POPULATION STUDY OF GREATER SNOW GEESE ON BYLOT ISLAND (NUNAVUT) IN 1999: A PROGRESS REPORT

by

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INTRODUCTION

In 1999, 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 1999 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) Study the movements of geese during their reproductive cycle on Bylot Island, and determine reproductive performance of radio-marked geese.

3) Collect goose females at the time of laying to examine the contribution of body reserves accumulated during spring staging to egg-formation.

4) Examine the relationship between nest site selection, predator abundance, lemming cycles and nesting success of geese.

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

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

7) 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.

8) Fit a number of adult females with conventional radio-transmitters to study their movements during the spring and fall migration, and summer 2000 on Bylot Island.

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

10) Study the past and present evolution of wetlands (polygons) and associated landforms on Bylot Island, and evaluate how goose grazing may affect this process.

11) Characterize the vegetation in upland habitats used by geese.

12) Band and monitor nesting success of small birds (Lapland Longspurs) and Snowy Owls.

FIELD ACTIVITIES

Field camp. **—** As in previous years, we operated two 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 26 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 1 June to 16 July.

Field party. **—** The total number of people in both camps ranged from 6 to 12 depending on the period. Members of our field party included project leaders Gilles Gauthier, Austin Reed, Jean-François Giroux, Line Rochefort, Esther Lévesque and Michel Allard. There were also graduate and undergraduate students whose thesis projects addressed several of the objectives laid out above. Students were: Joël Bêty (PhD, objectives 2, 3 and 4), Eric Reed (PhD, objective 7), Chistopher Ellis (Post-doc, objective 10), Daniel Fortier (MSc, objective 10), Arnaud Béchet (PhD, objective 8), Jonathan Olson (MSc, objective 8), Julie Lambert (BSc, objective 6), Mathieu Dumas (BSc, objective 11), Isabelle Duclos (BSc, objective 9), and Jonatan Blais (BSc, objective 1). Other members of our field party included Gérald Picard (wildlife technician) and Anita Ootovak, Nathan Tigularaq and Joasie Ootovak from Pond Inlet. Two board members of the Pond Inlet HTO, M. Jayko Alloloo (chairman) and M. Paniloo, also visited the camp and our field site during the banding operation.

Weather station. **—** Weather data continued to be recorded at our two automated weather 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 also 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. **—** During the pre-laying and laying periods, transects were conducted on skis to assess the relative abundance of nest predators on each study area. Intensive 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 also conducted behavioral observations to record the activity of predators (presence, attacks, and predation events) around goose nests during incubation. During the hatching period, we visited a sample of nests almost every day to record hatching dates and to weigh, measure and web-tag goslings at the two study areas.

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 with radio transmitters. Scans were done every 1 to 2 days during the pre-laying and laying periods and every 1 to 5 days during incubation. We also used a snowmobile to track geese around the Base-camp (from 27-31 May) and the Camp 2 (from 1-15 June). Before and during nesting, we did aerial tracking with the helicopter over most of the south plain of Bylot Island (on 1, 10, 14, 18, 25 June and 16 July) and a small portion of Baffin Island (Tay and Tremblay Sound on 28 June) to locate marked geese. We searched for nests of geese with radio-transmitters on foot using a portable antenna. Aerial tracking was also conducted over Bylot Island during the banding period (14 August).

***Collection of birds and eggs.* —** During laying, we shot some adult females and collected eggs to examine the condition of these birds and to conduct isotopic analyses. Live eggs were also collected just before hatch.

***Aerial Survey.* —** No aerial survey of the goose population of Bylot Island was conducted in 1999. However, preliminary results of the aerial photo survey conducted in July 1998 are presented in this report.

***Goose banding.* —** From 10 to 15 August, we banded geese with the assistance of Inuit people from Pond Inlet and a helicopter. All geese captured were sexed and leg banded. A sample of young and adults were measured (mass and length of culmen, head, tarsus and 9th primary). A sample of young was fitted with coded red plastic leg bands and most adult females were fitted with coded yellow plastic neck-collars. In a parallel banding operation, conventional radio-transmitters were also placed on adult geese. These radios were glued onto green neck-collars, and the total package weighed 60g. The mates of these females received yellow neck-collars (without radios). This operation, also conducted with the help of Inuit, involved the capture of small groups only (< 10 families).

***Small mammal, predator and bird monitoring.* —** We participated for the sixth time in the small-mammal survey coordinated across the NWT by the Renewable Resources office in Yellowknife. The trapping method and detailed results are given in an appendix to this 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 grazing by geese was evaluated in wet meadows dominated by graminoid plants at 3 different sites on the island. These sites are the Base-camp Valley (brood-rearing area), Camp-2 area (nesting and brood-rearing area) and Dufour Point (brood-rearing 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. Use of brood-rearing areas by families was monitored by counting faeces on 1x10 m transects located near each exclosure. Faeces counts were made every 2-weeks in the Base-camp Valley and only once, when plants were sampled in August, at the other sites.

This year, we expanded our study of vegetation used by geese to the mesic and dry habitats. A large scale survey was carried out by foot and helicopter to identify the dominant vegetation types. The survey focused primarily on the portion of the valley more intensely used by geese. The study area was stratified and three replicate stations within each of the dominant vegetation types were marked. A preliminary characterization of the vegetation was carried out by point sampling (100 points per quadrat) within three random quadrats (50cm x 50cm) per plant community. In order to develop a reliable method to assess plant biomass without extensive destructive plant collection, we tested a few methods for assessing biomass (10x10cm or 25x25cm quadrats and species specific collections). These collections will serve to establish correlations between plant cover and plant biomass.

Study of polygon formation. — Morphometric data on ice-wedges and polygons were obtained by direct field measurements. A trench (40 m long x 1.5 m wide x 1.0 m deep) was dug along an East-West transect, bisecting a low-centre-polygon-area of the valley, and 25 cores (16 of 3 m deep and 9 of 1 m deep, 5 cm in diameter) were taken from the trench for stratigraphical analysis. Detailed description of the trench was supplemented by the collection of cores from across the valley – providing a wider spatial resolution, and being strategically placed in order to yield data on the hydrological and erosive regime of an arctic ecosystem at a landscape scale. The different landforms sampled were: low- and high-centre polygons and pools, slope ice-wedge, lake shores and pingos.

To examine the effect of geese on the thermal regime of the polygon field, four 'thermistor' cables were installed in the permafrost. They are located (a) in a low centre polygon protected by an exclosure (1m deep), (b) in an low centre polygon unprotected from goose grazing (3m deep) and (c) in a high centre polygon (3m deep). A fourth cable (16 m deep) is situated in a transitional polygon zone.

PRELIMINARY RESULTS

Weather conditions. —The spring of 1999 was characterized by an above-average snow-pack: snow depth on 1 June was 34.5 cm compared to a long-term average of 32 cm (Fig. 1). Air temperature in spring were near normal with an average of 0.39 ^{o}C between 20 May-20 June compared to a long-term average of 0.22 ^{o}C. However, most days were overcast due to unusually persistent cloud cover in June. As a result, snowmelt was much later than in 1998, a very early year, but only slightly later than normal (Fig. 1). Temperature in July and August were near average with unusually sunny weather throughout July. Both spring and summer were very dry with only 45 mm of rain between late May and late August, which is half of the long-term average (89 mm for these 3 months). The growing conditions for plants were nonetheless satisfactory owing to warm weather in July and a good spring run-off.

Goose nesting activity. — For the second year in a row, departure of geese from spring staging areas in Québec was very early, probably a consequence of unusually warm weather in May. However, arrival of geese on Bylot Island was somewhat delayed this year. Though the first geese were already present upon our arrival on 26 May, daily counts of geese on the hills surrounding the Base-camp Valley were low until 11 June (<200 pairs). There was then a large influx of birds with a peak count of 500 pairs on 15 June, which was at least a week later than usual.

Median egg laying date was 17 June, the second latest initiation date on record (Table 1). In contrast to last year, reproductive effort of geese on Bylot Island was low at both study sites in 1999. Only 5 nests were found in the Base-camp Valley. The number of nests in the Camp-2 area was also very small compared to normal years. We found 300 nests over an area that usually harbours a few thousands nests. Clutch size was only 3.12, which is the lowest value ever recorded on Bylot Island (Table 1). We also found 2 nests of Ross' geese which is the first nesting record for Bylot Island.

Monitoring of geese fitted with radio-transmitters. **—** For a third year, we had a large number of radio-marked geese that had been tracked on spring staging ground in southern Québec until their departure for the Arctic. The signal of only 11 of these birds (19%) was detected on Bylot Island which contrasted sharply with the previous 2 years when 77% to 95% of all radio-marked geese tracked in spring were detected on Bylot Island (Table 2). Arrival dates of these birds on Bylot Island was also delayed compared to previous years: median date was 18 June (range: 10 June to 25 June) in 1999 compared to 10 June in 1997 and 7 June in 1998. Many of the marked geese that were not detected at Bylot Island were located this fall along the St-Lawrence river, indicating that they were alive and with operating radios last summer.

None of the radio-marked geese were found nesting in 1999, which is again in sharp contrast to the previous 2 years when we found the nests of more than half of the radio-marked geese (Table 3). This further confirms that reproductive effort was very low this year on Bylot Island and that many birds did not even complete their spring migration all the way to their usual breeding site. As in the previous years, all radio-marked birds that did not nest (or lost their nest very early) had disappeared from the Island by 25 June (n = 11). These birds must have therefore molted away from Bylot Island, at a yet unknown area.

Collection of birds and eggs. **—** During laying, we shot 21 adult females and collected 39 eggs, mostly from the nests of the shot geese. The reproductive tract, abdominal fat and breast muscles of collected birds were removed to assess their condition and reproductive status. Laboratory analyses are still underway. We 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.

Nesting success, hatching and brood density. **—** Nesting success was only 14% this year, equal to the lowest year on record (1995). This is well below the long-term average (Table 1). This poor nesting success was a consequence of the very high activity of predators at goose nests. Sustained attacks by Arctic foxes (*Alopex lagopus*), parasitic jaegers (*Stercorarius parasiticus*) and glaucous gulls (*Larus hyperboreus*) were observed throughout the incubation period. During incubation, we observed only 25 different neck-collared geese on nests compared to 494 last year.

Peak hatch was on 12 July, the second latest on record (Table 1). We tagged about 285 goslings in nests, a number much reduced compared to previous years owing to the low density of nests remaining at hatch. Goose faeces density at the end of summer 1999 was extremely low in the Base-camp Valley (0.9 faeces/m^2) and reflected the almost total absence of broods there compared to the previous year (58.7 faeces/m^2). Similarly, low values were recorded at Dufour Point, another brood-rearing area (5.2 faeces/m^2 in 1999 compared to 66.6 faeces/m^2 in 1998). Moderate faeces density was only found at the nesting colony of Camp-2 with 22.4 faeces/m^2 (compared to 32.0 faeces/m^2 in 1998). Brood density was therefore very low this year on Bylot Island, and few families dispersed from the Camp-2 nesting colony to the usual brood-rearing habitats of the Base-Camp Valley and Dufour Point.

***Aerial survey.* —** The total population survey of Bylot Island for 1998 was 119,779 (SE = 14,242), down from 155,945 (SE = 14,910) in 1993 (Fig. 2). The number of goslings was reduced (86,470 in 1993 vs 59,107 in 1998) which is not surprising considering that 1993 was an all-time high for production of young on Bylot Island. The number of adults accompanied by young (breeders) was also reduced (55,000 vs 37,575, respectively) but the number of adults without young (non and failed-breeders) increased (14,475 vs 23,097, respectively). Overall, there was only a slight, non-significant decline in total adult geese on Bylot Island between 1993 and 1998 (69,475 vs 60,672).

***Goose banding.* —** The banding operation was moderately successful this year. We banded a total of 1717 geese, including 468 adult females and 82 adult males marked with neck-collars, and 604 young with plastic tarsal bands. In addition, there were 112 recaptures of web-tagged young and 80 recaptures of adults banded in previous years. We also marked 93 adult females with radio-transmitters. The operation was difficult owing to the very low density of broods on Bylot Island. In a normal year we easily band 4000 geese over an area corresponding roughly to 10% of the south plain of Bylot Island. This year we banded 1700 birds over the whole south plain of the island. Average catch size was also much smaller this year (~80 birds/drive, n= 23) than in previous years (~400 birds/drive). The gosling:adult ratio among geese captured at banding (0.54:1; Table 1) was by far the lowest value ever recorded, as was the average brood size (1.67 young, SD = 0.68, n = 27; counts conducted between 30 July-13 August). By combining information on brood size and young:adult ratio at banding, we estimate that 65% of the adults captured were accompanied by young, also a low value. This suggests that the high predation rate persisted during the brood-rearing period.

***Small mammal and predator monitoring.* —** For our small-mammal survey, we accumulated about 1000 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 only 1 brown lemming (*Lemmus sibiricus*), a very low index of abundance (0.10 lemming/100TTN). Three collared lemmings (*Dicrostonyx groenlandicus*) were captured at the Camp-2 site, again a low index of abundance (0.61 lemming/100TTN; see report: **Small mammal trapping results - Bylot Island 1999** for details). This suggests that lemming abundance in 1999 was at its lowest level since the peak of 1996.

We found signs of fox activity (digging or fresh prey remains) at 14 of 37 known denning sites (38%) compared to 18 of 32 sites (56%) in 1998. We confirmed the presence of pups at 3 dens, down from 9 dens in 1998. Two dens were occupied by Arctic Foxes and one by Red Foxes (*Vulpes vulpes*). Litter size was a minimum of 1 to 4 pups. This suggests that fox breeding activity was much reduced, presumably a consequence of low prey abundance (lemmings and geese). No Snowy Owls were found nesting this year and one Rough-legged Hawk (*Buteo lagopus*) pair nested in the Base-camp Valley.

***Plant growth and grazing impact.* —** Above-ground biomass of graminoid plants sampled in ungrazed areas in mid-August was among the highest value recorded in the Base-camp Valley (41.0 g/m^2, SE = 4.7, Fig. 3), showing that plant production in wet meadows was favored in 1999. It is noteworthy that annual plant production in ungrazed areas apparently rebounded fairly well since the very low values of 1994, which coincided with a drought that year and a very high grazing pressure in the previous year (1993). Plant biomass in ungrazed wet meadows was similar at Camp-2 (nesting and brood-rearing area; 38.7 g/m^2, SE = 4.0) and at Dufour Point (brood-rearing area; 43.0 g/m^2, SE = 7.2).

Goose grazing was very light in the wet meadows of the Base-camp Valley, as anticipated based on the low brood density this year. By mid-August, the difference in above-ground biomass between paired grazed and ungrazed plots was 13%, a non-significant difference (Fig. 3). Only *Dupontia* showed a significant decrease due to goose grazing (16%). In comparison, geese had removed 50% of the above-ground biomass in 1998. This is the lowest grazing impact recorded since the beginning of the study in 1990. At Dufour Point, another brood-rearing area, grazing was also negligible as the above-ground biomass sampled was actually higher outside than inside exclosures. A significant impact of grazing was only detected at the Camp-2 nesting colony. Geese removed 36% of the above-ground biomass at this site, a value comparable to last year. This was also the only area where faeces counts indicated a significant use by geese this year.

The mesic and dry habitats represent approximately 90% of the deglaciated area on Bylot Island. They were found at various altitudes from the well drained portion of the valley floor to mountain ridges and they varied in topography from flat ridges to steep slopes. During our survey, we found a mosaic of plant communities growing in these habitats, from mesic meadow and heath tundra to polar deserts. Four vegetation types were selected for further studies (*Cassiope*- and *Dryas*- dwarf shrub heath, *Luzula*-dwarf-shrub tundra and herb tundra) and a species list was established. Vegetation samples collected are currently being analyzed.

Study of polygon formation. — Geomorphological and paleoecological samples are currently subject to laboratory analysis. However, preliminary data already provide original insight regarding the inter-relationships of ice-wedge growth, polygon development, paleoecology and paleoclimatology. Data from the trench suggests that the development of the low-centre polygons around the transect has been a function of climatic conditions and sediment accumulation. Variations in the oxygen isotopes and in the wind blown sand content of the cores (yet to be analysed) will allow us to infer more fully the paleoclimatic conditions (temperature and wind) which may have impacted on polygon development in the past, and, at this early stage, we speculate that the entire polygon field must have evolved in synergy with river-bank erosion and major thermokarst processes.

Cores from across the valley are being examined in order to reconstruct the vegetational development of fenland polygons. Early results show a marked non-random variation in the past vegetation of low-centre polygons, probably related to erosive and hydrological processes. Continued examination will provide the opportunity to asses the resilience of the polygon vegetation, the primary food source for breeding geese, to environmental perturbation – including the continued increase in snow goose numbers.

CONCLUSIONS

Overall, 1999 was the poorest breeding year of this decade for geese on Bylot Island. Based on telemetry data, a high proportion of geese apparently did not even complete their spring migration all the way to Bylot Island. Among those that reached the island, the proportion of geese that attempted to breed was low. Finally, among those that did nest, predation rate was extremely high. The very low abundance of lemmings combined with the low density of nesting geese may explain this high rate of nest predation. Predation was also high during brood-rearing, resulting in a record low density of broods at the end of the summer. Based on the young:adult ratio at banding, we predicted one of the lowest productions of young for the fall (about 2% juveniles in the fall flock). Observations conducted along the St. Lawrence estuary confirmed this prediction, and suggest that conditions encountered on Bylot Island this year were representative of the whole breeding range of the population.

The poor breeding of geese in 1999 is somewhat surprising. Very late snow-melt in spring is typically the main cause of breeding failure events in arctic-nesting geese (this was the case in 1992 for instance). However, spring temperatures were normal and snow-melt was only marginally delayed. For instance, snow-melt was later in 1996 than in 1999 and yet reproduction was much better in 1996. We believe that a poor body condition of geese in spring may largely explain the breeding failure this year. In mid-May, we captured snow geese on their staging grounds in southern Québec, just before their departure for the Arctic. Their body fat reserves were only 50-60% of values recorded in previous years. Why body condition was so low is still speculative. We noted a reduced availability of waste corn in southern Québec this spring as a much higher proportion of fields than usual had been ploughed the previous fall. More importantly, Québec experienced for the first time in 80 years a full spring conservation hunt of snow geese from 15 April to 31 May. Participation by hunters was massive and our observations showed that disturbance rate of geese feeding in farmlands was very high, resulting in more time spent in flight and reduced feeding time. These factors could explain the low body condition of geese at departure.

The population survey conducted in 1998 suggests that the population increase on Bylot Island has levelled off in recent years. However, these results should be interpreted with caution. Because the survey is conducted during the brood-rearing period, it can not record the non-breeders or failed nesters that leave the island to molt elsewhere, a common occurrence on Bylot Island. Therefore, the adult component surveyed on Bylot Island in July is greatly influenced by the breeding success in that year. Indeed, in 1993 breeding success was the highest ever recorded, making it likely that an exceptionally high proportion of potential breeders were still present at the time of the survey, resulting in an estimate that was "inflated" in comparison with the other survey years (1983, 1988, 1998) when breeding success was closer to average. However, even if the 1993 results are ignored, the other three survey years indicate an annual growth rate of 6% on Bylot Island, which is less than the 10% increase estimated for the entire population over the same 15-year period.

This year, plant production in wet meadows of the Base-camp Valley was again good, and grazing impact was very light due to the low density of broods. As a result, the above-ground plant biomass in grazed areas was the highest ever recorded. We detected a significant impact of grazing only at the Camp-2 colony where most broods apparently stayed throughout the summer instead of dispersing to the usual brood-rearing areas of the Base-Camp Valley or Dufour Point. Therefore, vegetation at these sites was relieved from the cumulative impact of goose grazing in 1999.

PLANS FOR 2000

The long-term objective of our work is to study the population dynamics of the expanding 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, status report of 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 2000, 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) Monitor movements from arrival until fledging, and determine reproductive performance of radio-marked geese (fitted with conventional radio transmitters in 1998 and 1999).
3) Examine the relationships between nest site selection, predator abundance, lemming cycles and nesting success.
4) 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.
5) Collect 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 monitoring of several demographic parameters (e.g. survival, breeding propensity).
7) Fit some adult females with conventional radio-transmitters.
8) Study the effect of intestinal parasites on goslings growth
9) Sample plants in exclosures to assess annual impact of goose grazing on plant abundance.
10) Expand our study of goose/plant interaction to the upland habitat to eventually estimate the carrying capacity of this habitat for geese.
11) Examine the effect of goose grazing on the thermal regime of the soil and the evolution of polygon landforms.

In 2000, at least 3 graduate and post-graduate students will be involved in the Bylot Island snow goose project. **Joël Bêty** (PhD) will study movements and reproductive performance of radio-marked geese. **Eric Reed** (PhD) will study the cost of reproduction and annual variations in breeding propensity and recruitment of geese based on the resighting/recapture of neck-collared birds. **Mohamed Righi** (post-doc fellow) will study the effect of parasites on goslings growth.

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

	1990	1991	1992	1993	1994	1995	1996	1997	1998	**1999**	Average
Number of nest monitored	168	239	199	367	846	312	367	326	349	**185**	--
Median date of egg-laying	13 June	11 June	20 June	6 June	11 June	10 June	14 June	10 June	7 June	**17 June**	11 June
Clutch size	3.52	3.59	3.21	4.41	3.55	3.64	3.99	4.27	4.06	**3.12**	3.74
Nesting success[1]	79%	72%	70%	89%	40%	14%	65%	83%	79%	**14%**	61%
Median date of hatching	8 July	8 July	15 July	3 July	7 July	7 July	11 July	7 July	4 July	**12 July**	7 July
Number of geese banded	729	1859	2004	3134	3531	3985	3824	3956	3998	**1717**	--
Ratio young:adult at banding	1.15:1	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**	1.04:1
Brood size at banding	2.74	2.83	2.20	3.12	2.66	2.50	2.34	2.47	2.70	**1.67**	2.52
Proportion of adults with young at banding	84%	100%	74%	99%	60%	88%	71%	86%	81%	**65%**	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%**

Table 3. Number of nests found among radio-marked geese detected during the summer on Bylot Island.

Year	Number detected on Bylot Island	Number of nests found	%
1997	35	20	57%
1998	54	29	54%
1999	**11**	**0**	**0%**

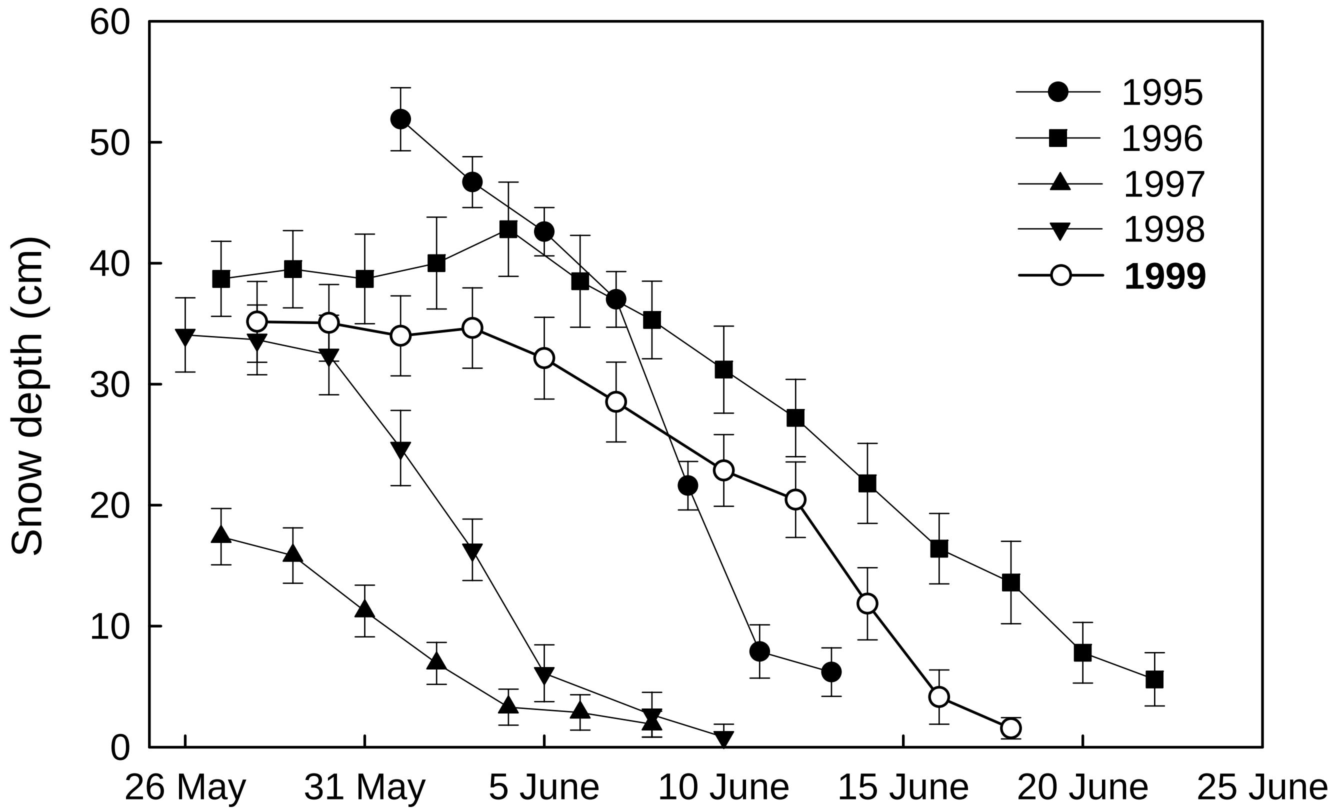

Figure 1. Depth of snow (mean ± SE) along 2 transects showing the rate of snow-melt in Bylot Island lowlands (*n* = 50 stations).

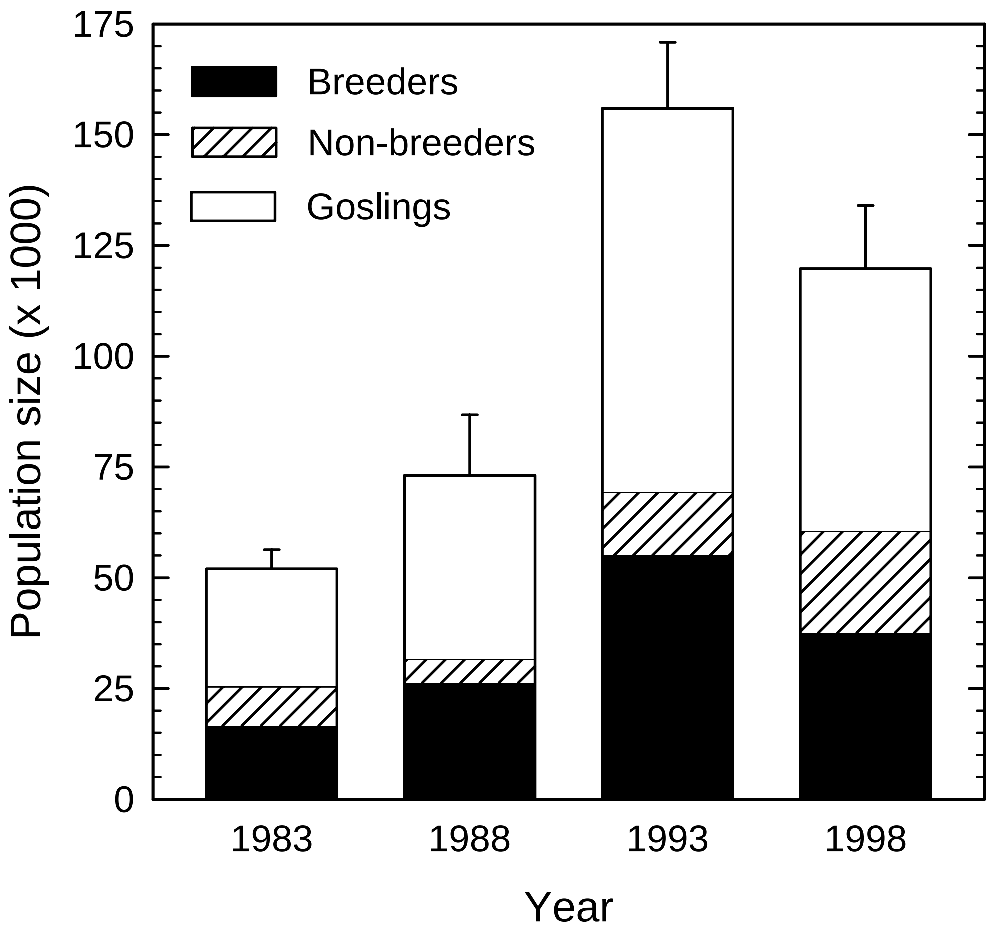

Figure 2. Population size of greater snow geese on the south plain of Bylot Island partitioned by adult breeders and non-breeders (include failed breeders), and goslings. Surveys were conducted in late July. Standard error of total estimate is given.

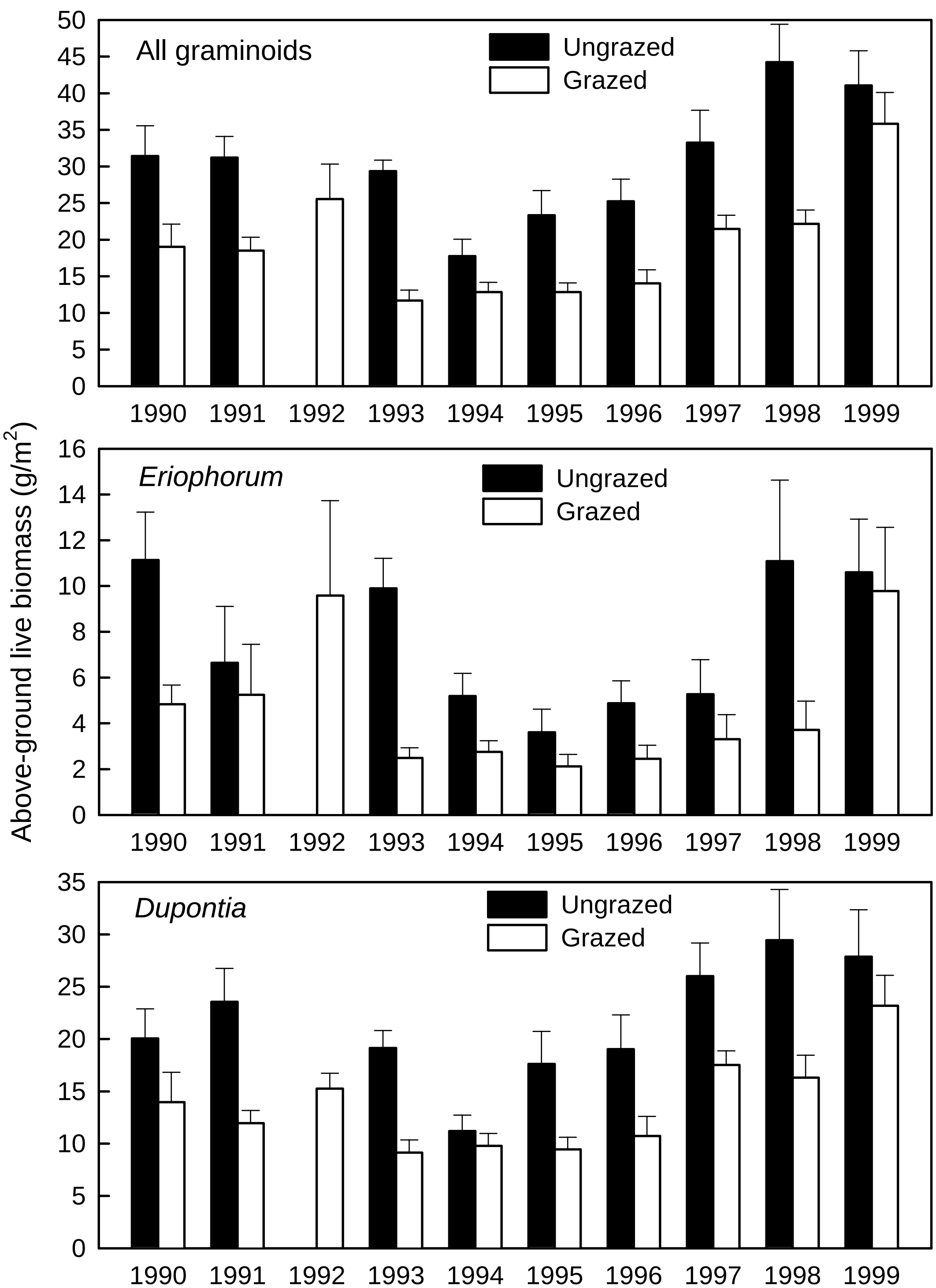

Figure 3. Live above-ground biomass (mean ± SE, dry mass) of graminoids around 15 August in grazed and ungrazed wet meadows of the Base-camp Valley, Bylot Island, 1990-1999 (*n* = 12). No data from ungrazed area in 1992 because grazing was negligible following the almost complete breeding failure of geese.