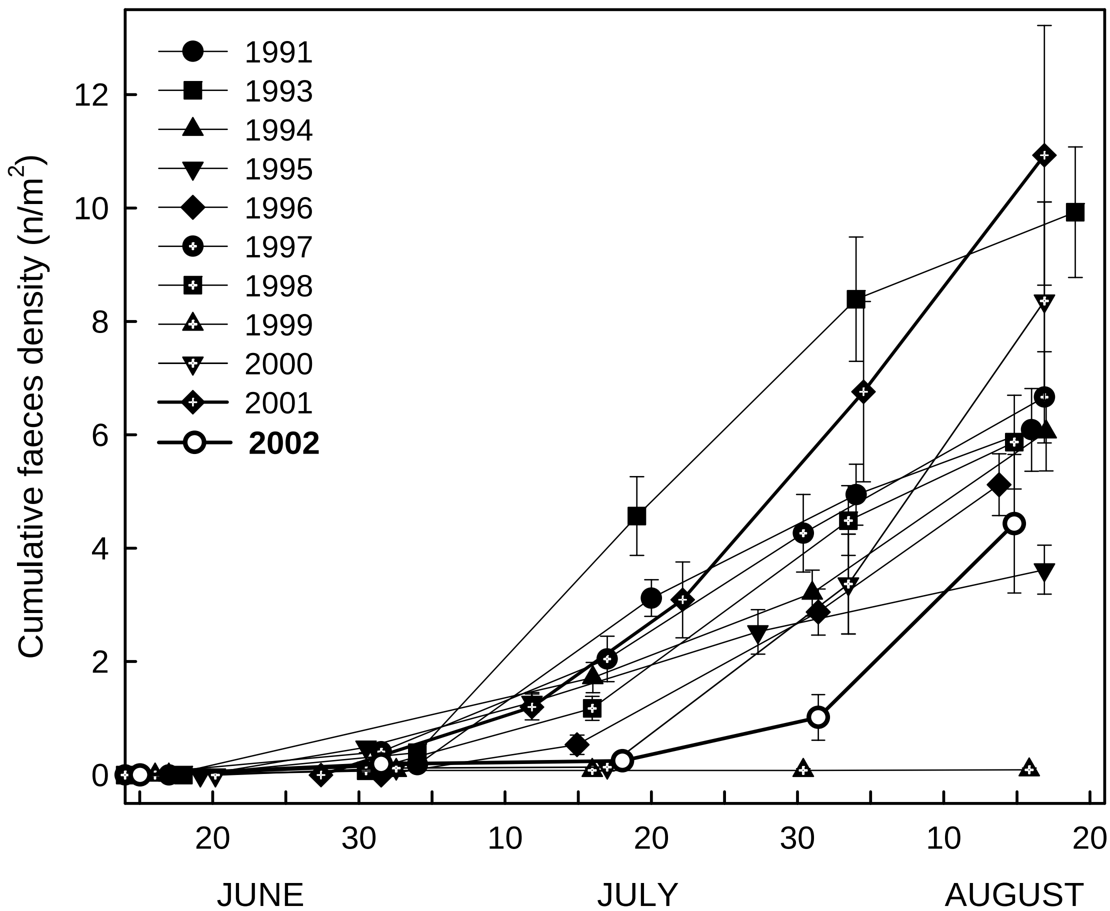

Figure 3. Cumulative faeces density (mean ± SE) showing the use of Base-camp Valley by Greater Snow Goose families on Bylot Island throughout the summer (n = 12 transects of 1x10m).

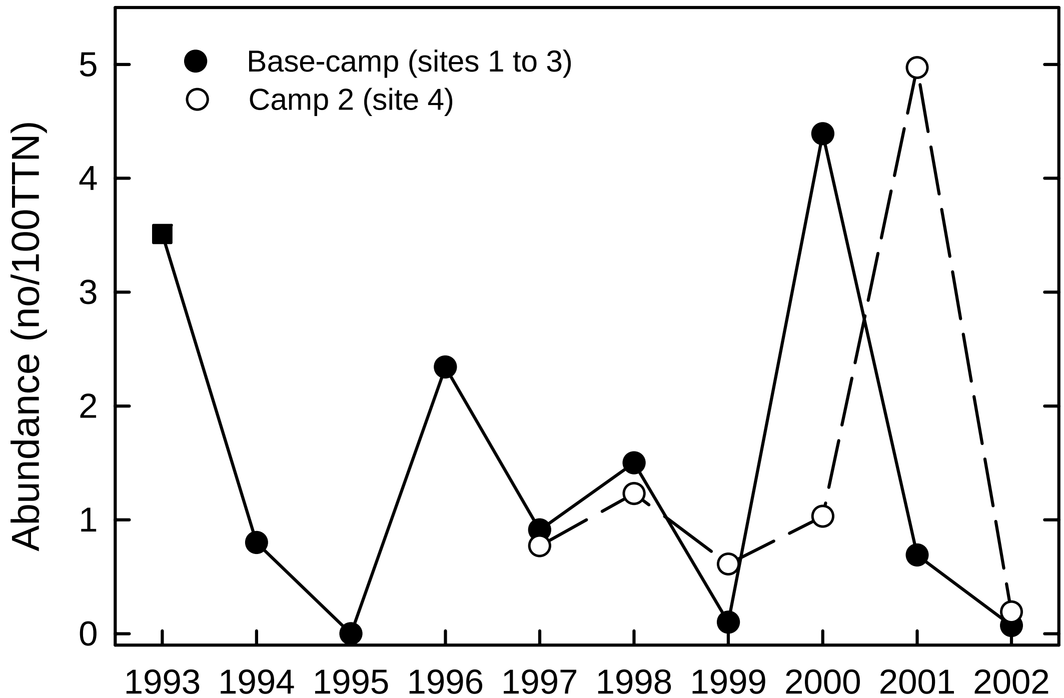

Figure 4. Annual abundance of lemmings at two study areas (Base-camp Valley and Camp-2) located 30 km apart on Bylot Island.

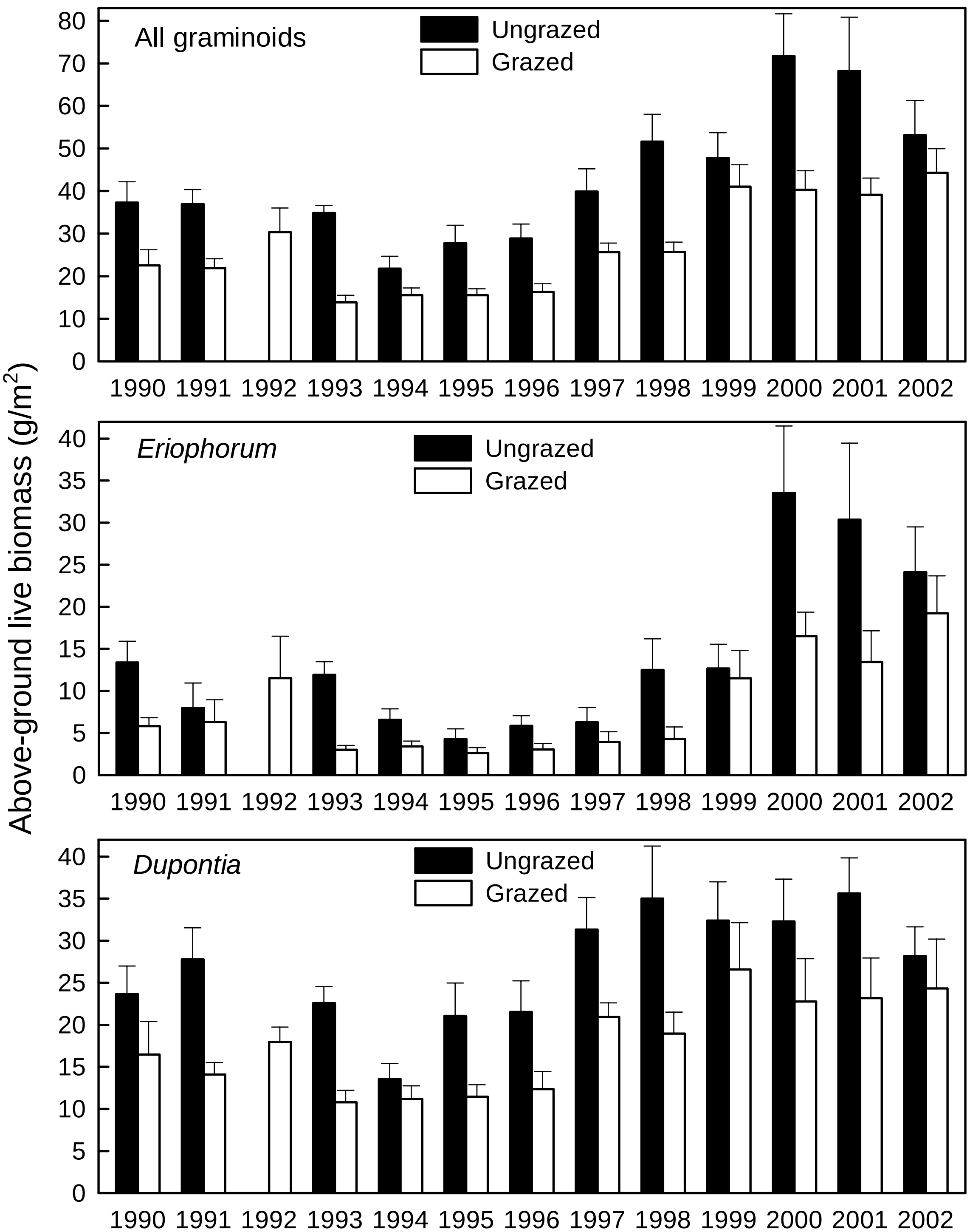

Figure 5. Live above-ground biomass (mean ± SE, dry mass) of graminoids around 15 August in grazed and ungrazed wet meadows of the Base-camp Valley, Bylot Island (n = 12). Total graminoids include *Eriophorum scheuchzeri*, *Dupontia fisheri* and *Carex aquatilis*. There is no data from ungrazed area in 1992.