POPULATION STUDY OF GREATER SNOW GEESE ON BYLOT ISLAND (NUNAVUT) IN 2005: A PROGRESS REPORT

Gilles Gauthier Département de biologie & Centre d'études nordiques
Université Laval, Québec

Austin Reed Canadian Wildlife Service, Environment Canada, Québec

Jean-François Giroux Département des sciences biologiques
Université du Québec à Montréal

Dominique Berteaux Département de biologie, chimie et sciences de la santé
& Centre d'études nordiques
Université du Québec à Rimouski

Marie-Christine Cadieux Département de biologie & Centre d'études nordiques
Université Laval, Québec

Josée Lefebvre Canadian Wildlife Service, Environment Canada, Québec

16 November 2005

INTRODUCTION

In 2005, 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 many goose populations worldwide, Greater Snow Geese have increased considerably during the late XXth century (annual growth rate of ~10%). The exploding population of snow geese has imposed considerable stress on its breeding habitat, while extensive use of agriculture lands provides an unlimited source of food during winter and migratory stopovers for them. Remedial management during autumn, winter and spring has been undertaken since 1999 to curb the growth of this population. The long-term objectives of this project are to (1) study changes in the demographic parameters of the Greater Snow Goose population, and especially the effects of the recent spring conservation harvest, (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 2005 were as follows:

1) Monitor productivity (egg laying date, clutch size and nesting success) of Greater Snow Geese on Bylot Island.
2) Study the spatial structure of colonies and nest site selection.
3) Mark goslings in the nest to provide a sample of known-age individuals to be used to assess the growth of goslings by their recapture in late summer.
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 evaluate the impact on their survival.
6) Monitor the abundance of lemmings and study their demography.
7) Monitor the breeding activity of other bird species and in particular avian predators (Snowy Owls, jaegers and Glaucous Gulls).
8) Monitor the breeding activity of foxes at dens.
9) Capture and mark adults Arctic Foxes and their pups with ear-tags to study their movements and demography.
10) Study the egg caching behaviour of Arctic Foxes in the goose colony using radio-tagged eggs.
11) Sample plants in exclosures to assess annual production and the impact of goose grazing on plant abundance in wet meadows.
12) Maintain and upgrade our automated environmental and weather monitoring system.

FIELD ACTIVITIES

Field camps. — In 2005, 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^o 08' N, 80^o 00' W), was occupied from 30 May to 22 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^o 53' N, 79^o 54' W) was occupied from 7 June to 22 July. Both of these camps are now protected by semi-permanent bear-deterring fences. Finally, eleven fly camps were also established for 2-6 days at various times throughout the island, west of Pointe Dufour.

Field party. — The total number of people in the camps ranged from 2 to 16 depending on the period. Members of our field party included project leaders Gilles Gauthier and Austin Reed. There were also graduate and undergraduate students whose thesis projects addressed several of the objectives mentioned above. Students were: Nicolas Lecomte (PhD, objectives 1 and 2), Cédric Juillet (PhD, objective 1 and 4), Nicolas Gruyer (MSc, objective 6), Guillaume Szor (MSc, objective 8) Vincent Careau (MSc, objective 10), Marie-Andrée Giroux (MSc, objective 9), Gabrielle Darou, Simon Côté, Maude Graham-Sauvé and Manon Morrissette. Other people in the field included Gérald Picard, a technician in charge of the banding operation (objective 4); Marie-Christine Cadieux, a research professional in charge of plant sampling (objective 11); Denis Sarrazin, a research professional responsible of the maintenance of the weather stations (objective 12); Josée Lefebvre, a biologist from the Canadian Wildlife Service (CWS), who helped with mark goslings in the nests, and Stéphane Turgeon, a technician from the CWS, who helped for the goose banding. Finally, we hired 3 persons from Pond Inlet: James Inootik (marking goslings in the nests and goose banding), Patrick Enokooloo (goose banding) and Jimmy Pitseolak (for fox den visits and sampling).

Other people that shared our camp for part of the summer include the field party of Esther Lévesque (Dominique Deshaies [BSc student] and Benoît Tremblay) who monitored the impact of goose grazing in mesic habitats, Joël Bêty (Laura McKinnon [PhD student] and Benoît Laliberté [BSc student]) who monitored nesting of shorebirds, Isabelle Laurion and Julie Breton (MSc student) who studied the carbon cycle in thermokarst ponds and finally Reinhard Pienitz, Ghislain Côté (BSc student) and Gaute Velle (Post-doc) who studied the impact of snow geese on the water supply of the island using paleolimnology techniques. Several persons from Parks Canada visited our camp this summer and spent some time with us, especially when the BBC film crew was present. They include the patrol persons Terry Kallut and Adam Ferguson (the latter person also worked with us) from Pond Inlet, the biologist Chantal Ouimet from Parks Canada’s office in Winnipeg, the warden Israel Mablick, and the chief warden of *Sirmilik National Park*, Carey Elverum, accompanied by two members of the Joint Park Management Committee. Our camp was also visited on 19 June by the Governor General of Canada, her Excellence Adrienne Clarkson, accompanied by her husband, John Ralston Saul, an RCMP officer, and Vicki Sahanatien from Parks Canada. Furthermore, a film crew of 3 people from the British Broadcasting Company (BBC) spent 3 weeks at our camp in late June-early July, and a journalist from the newspaper *La Presse*, Charles Côté, visited our camp for one day with his photographer Martin Chamberland.

Environmental and weather data. — Environmental and weather data continued to be recorded at our four automated stations. Our network includes 3 full stations, two at low and one at high elevation (20 m and 370 m 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 fourth 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. A few damaged sensors (especially those recording ground temperatures) were replaced and the station at 370 m ASL was elevated 6" and the data logger was replaced due to some water infiltration during spring thaw. 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 7 and 21 June. Nests were found in 2 ways: 1) through systematic searches at the Base-camp and Camp-2 or 2) searches of randomly located 2.25-ha plots at Camp-2. We also attempted to find the nests of as many neck-collared females as possible throughout both study areas. All nests were revisited at least twice to determine laying date, clutch size, hatching date and nesting success. During the hatching period, we visited a sample of nests almost every day to record hatch dates and to web-tag goslings.

Goose banding. — From 9 to 16 August, we banded geese with the assistance of local Inuit people and a helicopter. All geese captured were sexed and banded with a metal band, and all recaptures (web-tagged or leg-banded birds) were recorded. For the third consecutive year, we participated in the reward band study of the USFWS. A sample of young and adults was measured (mass and length of culmen, head, tarsus and 9^{th} primary) and a sample of adult females were fitted with coded yellow plastic neck-collars. We continued to inject some young with Droncit©, a drug that kills intestinal parasites, as part of a study on the impact of parasites on survival. In order to examine genetic differentiation among geese using different brood-rearing areas on the island, blood samples were collected from females and males caught in the Base-camp Valley and around Camp-2. Genetic analyses will be conducted on these samples during the winter.

Breeding activity of foxes at dens and marking. — A total of 108 known potential fox denning sites were visited from one to five times during the summer and inspected for signs of use by foxes and/or presence of reproductive foxes with pups. At dens used for reproduction, we noted the species (Arctic Fox, *Alopex lagopus*, or Red Fox, *Vulpes vulpes*) and minimum litter size, and, whenever possible, we trapped pups and adults with Tomahawk© collapsible live traps (cage traps) or padded leghold traps. Traps were either kept under continuous surveillance or at least visited every 12 hours depending on the site. Captured foxes were measured, weighed and tagged on both ears using a unique set of coloured and numbered plastic tags. Adult foxes were anaesthetized using Telazol®, an anaesthetic commonly used for dogs, to allow safe manipulation. Samples of winter and summer fur, blood, collagen and scats were also collected for diet analysis.

Egg caching by Arctic Foxes. — We created artificial goose nests by placing one radio-tagged eggs (similar in size, shape and color to goose eggs) and one real egg into old nests randomly distributed in the colony (Camp-2). We located by telemetry radio-tagged eggs removed and hidden by predators. The fate of cached eggs was determined by periodic visits until late August. We also observed the behaviour of Arctic Foxes from 2 blinds located in the goose colony to measure their hunting activity, their attack and success rates on goose eggs, the frequency of caching and the behaviour of geese during the attacks.

Small mammals. — We continued to participate in the small-mammal survey coordinated across the NWT and Nunavut by the Department of Environment and Renewable Resources in Yellowknife. We used Museum Special traps baited with peanut butter and rolled oats. We sampled lemming abundance at two sites in the Base-camp Valley (one in wet meadow habitat and one in mesic habitat) and one site at the Camp-2 (mixed habitat) in July. At each site, we used 50 traps set at 10-m intervals along two parallel transect lines 100 m apart (25 traps/transect) and left open for ~10 days. Our new sampling program based on live-trapping of lemmings initiated in 2004 was continued this year. We used 2 grids (300×300 m) at the Base-camp Valley (one in wet meadow habitat and one in mesic habitat) each with 100 Longworth© traps baited with apples and set at each grid intersection every 30-m. We trapped during 4-consecutive days every 15 days on each grid from mid-June to mid-August. All trapped animals were identified, sexed, weighed and marked with electronic PIT tags (or checked for the presence of such tags).

Other bird monitoring. — We monitored the nesting activity of Snowy Owls (*Nyctea scandiaca*), Jaegers (*Stercorarius* spp.), Glaucous Gulls (*Larus hyperboreus*), and Lapland Longspurs (*Calcarius lapponicus*). Nests were found through systematic searches of suitable habitats and revisited to determine their fate (successful or not).

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 Pointe Dufour (brood-rearing areas), and the Camp-2 area (nesting colony). 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 16 and 17 August. Plants were sorted into sedges (*Eriophorum scheuchzeri* and *Carex aquatilis*) and grasses (*Dupontia fisheri*). Use of the area by geese was monitored by counting faeces on 1 x 10 m transects located near each exclosure every 2 weeks in the Base-camp Valley and once at the end of the season at Pointe Dufour and the Camp-2 area.

PRELIMINARY RESULTS

Weather conditions. — The spring of 2005 was characterized by a normal snowmelt at the Base-camp and close to normal temperatures. Air temperature averaged -0.40°C between 20 May and 20 June (0.24°C below normal) and 1.52°C during 1-15 June (0.12°C below normal). Snow depth on 1 June was 34 cm compared to a long-term average of 31 cm (Fig. 1). However, there was some indication that snow may have been deeper at the Camp-2 (i.e. in the goose colony) than at the Base-camp and thus that snow-melt was slightly delayed there compared to previous years. Precipitation was high in June (40.5 mm of rain) but concentrated over just 5 consecutive days. Precipitation was very high in July (a record 87 mm) but August was characterized by exceptionally good weather with lots of sunshine, warm temperatures, and little precipitation (5 mm up to 20 August).

Goose arrival and nesting activity. — The number of geese counted on the hills surrounding the Base-camp Valley (the first area used by geese upon arrival) increased from 41 pairs on 2 June to a peak of 330 pairs on 7 June (Fig. 2). These values are in the usual range recorded in previous years and indicate that arrival dates of geese on Bylot Island were near normal. Pair counts at arrival indicate a greater number of geese on the island compared to 2004 when counts remained low for the same period.

Median egg-laying date was 12 June, which is also the long-term average (Table 1). Our field observations suggest that the reproductive effort of geese was moderately high at the main colony (Camp-2). Although nest density appeared slightly lower than usual in the center of the colony, the colony tended to be more spread-out this year. Only 5 nests were found at the Base-camp Valley (predominantly a brood-rearing area), a situation common in years when no Snowy Owls are nesting (see below). Average clutch size was 3.60, which is slightly lower than the long-term average (Table 1).

Nesting success of geese. — Nesting success (proportion of nests hatching at least one egg) was good this year (66%, a value close to the long-term average, Table 1). Activity of predators at goose nests, especially Arctic Foxes, was moderate but slightly higher than in 2004. During nesting and brood-rearing, 200 neck-collared birds were sighted, a high number compared to last year (56). Peak hatch was on 8 July, the same date as the long-term average (Table 1). We tagged approximately 2920 goslings in nests at hatch, all in the main colony at Camp-2.

Density of broods. — In 2005, density of goose faeces at the end of the summer in wet meadows of the Base-camp Valley was high (8.9 ± 1.3 [SE] faeces/m^2, Fig. 3). This value is actually twice as high as the values recorded in the last 3 years (4.7 ± 0.7 in 2004, 4.9 ± 1.0 in 2003 and 4.4 ± 1.2 in 2002). Accumulation of faeces increased steadily until the end of the summer in contrast to other years where it tended to level off in August. We believe that this reflects a sustained use of the wet meadows by broods until the end of the summer and the absence of movement toward upland habitats in August as it often occurs at that time. The absence of late summer movement may be a consequence of the high plant production in wet meadows this year (see below). In the past 2 years, late summer movements of broods out of the wet meadows may also have been enhanced by their flooding due to very high rainfall in August, unlike this year. Faeces density at the end of the summer was low in the wet meadows of the nesting colony at Camp-2 (2.2 ± 0.3 faeces/m^2 vs. 3.8 ± 1.8 in 2004). They were higher at Pointe Dufour, the other brood-rearing area, though lower than in previous years (6.6 ± 1.0 faeces/m^2 vs. 10.8 ± 1.9 in 2003).

Goose banding. — The banding operation was highly successful this year. We conducted 10 drives in our usual banding area, i.e. in the lowlands and hills bordering the Base-camp Valley to the south and north (<8 km), and 3 additional drives further away, i.e. 1 at the Camp-2 area, 1 half-way between the Camp 2 and the Base-camp Valley, and 1 near Dufour Point. We banded a total of 5304 geese (a record number), including 650 adult females marked with neck-collars and 196 young which were marked with web-tags at hatch and recaptured. We injected

629 young with Droncit© and 578 with a saline solution (control group). In addition, there were 417 recaptures of adults banded in previous years. We collected blood samples from 54 females and 60 males in the Base-camp Valley, 35 females and 39 males at Camp-2, 40 females and 32 males at the site between the 2 camps and 34 females and 38 males near Pointe Dufour. The gosling:adult ratio among geese captured at banding (1.03:1) and mean brood size toward the end of brood-rearing (2.42 young, SD = 1.07, n = 229; counts conducted from 1 to 7 August) were very close to the long-term averages (Table 1). By combining information on brood size and young:adult ratio at banding, we estimated that 86% of the adults captured were accompanied by young, which is suggestive of a relatively low mortality rate of young during the summer. Overall, these values are indicative of a moderately high production of young on Bylot Island this year.

Breeding activity of foxes at dens and marking. **—** We found signs of activity (fresh digging and/or footprints) at 80 dens. The breeding activity of foxes was low as we found 7 litters (7% of known denning sites with a different litter) of Arctic Foxes and none of Red Foxes. Two Red Foxes using two nearby dens were observed but no young were seen. The level of den use is lower than last year (15% of the dens were used in 2004) and typical of the proportion of fox dens used in previous years of relatively low lemming abundance (~5%). Minimum litter size varied between 3 and 9 pups (6.9 pups on average). A total of 8 adult and 17 juvenile Arctic Foxes were captured during trapping sessions and marked with ear-tags. We also recaptured 4 adults that had been marked in previous years (3 marked as adult and 1 as young in 2004). In addition, we resighted 2 foxes that had been ear-tagged in previous years (2003 or 2004), and one of them was a female that bred successfully and produced at least 7 pups this year.

Egg caching by Arctic Foxes. — Predators removed 24 radio-tagged eggs from artificial nests and cached them at an average distance of 191 m from the nests. Thirteen of those eggs were later moved to a new cache, four of which were moved more than once. When foxes moved eggs from one cache to another, the average distance between caches was 335 m. For the summer period, primary caches survived for shorter period than secondary caches. The latter were located farther from nests and more likely to be outside the colony than the former. These results suggest that Arctic Foxes use the hoarding foraging strategy partly to acquire food at a high rate and re-cached eggs to more secure sites (outside the colony, closer to their den).

Small mammals. — During our survey using snap traps, we accumulated 1196 trap-nights in the Base-camp Valley at our 2 trapping sites from 23 July to 3 August, and 548 trap-nights at the Camp-2 from 5 to 20 July. In the Base-camp sites, we caught 2 Collared Lemmings (*Dicrostonyx groenlandicus*) in the mesic site and none in the wet meadow site, and no Brown lemmings (*Lemmus sibiricus*) were caught, which yielded a combined index of abundance of 0.17 lemmings/100 trap-nights, a low value (Fig. 4). In the Camp-2 site, 4 lemmings were caught, 1 Brown and 3 Collared Lemmings for an index of 0.75 lemmings/100 trap-nights. For the second year of our live-trapping survey, we captured 55 different lemmings (compared to 180 in 2004), of which 24 were captured more than once. We captured 16 Brown Lemmings and 14 Collared Lemmings in the mesic habitat, and 13 Collared and 12 Brown ones in the wet habitat. These numbers combined with our snap-trap survey confirm that lemmings at the Base-camp Valley had decreased considerably following the moderate peak of last year and were in the low phase of their cycle. However, similar to the situation observed during the previous peak, it appeared that the peak in lemming abundance at the Camp-2 area was delayed compared to Camp-1.

Other bird monitoring. — We found 12 nests of Glaucous Gull, 18 nests of Long-tailed Jaegers and 68 nests of Lapland Longspurs. Nesting success (proportion of nests successful in fledging at least one young) was high for gulls (80%) but low for jeagers and longspurs (8% and 19% respectively). Average clutch size was 2.9 eggs for gulls, 1.8 eggs for jaegers and 5.1 eggs for longspurs. No Snowy Owls were found nesting in our study area in 2005.

Plant growth and grazing impact. — Plant production in wet meadows of the brood-rearing area was higher than last year and above the long-term average (Fig. 5). Above-ground biomass of graminoid plants in the Base-camp Valley reached 57.1 ± 8.2 [SE] g/m^2 in ungrazed areas in mid-August compared to 43.7 ± 5.6 in 2004 (long-term average since 1990: 44.3 g/m^2). Plant production was therefore good this year in wet meadows. However, it is mostly the production of *Dupontia* that increased this year as the production of *Eriophorum*, the plant preferred by geese, was similar to last year. At the Camp-2 area (colony), total plant production was similar to last year (25.1 ± 4.9 in 2005 vs. 25.5 ± 4.4 g/m^2 in 2004) but still below the average value recorded since 1998 (31.2 g/m^2), and much lower than the plant production in the Base-camp Valley. Graminoid plants production at Pointe Dufour was similar to 2003 (42.3 ± 6.0 in 2005 vs. 46.0 ± 8.4 g/m^2 in 2003) and below the long-term average recorded since 1998 (49.2 g/m^2).

Goose grazing was relatively high in the wet meadows of the Base-camp Valley where geese removed 46% of the above-ground biomass (difference between paired grazed and ungrazed plots) by mid-August. In comparison, no impact was detectable in 2004 in the Base-camp Valley (long-term average: 35%; Fig. 5). At the Camp-2 area (colony), the grazing impact was also relatively high with 41% of the graminoid biomass removed by geese, a value similar to 2004 (38%) and above the long-term average at this site (31%). Similarly, at Pointe Dufour, another brood-rearing area, geese removed 39% of the total biomass compared to 41% in 2003 (long-term average: 26%).

CONCLUSIONS

The production of young on Bylot Island was moderately high in 2005. The phenology of migration and reproduction were normal (i.e. geese arrived on the island and initiated nesting at the usual dates), their reproductive effort was moderate (i.e. the density of geese on the island during nesting). Geese benefited from a low nest predation rate and thus had a relatively high nesting success. The young:adult ratio observed during our banding operation suggests that, overall, production of young on Bylot Island was relatively good this year. Based on this youg:adult ratio, we anticipated a proportion of young in the fall flock of 23%. This prediction was upheld as juvenile counts conducted in Québec indicated a proportion of young of 21% (n = 29,022) in the fall flock, a value slightly below the long-term average (24%).

Results from our dead and live-trappings showed that lemming abundance was quite low in 2005, and confirmed that 2004 was a peak in lemming abundance at the Base-camp, even though the numbers captured last year were relatively low compared to previous peaks. The marked decline in the number of breeding foxes in 2005 compared to last year, and the absence of nesting owls, further confirm the decline in lemming abundance this year. Despite this decline, predation rate on goose eggs increased only slightly, and their nesting success remained relatively high. This may be due to a moderate nesting effort, which diluted the effect of predators, and perhaps a reduced survival of foxes last year due to the relatively low lemming peak.

This year, plant production in the wet meadows of Bylot Island was high at their main brood-rearing site, the Base-camp Valley, compared to the last 2 years. Plant production was also much lower at the goose colony than in the peripheral brood-rearing areas of the Base-camp Valley and Pointe Dufour, as in previous years. The good plant production in 2005 may be explained in part by the light grazing impact recorded in the past 2 years at the Base-camp Valley. In addition, the exceptionally good weather conditions prevailing in late summer may have prolonged the period of plant growth this year. However, these favorable conditions allowed broods to feed on their preferred plant species in wetlands without having to use much of the upland habitats until the end of the summer. Therefore, this resulted in a relatively high grazing impact in wetlands compared to recent years.

Based on the production encountered this year, the Greater Snow Goose population is expected to decline slightly between 2005 and 2006 under the current exploitation regime, which includes a spring harvest. However, this assumes that harvest rates observed during the period 1999-2002 are maintained. A preliminary estimate for the 2005 survey indicates a spring population of 814,600 ± 59,100, a similar level of population as in 2004 (957,600 ± 81,100) if we consider survey estimate variability. The demographic data over the period 1999-2005 thus suggests an overall decline of the population of 19% (about 3.5% per year) since the implementation of the special conservation measure in 1999. This decline is lower than the one predicted by current population models (~8% per year), which are based on harvest rates observed in the first 4 years following implementation of the special measures. This may indicate that harvest rate is declining in most recent years.

PLANS FOR 2006

The long-term objectives of our work are to study the population dynamics of Greater Snow Geese, 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 harvest and other special management actions implemented since 1999 in Québec. Other current focuses of the project include *i*) understanding better the spatial structure of colonies and goose movements on Bylot Island; *ii*) expanding our estimate of the carrying capacity of the Island for geese to upland habitats; *iii*) determining long-term effects of geese on the arctic landscape; *iv*) study indirect interactions between snow geese and lemmings via shared predators; and *v*) study the ecology of the main predator of geese, Arctic Foxes. Next year, we will initiate other projects to examine the links between events occurring on the spring staging area and the reproduction of geese after several years of spring harvest, and to study shorebirds on Bylot Island. In 2006, 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 with radio-transmitters snow geese on their Québec spring staging to monitor their behaviour, spring migration, and subsequent reproduction on Bylot Island.
3) Mark goslings in the nest to provide a sample of known-age individuals to assess the growth and pre-fledging survival of goslings by their recapture in late summer.
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 study their impact on survival.
6) Monitor the abundance of lemmings and study their demography.
7) Monitor the breeding activity of other bird species in particular avian predators (Snowy Owls, jaegers and Glaucous Gulls) and shorebirds.
8) Monitor the breeding activity of foxes at dens and capture and mark adults and pups with ear-tags to study their movements and demography.
9) Sample plants in exclosures to assess annual production and the impact of goose and lemming grazing on plant abundance in wet meadows.
10) Maintain our automated environmental and weather monitoring system.

In 2006, at least 9 graduate students will be involved in the Bylot Island snow goose project. **Cédric Juillet** (PhD) will continue to study the effect of hunting on the population dynamics and demography of geese. **Grégoire Kuntz** (PhD) will investigate the effect of intestinal parasites on the survival of goslings. **Manon Morrissette** (MSc) will study the impact of climate and trophic interactions on snow goose productivity. **Maude Graham-Sauvé** (MSc) will examine the impact of climate on the trophic dynamics of the arctic tundra. **Peter Fast** (PhD) will study the causes and reproductive consequences of changes in migratory behaviour of snow geese. **Maud Poisbleau** (Post-doc) will study hormonal mechanisms in snow geese in response to environmental stress. **Laura McKinnon** (PhD) will continue to monitor the reproductive ecology and migration of arctic-nesting shorebirds. **Marie-Andrée Giroux** (MSc) will complete her study on the relative contribution of terrestrial and marine food sources to the annual diet of Arctic Foxes using stable isotopes. Finally, **Arnaud Tarroux** (PhD) will monitor Arctic and Red Foxes and investigate their relative roles in the ecology of the tundra using radio-telemetry.

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

	1996	1997	1998	1999	2000	2001	2002	2003	2004	**2005**	Average[2]
Number of nest monitored	367	326	350	266	386	296	470	585	676	**346**	--
Median date of egg-laying	14 June	10 June	7 June	17 June	16 June	13 June	16 June	9 June	11 June	**12June**	12 June
Clutch size	3.99	4.27	4.00	3.09	3.51	3.43	3.43	3.90	3.65	**3.60**	3.70
Nesting success[1]	65%	83%	79%	12%	83%	57%	53%	82%	78%	**66%**	64%
Median date of hatching	11 July	7 July	4 July	13 July	13 July	9 July	11 July	6 July	7 July	**8 July**	8 July
Number of geese banded	3824	3956	3998	1717	4269	3430	2650	5259	3617	**5304**	--
Ratio young:adult at banding	0.83:1	1.06:1	1.09:1	0.54:1	1.08:1	1.03:1	0.81:1	1.31:1	0.94:1	**1.03:1**	1.04:1
Brood size at banding	2.34	2.47	2.70	1.67	2.78	2.37	1.67	2.74	2.50	**2.42**	2.48
Proportion of adults with young at banding	71%	86%	81%	65%	78%	87%	97%	96%	75%	**86%**	83%

[1] Mayfield estimate

[2] Period 1989-2005

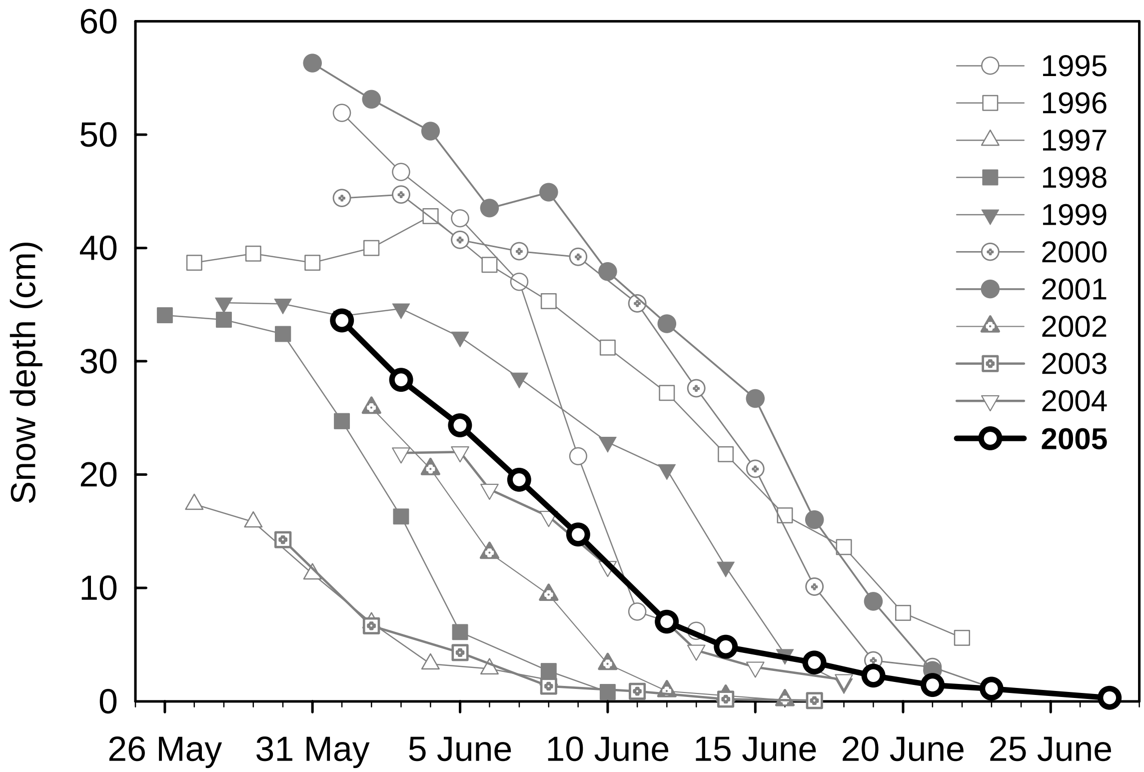

Figure 1. Average depth of snow along 2 transects showing the rate of snowmelt in Bylot Island lowlands (n = 50 stations).

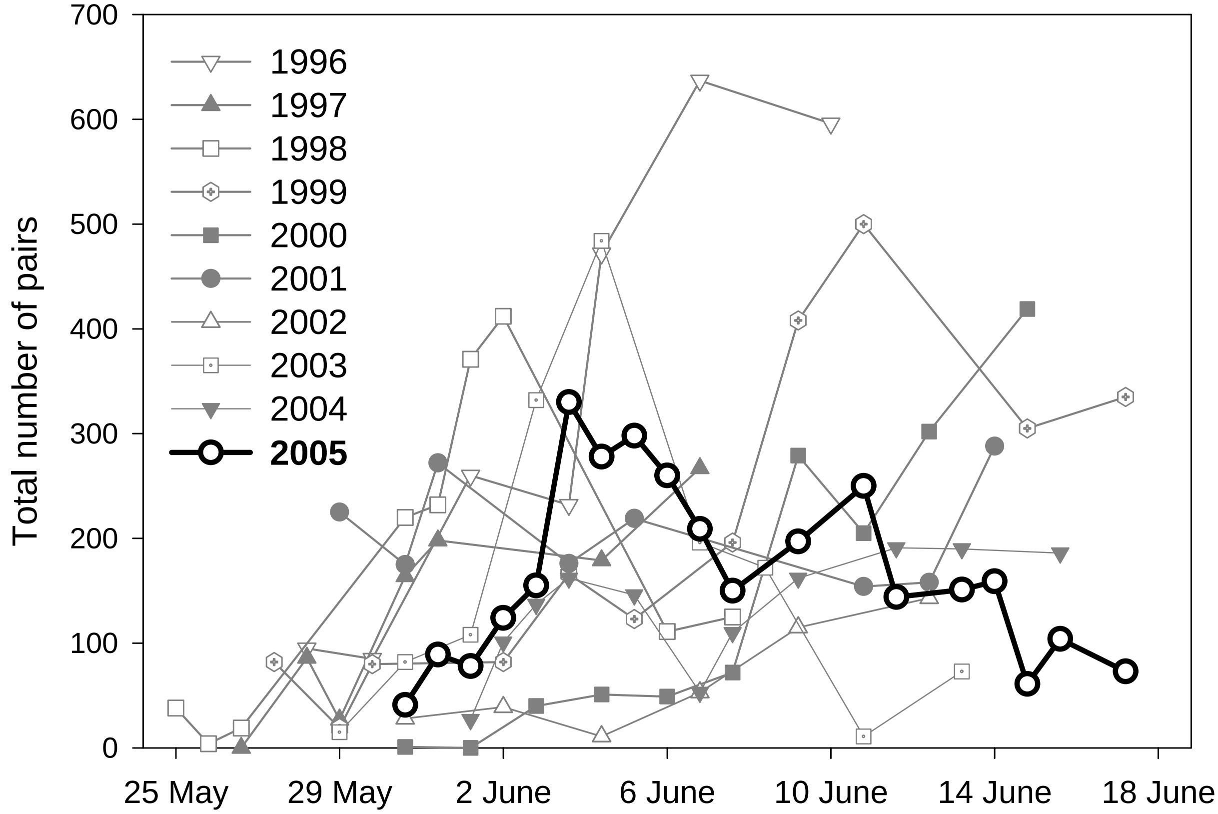

Figure 2. Total number of goose pairs counted in the Base-camp Valley from arrival of our crew on Bylot Island until the end of snowmelt.

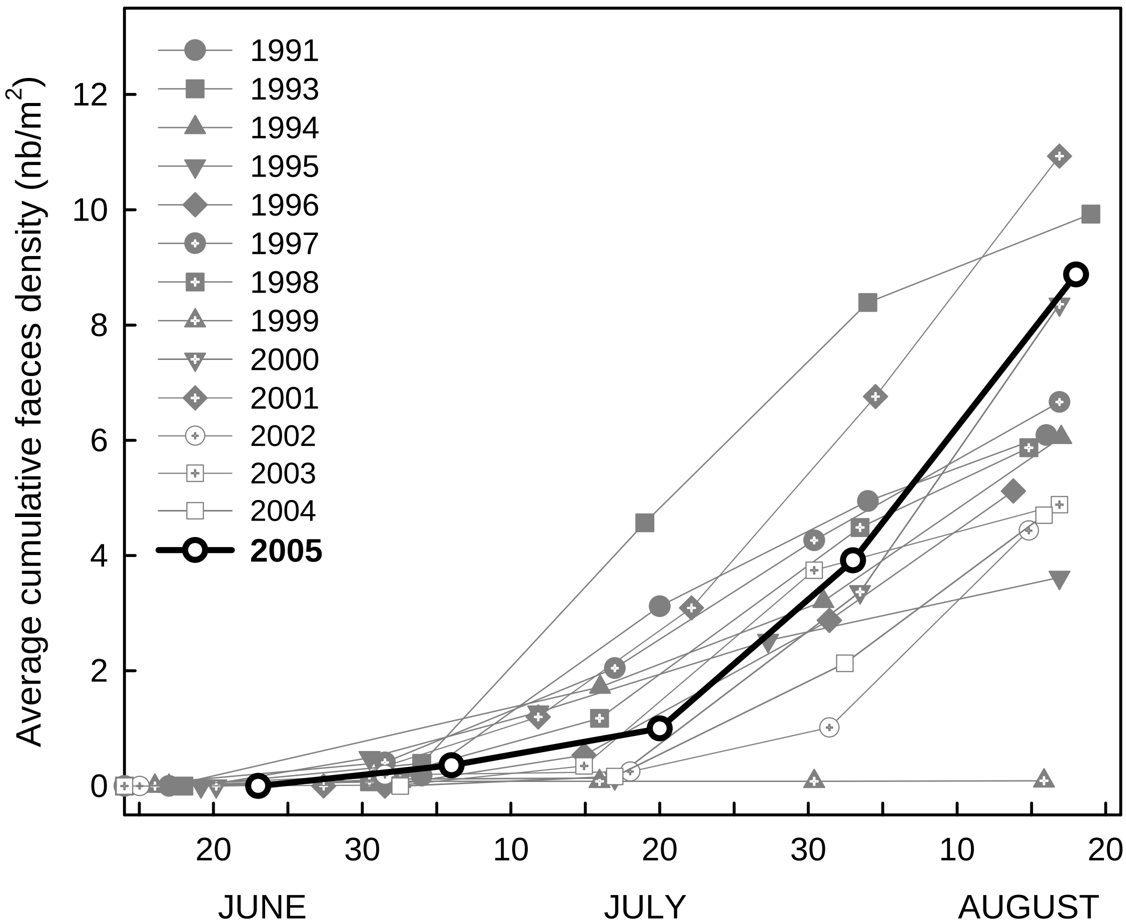

Figure 3. Average cumulative faeces density showing the use of Base-camp Valley by Greater Snow Goose families on Bylot Island throughout the summer (*n* = 12 transects of 1 x 10 m).

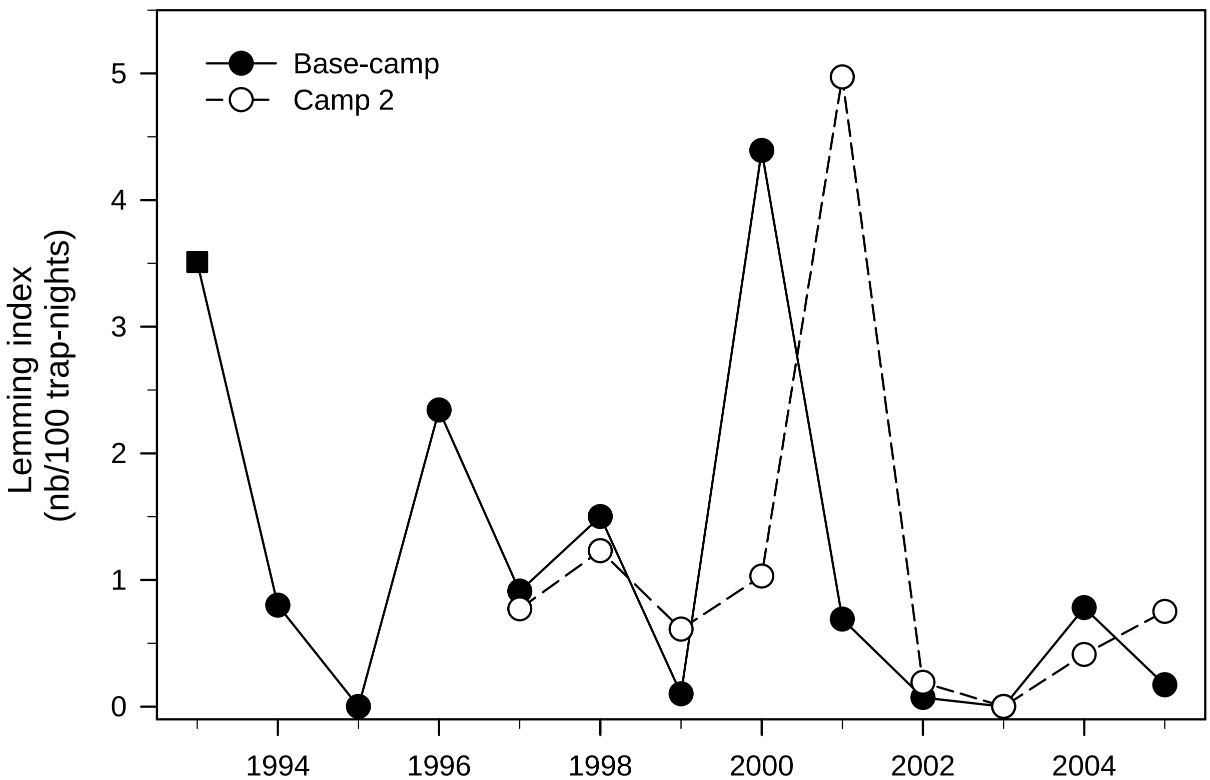

Figure 4. Annual abundance of lemmings at two study areas (Base-camp Valley and Camp-2) located 30 km apart on Bylot Island.

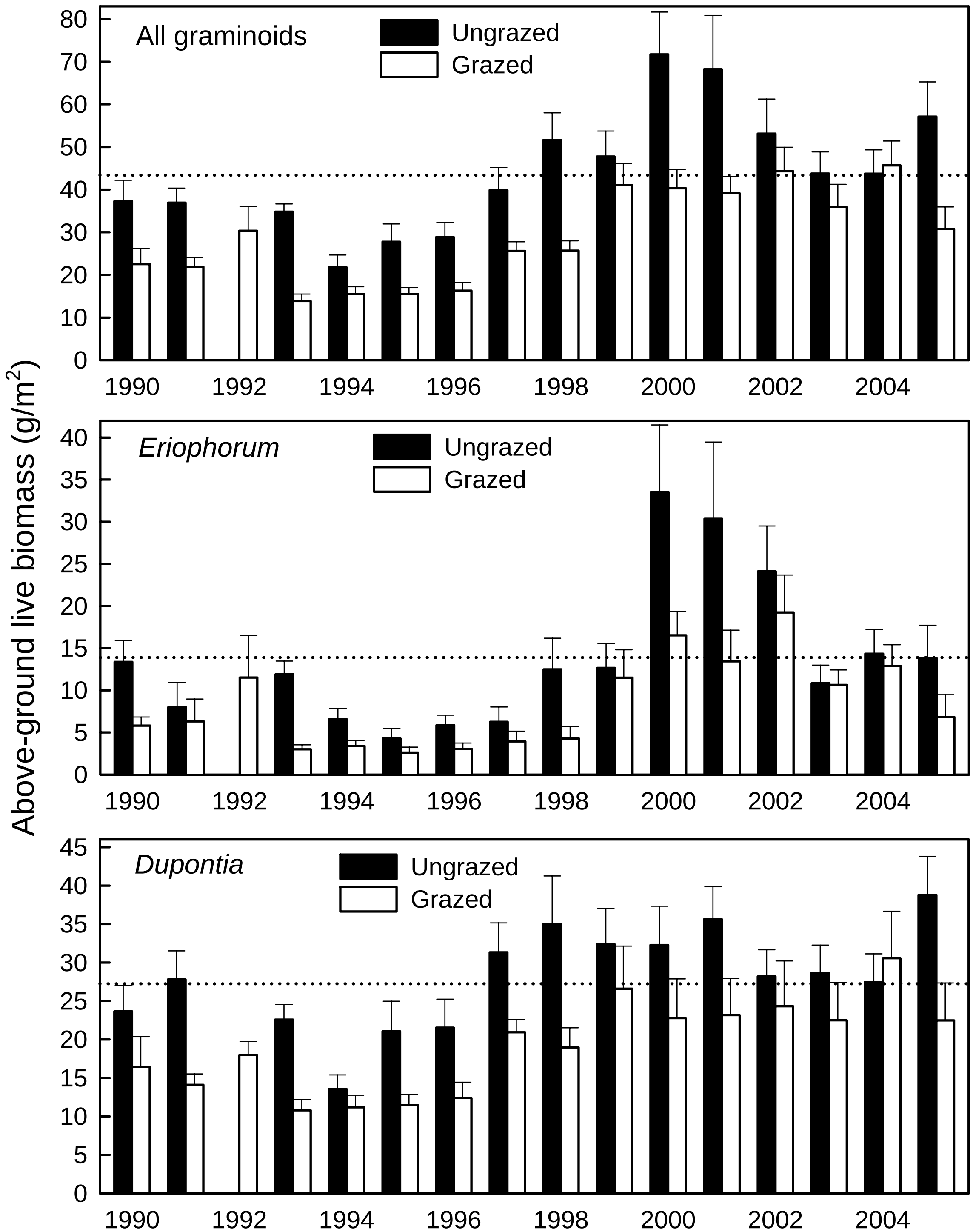

Figure 5. Live above-ground biomass (mean + SE, dry mass) of graminoids around 16 August in grazed and ungrazed wet meadows of the Base-camp Valley, Bylot Island (*n* = 12). Total graminoids include *Eriophorum scheuchzeri*, *Dupontia fisheri* and *Carex aquatilis*. There is no data from ungrazed area in 1992. The dashed line is the long-term average for ungrazed area.