POPULATION STUDY OF GREATER SNOW GEESE ON BYLOT ISLAND (NUNAVUT) IN 2001: A PROGRESS REPORT

by

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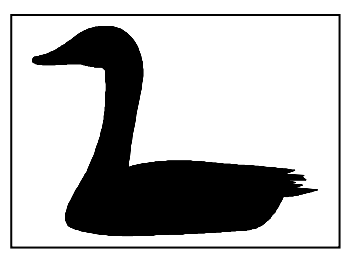

9 November 2001

INTRODUCTION

In 2001, 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 2001 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) Collect female geese at the time of laying to examine the contribution of body reserves accumulated during spring staging to egg-formation.

3) Assess the growth and pre-fledging survival of goslings using goslings marked in the nest.

4) Collect live goose eggs to continue experiments on metabolism and thermoregulation of growing goslings in the laboratory.

5) Capture adult females on the nest and mark them with conventional radio-transmitters to study the summer movements of families and habitat use.

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 in 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) Sample plants in exclosures to assess annual plant production and the impact of goose grazing on plant abundance.

10) Characterize and map the vegetation in upland habitats used by geese to include this habitat in our estimate of the carrying capacity of Bylot Island for geese.

11) 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.

FIELD ACTIVITIES

Field camps. — In 2001, 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 28 May to 20 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 5 June to 14 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 12 to 21 July.

Field party. — The total number of people in the three camps ranged from 6 to 14 depending on the period. Members of our field party included project leaders Gilles Gauthier, Austin Reed, Jean-François Giroux and Esther Lévesque. There were also graduate and undergraduate students whose thesis projects addressed several of the objectives laid out above. Students were: Eric Reed (PhD, objective 6), Julien Mainguy (MSc, objectives 1, 2, 5 and 11), Isabelle Duclos (MSc, objective 10 and 11), Pascale Otis (MSc, objective 4), Joëlle Taillon (BSc, objectives 3 and 8), Ariane Massé (BSc, objective 9), Jean-François Savard (objectives 5 and 8), and Catherine Gagnon (objective 11). Other people in the field included Gérald Picard, a technician from U. Laval, and Justin Merkosak, Joasie Ootovak and Amos Ootovak from Pond Inlet.

Other people that visited our camp included the *Sirmilik Park* chief warden, M. Carey Elverum, and one of his assistant; Vicki Sahanatien, ecosystem secretariat manager, Parks Canada; Elisabeth Seale, superintendent of Parks Canada, Nunavut; and Pauline Scott, also from Parks Canada. Two board member of the Pond Inlet HTO, Elijah Panipakocho and Salomon Koonoo, also visited the camp during goose banding.

Weather data. — Weather data continued to be recorded at our two automated stations. A third meteorological station was installed in July 2001 at a high elevation site (370m ASL). Our network now includes 2 full stations (one at low and one at high elevation) 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). 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. 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 at the two study areas.

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 25-27 June and searched for the nests of radio-marked females with the helicopter.

We captured females with bow nest traps during incubation and marked them with conventional radio transmitters at Camp-2. These radios were glued on green neck-collars and the total package weighed 60g. All goslings from these females were web-tagged. After hatch, we did daily radio-tracking from one receiving station located at Camp-3 (12 to 21 July), and from 2 stations located in the Base-Camp Valley (15 July to 9 August), which allowed positioning of broods on the study area by triangulation at the latter site. We also conducted aerial tracking and positioning of the birds with the helicopter over most of the south plain of Bylot Island on several occasions (11, 14, 17, 20 and 23 July; 6-9 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 in southern Québec in spring and autopsied. Thus, the condition of birds during laying could be compared with that of geese in southern Québec before departure for the Arctic. We further removed 44 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. Finally, some goslings were sacrificed during banding, and their intestines were removed to determine their parasite load.

Behavioural observations. — Observations were carried out daily during the whole brood-rearing period at the Base-camp Valley (from 12 July to 17 August) and at the Camp-3 (13 July to 21 July). 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 little known.

Goose banding. — From 8 to 15 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 green plastic leg bands and adult females were fitted with coded yellow plastic neck-collars. During 3 days, we also targeted specifically radio-marked birds in order to recapture them, determine the number of young still present, and weigh and measure them.

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 2 sites: the Base-camp Valley (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. We also set 12 exclosures at a third site, Dufour Point, in early July but this site could not be sampled at the end of the summer because of the late arrival of field crew to Bylot Island in August due to poor weather. 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 Camp-2 site.

This year we continued our study of the vegetation used by geese in upland mesic and dry habitats. In order to complete our characterization of plant communities, we sampled additional plots in vegetation zones that had been little studied (less than 4 plots) in 2000. We also sampled a zone adjacent to the beach because we discovered that this area is used as a migration corridor for goose families between nesting and brood-rearing areas. In addition, we assessed goose grazing in four types of mesic habitats (~15 km^2) in order to evaluate the importance of different plant species in the diet of geese. Between 15 and 20 permanent plots (1m x 0.5m) were positioned in each habitat. Every 2 weeks, these plots were visited and the number of grazed leaves and inflorescences were recorded for each species as well as any signs of grubbing. Phenology of each species was also noted.

PRELIMINARY RESULTS

Weather conditions. — For a second year in a row, we had a very thick snow-pack in spring: snow depth on 1 June was a record 55 cm compared to 44 cm in 2000 and a long-term average of 37 cm (Fig. 1). Temperature in spring was mild with an average air temperature of +0.4 ^{o}C between 20 May-20 June compared to a long-term average of -0.4 ^{o}C. Despite a rapid rate of snow-melt due to the mild weather, snow-melt was still slightly delayed due to the thick snow-pack (Fig. 1). Precipitation was moderate in June (31 mm), including one measurable snowfall (4 cm). Summer temperatures were generally warm and very sunny with precipitation below average (34 mm in July, including a record 15 mm in one day, and 16 mm up to 20 August). These conditions, combined with a good spring run-off, again resulted in excellent growing conditions for plants this year.

Goose nesting activity. — Arrival of geese on Bylot Island was much earlier than in the previous 2 years. Our first pair count on 30 May on the hills surrounding the Base-camp Valley was 225 pairs, whereas in 2000 we had to wait until 11 June to reach similar values. Median egg laying date was 13 June, which is earlier than in the previous 2 years but very close to the long-term average (Table 1). Despite normal nesting dates, reproductive effort of geese was moderate at the main breeding colony (Camp-2) and low at the Base-camp Valley (the latter site typically has low density of nesting geese in most years because it is mostly a brood-rearing area). The density of nests in the main breeding colony was similar to last year. Average clutch size was 3.43, which is below the long-term average (Table 1).

Nesting activity of radio-marked geese. — Even though we still had some geese with radio-transmitters present in the population at the beginning of the season, this number was considerably reduced because fewer birds were marked with radios on Bylot Island in 2000 than in previous years. During partial tracking in spring 2001 in southern Québec, we detected 19 birds that still had functioning radios. The signal of 9 of these birds (47%) was detected on Bylot Island, the highest number since the instauration of the spring hunt in 1999, but still lower than in 1997 or 1998 when >77% of all radio-marked geese tracked in spring were detected on Bylot Island (Table 2). We presume that most birds not detected on Bylot Island were still alive, as we found in previous years (1997 to 1999), even though there was no radio coverage along the St. Lawrence estuary this fall to confirm this assumption.

We found a nest for 2 of the 9 (22%) radio-marked geese tracked in spring and detected on Bylot Island in 2001, again the highest value since the beginning of the spring hunt in Québec, but lower than in 1997 or 1998 (Table 3). However, we must be cautious about this conclusion due to the low sample size. This nonetheless suggests that reproductive effort was moderate on Bylot Island this year but higher than in the previous 2 years.

During incubation, 21 females were captured on the nest and marked with radio-transmitters at the Camp-2 colony (most of these females had been previously marked with standard neck collars, i.e. without transmitters) and the nests of 3 females with old transmitters were found. Of these 24 nests, 6 were were preyed upon before hatch, and thus 18 radio-marked females hatched out a brood and were tracked to their brood-rearing site. As in the previous years, most radio-marked birds that did not nest (or lost their nests before hatch) disappeared from the Island by the end of June (82%, n = 11). These birds must have molted away from Bylot Island, at a yet unknown area.

Collection of geese and body condition. — The collection of geese in southern Québec prior to departure for the Arctic in mid-May was much reduced in 2001 (1 capture at 1 site) compared to the previous 2 years (3 captures at as many sites) due to budget restrictions. Birds leaving the Upper Estuary of the St. Lawrence River for the Arctic had a better body condition than in the previous 2 years when a spring hunt was also taking place (Fig. 2). Although their abdominal fat mass approached the range of annual values observed in previous years without spring hunt, it was still 14% less than the average value recorded in those years. In 2001, a sample of 25 females collected during laying on Bylot Island showed that condition was similar to last year but still lower than comparable values recorded in 1989-1990.

Nesting success of geese. — Nesting success (proportion of nests hatching at least one egg) declined from a high of 83% last year to 57% in 2001, slightly below the long-term average (Table 1). Activity of predators at goose nests was much higher than last year possibly because the abundance of lemmings (the main prey of predators) had started to decline following last year peak. Arctic foxes (*Alopex lagopus*) were especially abundant this year. During nesting and brood-rearing, 281 birds with neck-collars were sighted, a moderate number. Peak hatch was on 9 July, the normal date (Table 1). We tagged 1897 goslings in nests at hatch, 69 in the Base-camp Valley and 1828 in the Camp-2 area.

Movements and density of broods. — Of the 18 radio-marked females with broods, 11 moved all the way to the Base-camp Valley with their brood, 6 dispersed half-way in that direction and stopped around the Camp-3, and 1 moved inland toward the glacier. Those that reached the Base-camp Valley to raise their brood covered a distance of ca 30 km in 6 days on average (range: 4 to 8 days), which was slightly faster than last year. No radio-marked females stayed in the Camp-2 area with their brood as in previous years. All families moving to the Base-camp Valley passed through the area of Camp-3, half-way in between. Most families followed a coastal route, with many families walking directly on the sandy beach for part of the way. Those that moved via the tundra appeared to spend most of their time near wetland patches and ponds, even when crossing upland habitat.

Despite the moderate reproductive effort observed this year, goose faeces density at the end of the summer in wet meadows of the Base-camp Valley was, surprisingly, among the highest values ever recorded, (10.9 ± 2.3 [SE] faeces/m^2, Fig. 3). However, faeces density was variable among plots as shown by the large standard error. Accumulation of faeces increased steadily until the end of the summer, as in 2000, instead of levelling off in August as it was often observed in previous years Faeces density at the end of the summer was also relatively high in the wet meadows of the nesting colony at Camp-2 (4.86 faeces/m^2 vs. 3.62 in 2000). We do not believe that this is an indication of an exceptionally high density of broods across Bylot Island in 2001. The very high faeces density in wet meadows probably reflects a sustained use of this habitat by broods until the end of the summer and the absence of movement toward upland habitats, which typically occurs in August. The absence of late summer movement may be a consequence of the very high plant production in wet meadows this year. A higher density of predators than usual may also have contributed to restrain broods to the vicinity of ponds where they feel more secure. Indeed, we observed many attacks by foxes on broods this year, as well as attacks by wolves, which is a *première* on Bylot Island.

Behavioural observations. — At the Base-camp, eight types of upland habitat were determined, three large mesic habitats and five wet habitats. The mesic polygons are common in the valley bottom whereas hills and terraces are the dominant mesic habitats in the uplands are . The wet habitats are wet patches within the mesic habitats or are associated with streams. Behavioural observations confirmed that upland habitats were not intensively used in 2001 and that goose families mostly remained in wet lowlands. Nevertheless, use of upland habitats changed over the season. In early and mid-summer, all of the 8 habitat types were used by goose families. During this period, mesic polygons (wet sections included), streams and hills were most frequently used. In late summer, geese were counted in only 5 mesic habitat types, the hills and mesic polygons (wet sections excluded) being the dominant ones.

Goose banding. — The banding operation was moderately successful with 8 drives conducted in the lowlands and hills bordering the Base-camp Valley to the south (<8 km) and 1 drive conducted near the Camp-2 (30 km to the south). Our banding operation had to be curtailed because of the late arrival of the field crew to the camp in August due to bad weather. We nonetheless banded a total of 3430 geese, including 498 adult females marked with neck-collars and 1419 young with plastic tarsal bands. In addition, there were 128 recaptures of web-tagged young and 224 recaptures of adult females banded in previous years. No geese were marked with new radio-transmitters during banding. The gosling:adult ratio among geese captured at banding (1.03:1) and mean brood size (2.37 young, SD = 1.08, n = 117; counts conducted between 29 July and 14 August) were both slightly below the long-term average (Table 1). By combining information on brood size and young:adult ratio at banding, we estimated that 87% of the adults captured were accompanied by young, a rather high value.

All radio-marked females still present on the island were recaptured at banding (n = 19), including one female that hatched a brood but that was found dead at the end of the summer. The 17 females that left their nest with a brood had a total of 55 goslings (3.24 young/female, SD = 1.09) but only 22 were recaptured at banding (1.29 young/female, SD = 1.05; survival rate of 40%). There was 5 females that lost all their goslings (i.e. 29% of total brood loss); brood size among females that still had goslings at banding was 1.83 young, SD = 0.72, which is lower than for unmarked geese. Data from the radio-marked females thus suggest that mortality of young may have been higher than suggested by the young:adult ratio at banding.

Small mammal and predator monitoring. — For our small-mammal survey, we accumulated 1100 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 4 brown lemming (*Lemmus sibiricus*) and 3 collared lemmings (*Dicrostonyx groenlandicus*), for an index of abundance of 0.69 lemmings/100TTN, a low number. This indicates that lemmings had crashed following the peak of 2000 (4.39 lemmings/100TTN). Surprisingly, lemming abundance at the Camp-2, which was moderate last year (1.03 lemmings/100TTN), was very high this year (4.97 lemmings/100TTN with 18 brown lemmings and 5 collared lemmings captured). This suggests that the decline in lemming abundance was not yet generalized to the whole Bylot Island in 2001.

We found signs of fox activity (digging or fresh prey remains) at 47% of known denning sites (n = 45) compared to 46% in 2000 and 38% in 1999. We confirmed the presence of pups at 8 dens, compared to 7 in 2000 and 3 in 1999. Six dens were occupied by Arctic foxes and two by Red foxes (*Vulpes vulpes*). The proportion of dens with pups was higher at Camp-2 (29%, 5 out 17 dens) than at the Base-camp (11%, 3 out of 28 dens). Litter size ranged from 1 to 6 pups. This suggests that fox breeding activity was again high this year. No Snowy owl nests were found at either study area compared to 13 nests last year. This further confirms that lemmings were declining this year on Bylot Island. One Rough-legged Hawk (*Buteo lagopus*) pair nested in the Base-camp Valley.

Plant growth and grazing impact. — For the second year in a row, plant production in wet meadows was very good as above-ground biomass of graminoid plants reached 68.2 ± 12.6 [SE] g/m^2 in ungrazed areas in mid-August (Fig. 4). This is close to the record high production of 2000. This high plant production is again entirely due to a very high biomass of *Eriophorum*, the preferred plant of geese, as the biomass of *Dupontia* has remained stable over the last 5 years. *Eriophorum* biomass in 2000 and 2001 has been 2.5× higher than in 1998 and 1999. Plant production was also high at the Camp-2 area (nesting area; 48.7 ± 10.2 g/m^2 vs. 28.9 ± 5.5 in 2000 and 38.7 ± 4.0 in 1999).

Goose grazing was again moderately high in the wet meadows of the Base-camp Valley where geese removed 43% of the above-ground biomass (difference between paired grazed and ungrazed plots) by mid-August, compared to 44% in 2000 (Fig. 4). The impact was much higher on *Eriophorum* (56% of biomass removed) than on *Dupontia* (35% of biomass removed). Grazing impact at Camp-2 (nesting area) was also significant with 40% of the graminoid biomass removed by geese (51% for *Eriophorum*). This contrasted with 2000 when the low plant production at this site was associated by a negligible grazing impact (4% difference in biomass between grazed and ungrazed sites).

Ten mesic plant communities were recognized in the vicinity of the Base-camp Valley. All of them were dominated by arctic willows (*Salix arctica*) and some were co-dominated by graminoids or legumes that are frequently grazed by geese. In addition, a large variety of flowers was produced in most mesic plant communities. These flowers could be an important source of food for geese in late summer. Because geese made little use of upland habitats in 2001, few signs of grazing were recorded in the permanent plots except in one habitat where inflorescences of *Luzula* spp. and *Arctagrostis latifolia* were grazed at the end of the season. No signs of grubbing were noted in permanent plots at the end of the season. However, abundant signs of grazing by lemmings on graminoids (*Arctagrostis latifolia*, *Alopecurus alpinus*, *Poa arctica*, *Luzula nivalis*, *L. confusa*) were noted early in the season in mesic polygons reflecting the impact of the lemming population peak in 2000-2001.

CONCLUSIONS

In 2001, geese nested at normal dates and experienced good feeding conditions during brood-rearing due to a very high plant production. However, these positive factors were offset by a relatively high predation rate and, more importantly, the moderate reproductive effort as shown by the telemetry data. Even though the young:adult ratio at banding was near average, 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. Based on our observations, we anticipated that the proportion of young in the fall flock of Greater Snow Geese should be around 20%, a value similar to last year but much higher than in 1999 (2%, the worst breeding failure in over 30 years). This prediction was partially upheld as preliminary data of juvenile counts in Québec indicate 27% of young in the fall flock, which is very near the long-term average (26%).

One explanation for the moderate reproductive effort on Bylot Island this year could be the thick snow pack in spring and the slightly delayed snow-melt. However, this explanation is at odd with the normal nesting dates as late snow-melt usually induces both reduced reproductive effort and delayed nesting. The warm weather in early June may have contributed to near normal nesting dates. The scant information that we have from the spring staging suggests a marginally reduced accumulation of fat in spring, presumably a consequence of the continued spring hunt, as we documented in previous years. Data from laying birds also suggested a reduced body condition. Therefore, a relatively high predation rate and a somewhat reduced body condition upon arrival in spring may be the primary factors responsible for an average production of young in 2001.

For the second year in a row, 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 2001 may be explained by 1) the virtual absence of grazing in 1999 due to the massive breeding failure of geese that year, and 2) the 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 despite the increase in the population. Plant production in recent years continued to be the highest values recorded over the last decade.

The effects of recent management actions (especially the spring conservation hunt) on population trends have been difficult to evaluate due to difficulty in getting good population estimate during the spring survey in recent years. The most recent estimates suggest a population around 830,000 in 2001. However, demographic data (annual production of young and hunting mortality) clearly indicates that the population should have declined by 15 to 25% over the last 2 years. It is therefore likely that the population has exceeded 1,000,000 birds 2 years ago, a figure partially supported by the survey data despite their low precision in recent years. This decreasing trend is due to a combination of factors, including a high participation by hunters to the spring hunt in Québec, an increase in the harvest during the regular season, and a 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). Based on the reproductive output of this year and assuming the same hunting pressure as in the previous 3 years, the population model anticipates a slight decline in population size in spring 2002.

PLANS FOR 2002

The long-term objectives of our work to study the population dynamics of the Greater Snow Geese, and the interactions between geese, plants and their predators on Bylot Island will remain unchanged in 2002. 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 new spring conservation hunt and other special management actions (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 2002, 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 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.
6) Monitor the abundance of lemmings, the breeding activity of snowy owls and foxes, and examine their influence on goose nesting success.
7) Sample plants in exclosures to assess annual plant production and the impact of goose grazing on plant abundance.
8) Evaluate the diet of geese grazing in upland habitats.
9) Develop a sampling protocol for plant biomass in upland habitats used by geese.
10) Complete the establishment of exclosures in upland habitat to eventually estimate the carrying capacity of this habitat for geese.

In 2002, at least 2 graduate students will be involved in the Bylot Island snow goose project. **Julien Mainguy** (MSc) will finish his study of the movements of geese between the hatching and brood-rearing site, and the effect of distance moved on gosling growth and survival. **Anna Calvert** (MSc) will start a new project to improve estimation of hunting mortality in greater snow geese by comparing several approaches.

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

	1992	1993	1994	1995	1996	1997	1998	1999	2000	**2001**	Average
Number of nest monitored	199	367	846	312	367	326	350	266	386	**296**	--
Median date of egg-laying	20 June	6 June	11 June	10 June	14 June	10 June	7 June	17 June	16 June	**13 June**	12 June
Clutch size	3.21	4.41	3.55	3.64	3.99	4.27	4.00	3.09	3.51	**3.43**	3.69
Nesting success[1]	70%	89%	40%	14%	65%	83%	79%	12%	83%	**57%**	63%
Median date of hatching	15 July	3 July	7 July	7 July	11 July	7 July	4 July	13 July	13 July	**9 July**	9 July
Number of geese banded	2004	3134	3531	3985	3824	3956	3998	1717	4269	**3430**	--
Ratio young:adult at banding	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	**1.03:1**	1.04:1
Brood size at banding	2.20	3.12	2.66	2.50	2.34	2.47	2.70	1.67	2.78	**2.37**	2.53
Proportion of adults with young at banding	74%	99%	60%	88%	71%	86%	81%	65%	78%	**87%**	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%
2001	**19**	**9**	**47%**

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%**

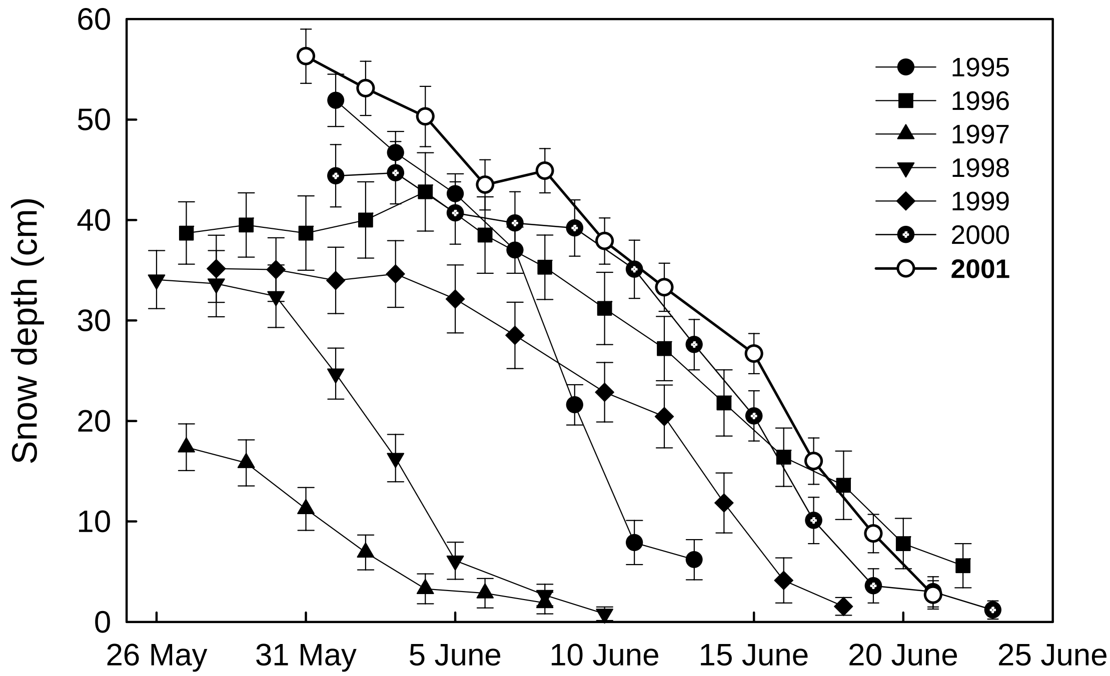

Figure 1. Depth of snow (mean $\pm$ SE) along 2 transects showing the rate of snowmelt in Bylot Island lowlands (n = 50 stations).

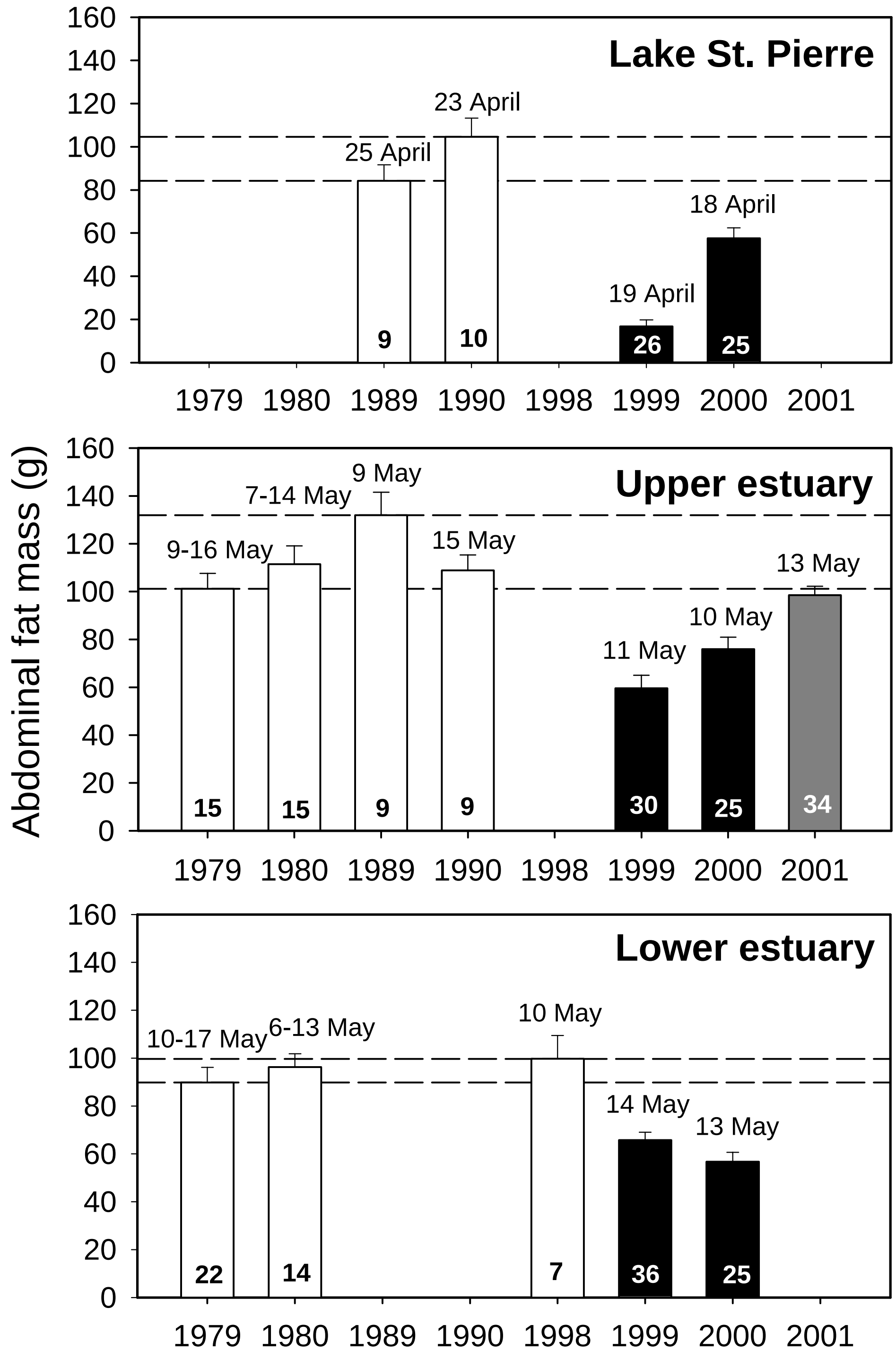

Figure 2. Abdominal fat mass of female greater snow geese upon departure from various spring staging areas along the St. Lawrence River. Geese were collected only in some years during the period 1979-2001. Numbers within bars are sample sizes and dates are sampling dates. Geese leaving Lake St. Pierre continue their fattening in the estuary area but geese leaving from the two estuary sites depart for the Arctic. The stippled lines show the minimum and maximum values recorded in years without spring hunt at each site. Black and gray bars show years with a spring hunt

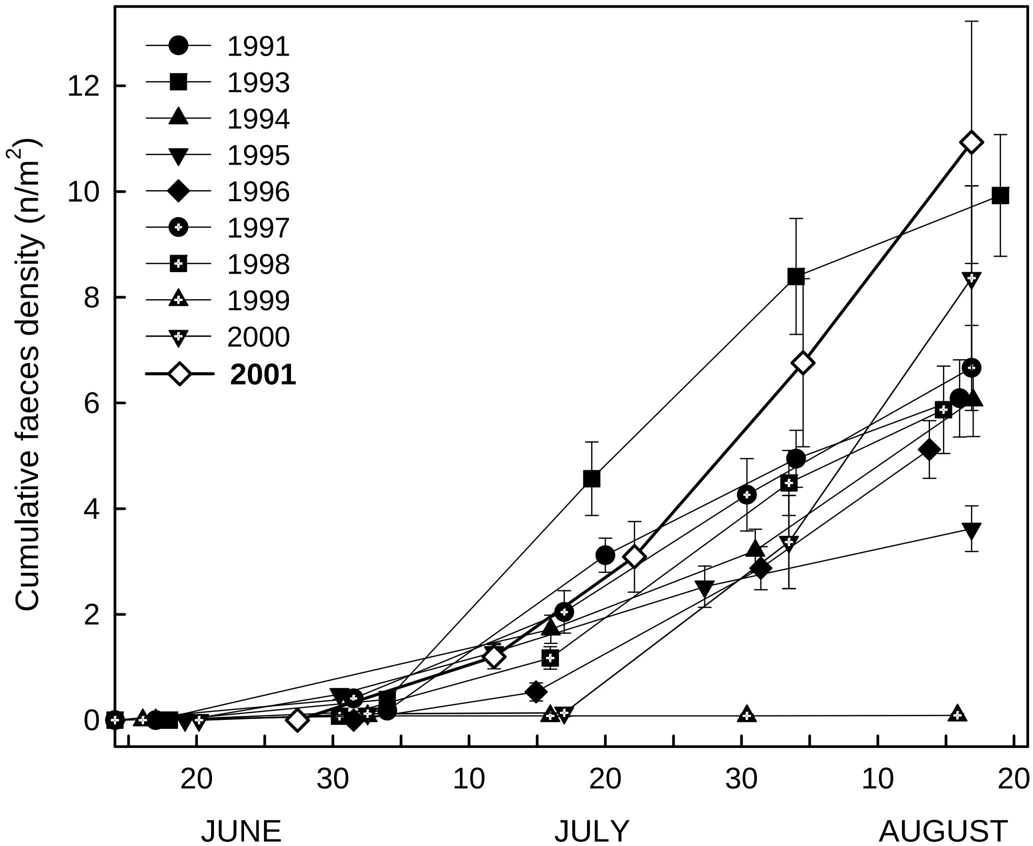

Figure 3. Cumulative faeces density (mean ± SE) showing the use of Base-camp Valley by Greater Snow Goose families on Bylot Island throughout the summer (n = 12 transects of 1x10m).

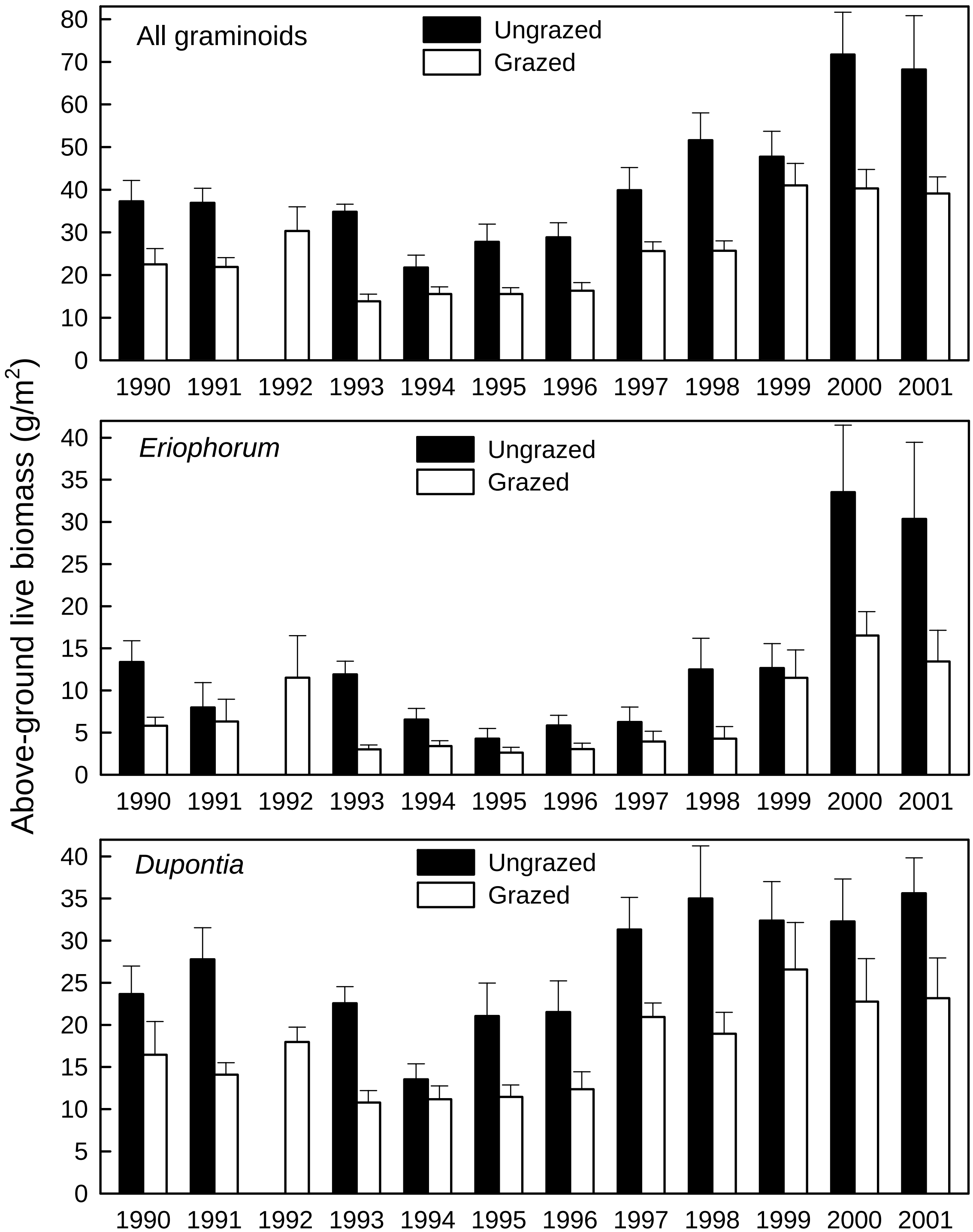

Figure 4. Live above-ground biomass (mean $\pm$ SE, dry mass) of graminoids around 15 August in grazed and ungrazed wet meadows of the Base-camp Valley, Bylot Island (n = 12). Total graminoids include *Eriophorum scheuchzeri*, *Dupontia fisheri* and *Carex aquatilis*. There is no data from ungrazed area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