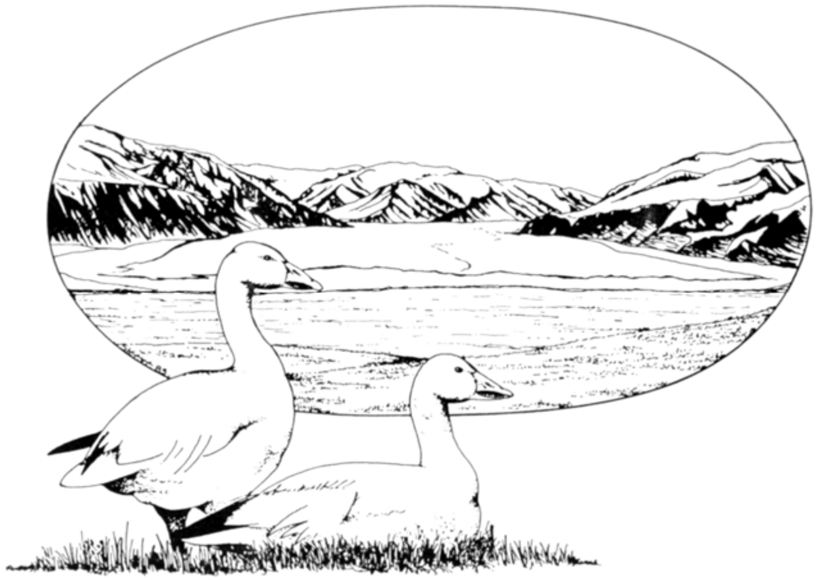
POPULATION STUDY OF GREATER SNOW GEESE ON BYLOT AND ELLESMERE ISLANDS (NUNAVUT) IN 2009: A PROGRESS REPORT



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INTRODUCTION

In 2009, 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 other goose populations worldwide, Greater Snow Geese have increased considerably during the late XXth century. The exploding population 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. A synthesis report produced in 2007 evaluated the initial success of these special conservation measures. However, the recent Action Plan released in 2006 by the Canadian Wildlife Service called for a continued monitoring of the dynamic of this population and of its habitats. In response to those needs, 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 spring conservation harvest, (2) determine the role of food availability and predation in limiting annual production of geese, and (3) monitor the impact of grazing on the Arctic vegetation.

OBJECTIVES

Specific goals for 2009 were as follows:

1) Monitor productivity (egg laying date, clutch size and nesting success) 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 of goslings by their recapture in late summer.
3) 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.
4) Mark adult females with radio-transmitters in the south and monitor their behaviour, migration, and subsequent reproduction on Bylot Island.
5) Monitor the level of intestinal parasite infestations in goslings.
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) Sample plants in exclosures to assess annual production and the impact of goose grazing on plant abundance in wet meadows.
11) Maintain our automated environmental and weather monitoring system.

12) Monitor the goose breeding activity, band geese and monitor the abundance of lemmings at another arctic colony on Ellesmere Island and surrounding areas.

FIELD ACTIVITIES

Field camps. — In 2009, 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 23 May to 21 August. A secondary camp, located in a narrow valley 30 km south of the Base-camp and 5 km from the coast (“Camp-2 area”, 72^o 53' N, 79^o 54' W) was occupied from 26 May to 19 July (Fig. 1). Both of these camps are protected by semi-permanent bear-deterring fences. Finally, fifteen fly camps were also established for 5-10 days at various times throughout the island, west of Pointe Dufour.

Field parties. — The total number of people in both camps ranged from 3 to 22 depending on the period. Members of our field party included project leaders Gilles Gauthier, Joël Bêty and Dominique Berteaux, and several graduate students whose thesis projects addressed many of the objectives mentioned above: Jean-François Therrien (PhD, objective 7), Madeleine Doiron (PhD student, objective 2), Sandra Lai (PhD, objective 9), Peter Fast (PhD, objective 4), Frédéric Bilodeau (PhD, objective 6), Meggie Desnoyers (MSc, objectives 1 and 3), Cassandra Cameron (MSc, objectives 8). Several other students assisted them in the field, including: Émilie Chalifour, Audrey Jobin-Piché, Maxime Sirois, Stéphanie Pellerin, Pierre-Yves L’Hérault and Elizabeth Tremblay. Other people in the field included Gérald Picard, a technician in charge of the banding operation (objectives 3 and 4); Marie-Christine Cadieux, a research professional in charge of plant sampling (objective 10); Denis Sarrazin, a research professional responsible of the maintenance of the weather stations (objective 11); Louise Laurin from the Bird Banding Office in Ottawa; Marie-Claude Martin, a wildlife technician; and Pierre Legagneux, a post doctoral fellow. Finally, we hired 4 persons from Pond Inlet to work with us: Joassie Otoovak (marking goslings in the nests), Lee Innuarak (goose banding), Samual Arreak (goose banding) and Leslie Qanguq (shorebird monitoring).

Other people used our camp during the summer. They were the field party of Esther Lévesque (UQTR) and Daniel Fortier (Université de Montréal), which included Naïm Perrault, Étienne Godin, Alexandre Guertin-Pasquier and Rachel Thériault, who studied plant ecology, the permafrost and the geomorphology of the island; Christopher Buddle (McGill University), Laura McKinnon (PhD student), Élise Bolduc (MSc student) Jean-François Lamarre, and Léonie Mercier who studied shorebirds and insects under the supervision of Joël Bêty; and the field party of Isabelle Laurion (Institut National de la Recherche Scientifique), which included Paul-George Rossi, Véronique Gélinas and Catherine Girard, who studied the carbon cycle in ponds. Finally, several other persons visited our camp during the summer. Ian Dixon (RM-Product) and Steven Panipakoochoo (Pond Inlet) worked on the new camp infrastructure; Carey Elverum (chief warden of *Sirmilik National Park*), Andrew Maher (park warden), and Abraham Kublu (mayor of Pond Inlet) inspected the camp; Cory Trépanier, an artist, and his cameraman came for a visit while filming a documentary on the Arctic; finally, John Nightingale (president and CEO of the Vancouver Aquarium) and two of his colleagues visited our Base-camp for a future exhibit on the Arctic.

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, precipitations, solar radiation, wind speed and direction are recorded on an hourly basis throughout the year (Fig. 1). A fourth station measures soil surface temperature in areas grazed and ungrazed by geese (i.e. exclosures). All automated stations were visited during the summer to download data and were found to be operating normally. Daily precipitation was also recorded manually during the summer. Finally, snowmelt was monitored by measuring snow depth at 50 stations along two 250-m transects and by visually estimating snow cover in the Base-camp Valley, both 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 8 and 18 June. Nests are found by systematic searches conducted over various areas in the field. At the Base-camp Valley where nest density is always low, nests searches are conducted throughout the valley. At Camp-2, nest searches are conducted in two ways: 1) over an intensively-studied core area (ca 50 ha) located in the centre of the colony every year, and 2) within a variable number of 1 and 2-ha plots randomly located throughout the colony. Nest density was calculated over a fixed 30-ha area within the intensively-studied core area. We also attempted to find the nests of as many neck-collared females as possible through intensive searches on foot throughout the nesting colony. 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 daily to record hatch dates and to web-tag goslings.

Tracking of geese marked in the south. — During spring staging in Quebec, we captured snow geese at Île-aux-Oies and Baie-du-Febvre using cannon-nets. Ten adult female snow geese were outfitted with GPS-enabled satellite transmitters at Baie-du-Febvre, and another twelve were outfitted at Île-aux-Oies. We captured an additional 1431 individuals (including 93 previously banded) at Île-aux-Oies using cannon-nets and 644 adult females were given standard neck collars with unique alphanumeric codes. On Bylot Island we subsequently conducted an intensive survey (8 June to 18 July) of breeding areas on foot to identify nests of geese previously marked at southern migration stopover sites.

Goose banding. — From 6 to 15 August, we banded geese with the assistance of local Inuit people and a helicopter. Goose flocks of a few hundred birds were rounded up and driven by people on foot into a holding pen made of plastic netting. All captured geese were sexed and banded with a metal band, and all recaptures (web-tagged or leg-banded birds) were recorded. A sample of young and adults was measured (mass and length of culmen, head, tarsus and 9th primary) and some adult females were fitted with coded yellow plastic neck-collars. Finally, we collected the intestine from a sample of goslings that died accidentally during banding to examine the level of parasite infection.

Small mammals. — We sampled the annual abundance of lemmings 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 using snap-traps. At each site, we used 240 traps set at 80 stations spaced 15-m apart along two to four parallel transect lines 100 m apart and left open for 3 or 4 days. We used Museum Special traps baited with peanut butter and rolled oats. We also sampled lemming abundance using live-traps. We trapped on 2 permanent grids (330×330 m) at the Base-camp Valley (one in wet meadow habitat and one in mesic habitat) with 144 traps per grid and on a 3rd grid (270 × 270 m; 100 traps) in mesic habitat where a snow-manipulation experiment was set up in 2007 with snow fences. We used Longworth© traps baited with apples and set at each grid intersection every 30-m. We trapped for 3 consecutive days during 3 periods (mid-June, mid-July and mid-August) on each grid. All trapped animals are identified, sexed, weighed and marked with electronic PIT tags (or checked for the presence of such tags). Finally, we sampled the abundance of lemming winter nests along 60 500-m transects randomly distributed in 3 different habitats of the Base-camp Valley: wetlands, mesic tundra and streams in mesic tundra.

Breeding activity of foxes at dens and marking. — All known fox dens located within a 475 km^2 area were visited one to five times during the summer and inspected for signs of use and/or presence of reproductive adults with pups. We attempted to live-trap adults with padded leghold traps at locations where foxes were seen hunting or travelling. At reproductive dens, we noted the species (Arctic Fox, *Vulpes lagopus*, or Red Fox, *Vulpes vulpes*) and minimum litter size, and, whenever possible, we live-trapped pups with Tomahawk© collapsible cage traps. Cage traps were kept under continuous surveillance and leghold traps were visited at least every 6 hours. Captured foxes were measured, weighed and tagged on both ears using a unique set of coloured and numbered plastic tags. In addition, some adult Arctic Foxes were fitted with ARGOS satellites collars. Samples of winter and summer fur, blood, and scats were also collected for genetic and diet analyses.

Monitoring of other bird species. — We monitored the nesting activity of Snowy Owls (*Bubo scandiacus*), Long-tailed and Parasitic Jaegers (*Stercorarius longicaudus* and *S. parasiticus*), Glaucous Gulls (*Larus hyperboreus*), Rough-legged Hawks (*Buteo lagopus*) and Lapland Longspurs (*Calcarius lapponicus*). Nests were found through systematic searches of suitable habitats or opportunistically and revisited to determine their fate (successful or not) until fledging. We also collected food pellets at one hawk nest to determine their diet based on prey remains.

Monitoring of plant growth and goose grazing. — The annual plant production and the impact of goose grazing was evaluated in wet meadows dominated by graminoid plants at 2 sites (Fig. 1): the Base-camp Valley (brood-rearing areas), and the Camp-2 area (nesting colony). At each site, 12 exclosures (1 × 1 m) were installed in late June, and plant biomass was sampled in ungrazed and grazed areas (i.e. inside and outside exclosures) at the end of the plant-growing season on 14 August. Plants were sorted into sedges (*Eriophorum scheuchzeri* and *Carex aquatilis*) and grasses (*Dupontia fisheri*). Use of the area by geese was monitored by counting faeces on 1 × 10 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 area.

Field activities on Ellesmere Island and surrounding area. — Field work was conducted on Ellesmere Island and surrounding area, within a radius of approximately 85 km from Eureka from 1 to 6 August. The field party included 3 employees from the Canadian Wildlife Service (Josée Lefebvre, Christian Marcotte and Francis St-Pierre). During the flights of the goose banding operation, we conducted a Snow Goose survey on the Fosheim peninsula, Ellesmere Island, and along the coast of Axel Heiberg Island. Goose banding took place over this area using the same technique than on Bylot Island. Near Eastwind Lake on the Fosheim peninsula, small mammal snap-trapping was conducted in both mesic and wet meadow habitats along 2 transects in each habitat. We used 60 traps set at 20 stations spaced 15-m apart on each transect.

PRELIMINARY RESULTS

Weather conditions. — Temperature in spring was warmer than normal. Air temperature averaged 1.07°C between 20 May and 20 June (1.13°C above normal), which corresponds to the period of goose arrival and egg-laying, and 1.67°C (0.32°C above normal) during 1-15 June, the normal pre-laying and laying period. Despite a normal snow pack at the end of winter (snow depth was 26 cm on 1 June), snowmelt was rapid due to the warm conditions and thus snow disappeared early, similar to last year (Fig. 2). From early June to late August, weather was exceptionally good with lots of sunshine and warm temperature. Except for a few short spells of rain, it was one of the driest summers on record (cumulative rain, June: 12.5 mm, July: 27 mm, August: 25 mm; all below the long-term average).

Goose arrival and nesting activity. — The number of geese counted on the hills surrounding the Base-camp Valley (usually the first area used by geese upon arrival) increased from 16 pairs on 31 May to a peak of 219 pairs on 13 June, a moderately high number but nonetheless one of the highest numbers recorded over the past few years (Fig. 3). The subsequent decline in goose numbers was due to the movements of geese to the nesting colony, away from the Base-camp Valley. The chronology of arrival of geese was therefore normal this year.

Median egg-laying date in the colony was 12 June, which is the long-term average egg-laying date on Bylot Island (Table 1). Nest density in the colony was slightly lower than last year (4.17 nests/ha vs. 4.34 nest/ha in 2008) but still above the long-term average. Only 3 nests were found at the Base-camp Valley (predominantly a brood-rearing area) compared to 23 in 2008. Overall, average clutch size was 3.38 which is lower than the long-term average (Table 1).

Nesting success of geese. — Nesting success (proportion of nests hatching at least one egg) was high this year (74%, a value well above the long-term average, Table 1). Activity of Arctic Foxes around goose nests was relatively low but Parasitic Jaegers were more active than in previous years. During nesting and brood-rearing, 399 neck-collared birds were sighted, a number slightly lower than last year (448). Peak hatch was on 9 July, which is again the long-term average (Table 1). We tagged 2437 goslings in nests at hatch, all in the Camp-2 area. Overall, nesting conditions of geese in 2009 were therefore good.

Density of broods. — In 2009, the density of goose faeces at the end of the summer in wet meadows of the Base-camp Valley was low (3.0 ± 0.6 [SE] faeces/m^2, Fig. 4) for the third consecutive year (Fig. 4). Accumulation of faeces was delayed; it started in late July and was moderate in August. Faeces density at the end of the summer was also low in the wet meadows of the nesting colony at Camp-2 (1.4 ± 0.1 faeces/m^2 vs. 6.1 ± 1.4 in 2008). These apparently low levels of use are difficult to explain considering the good reproductive effort of geese, which lead to a good production of young at the end of the summer (see below), and good weather that prevailed during most of the summer.

Goose banding. — The banding operation was highly successful this year. We conducted 9 drives in our core banding area, i.e. in the lowlands and hills bordering the Base-camp Valley to the south and north (<8 km), and 5 additional drives further away, between the Camp 2 and the Base-camp Valley. We banded a total of 5417 geese, including 701 adult females marked with neck-collars and 162 young which had been marked with web-tags at hatch and were recaptured. In addition, we had 352 recaptures of adults banded in previous years. The gosling:adult ratio among geese captured at banding (1.07:1) was slightly lower than last year but still above the long-term average (Table 1). In contrast, mean brood size toward the end of brood-rearing (2.35 young, SD = 1.11, n = 195; counts conducted from 30 July to 5 August) were much lower than last year and below the long-term averages. By combining information on brood size and young:adult ratio at banding, we estimated that 91% of the adults captured were accompanied by young, a value higher than the long-term average. Overall, these results are indicative of a good production of young on Bylot Island by the end of the summer. Finally, we collected 13 intestines from goslings that died accidentally during banding to examine their level of parasite infection.

Tracking of geese marked in the south. — We successfully tracked the migration of 23 adult females marked with satellite transmitters from southern Québec to the Arctic. These birds arrived in the Nunavut around 20 June and most of them spent the summer on Melville Peninsula, Baffin Island and one on the north shore of Bylot Island. We are currently tracking the autumn migration of 16 females. Data downloaded on 15 October indicates that all are currently in southern Québec. Their 2009 migration away from the Arctic started during the first week of September for most birds, but autumn arrival to southern agricultural stopover habitats was more variable. We are also in the process of recovering two transmitters from females recently harvested in Québec. Among the females neck-collared in spring at Île-aux-Oies, we found the nests of nine individuals on Bylot Island. These data will allow us to relate spring body condition to subsequent likelihood of breeding, timing of breeding, clutch size, and breeding success.

Small mammals. — During our survey using snap traps, we cumulated 1889 trap-nights at our 2 trapping sites of the Base-camp Valley from 24 to 31 July, and 949 trap-nights at the Camp-2 from 15 to 18 July. In the Base-camp sites, we caught 3 Collared Lemmings (*Dicrostonyx groenlandicus*) and no Brown Lemming (*Lemmus sibiricus*), which yielded a combined index of abundance of 0.16 lemmings/100 trap-nights, a very low value (Fig. 5). The estimated abundance was similar in the Camp-2 area, as 2 Collared Lemming and no Brown Lemmings were caught, for an index of 0.21 lemmings/100 trap-nights. The low estimate of lemming abundance yielded by our snap-trap survey was confirmed by our live-trapping survey in the Base-camp area. Overall, we captured 16 different lemmings (1 Brown and 15 Collared), including 5 that were captured more than once, for an index of 0.46 lemmings/100 trap-nights (excluding recaptures), a very low number compared to last year (6.99 lemmings/100 trap-nights). The number of lemming winter nests found along our transects was also extremely low compared to the previous year as 9 were found in 2009 compared to 117 in 2008. All indices therefore suggest that lemmings were in the low phase of their cycle.

Breeding activity of foxes at dens and marking. — We found 3 new fox dens on the island in 2009, bringing the total to 106 known denning sites still intact. Among these dens, we found signs of activity (fresh digging and/or footprints) at 19 of them, a low number. The breeding activity of foxes was very low as we found only 4 different litters (4% of known denning sites) of Arctic Foxes and none of Red Foxes. This was a dramatic reduction compared to last year (23% of dens used in 2008, a year of high lemming abundance) and typical of the proportion of fox dens used in previous years of low lemming abundance. Minimum litter size of Arctic Fox varied between 1 and 7 pups (4 pups on average). A total of 14 adult (8 females and 6 males) and 9 juvenile Arctic Foxes were captured during trapping sessions and marked with ear-tags. Twelve of the adults captured were new individuals and two of them had been marked in previous years. All adults were fitted with satellite collars to study their home ranges and movements at large spatial scale over an entire annual cycle.

Monitoring of other bird species. — We found 32 nests of Glaucous Gulls, a number similar to last year (30), and slightly more Parasitic Jaeger nests than last year (6 vs. 2, respectively). However, the number of nests found for all other avian predators decreased considerably in 2009: 1 nest of Long-tailed Jaegers (vs. 78 in 2009), 4 nests of Rough-legged Hawks (vs. 9 in 2009) and no nests of Snowy Owls (vs. 20 in 2008). Finally, we found 127 nests of Lapland Longspurs compared to 109 in 2008. Average clutch size was 2.7 eggs for gulls (vs. 2.8 in 2008), 5.9 eggs for longspurs (vs. 5.8 in 2008), and 1.6 eggs for jaegers (vs. 1.9 in 2008). Nesting success (proportion of nests successful in fledging at least one young) was moderate for longspurs (43% vs. 29% in 2008), low for gulls (26% vs. 57% in 2008) and unknown for jaegers and hawks.

Plant growth and grazing impact. — Plant production in wet meadows of the brood-rearing area was similar to last year and higher than the long-term average (Fig. 6). Above-ground biomass of graminoid plants in the Base-camp Valley reached 54.3 ± 9.0 [SE] g/m^2 in ungrazed areas in mid-August compared to 52.3 ± 8.7 in 2008 (long-term average since 1990: 46.0 g/m^2). At the Camp-2 area (colony), graminoid biomass in 2009 was higher than last year (53.0 ± 10.0 vs. 45.4 ± 7.7 g/m^2 in 2008; Fig.7) and was the highest value recorded since the beginning of the monitoring more than 10 years ago.

Grazing pressure was moderately high in the wet meadows of the Base-camp Valley as geese removed 34% of the above-ground biomass (difference between paired grazed and ungrazed plots) by mid-August compared to 14% in 2008 (long-term average: 33%; Fig. 6). This relatively high grazing pressure is consistent with the good production of young recorded in 2009 but not with the low density of goose faeces measured at this site (see above). At the Camp-2 area (colony), the grazing pressure was lower with 19% of the graminoid biomass removed by geese compared to 21% in 2008 (long-term average at this site: 28%; Fig. 7).

Goose nesting and banding on Ellesmere Island and surrounding area. — Very few geese nested this year in this area. Only 25 groups of goose families were seen during the survey with an average of 3.8 young/brood (n = 17). This value is lower than the brood size observed during the previous two years on Ellesmere Island (4.3 and 4.4 young/brood in 2008 and 2007, respectively). Family groups were smaller and more scattered than those observed on Bylot Island, which forced us to conduct 11 banding drives on Ellesmere and Axel Heiberg Islands. We banded a total of 486 geese, including 96 adult females marked with neck-collars. In addition, we recaptured 86 previously-banded birds. Two of them had been originally banded on Bylot Island (in 2001 and 1993) and 3 in southern Québec (at Cap Tourmente in 1997 and Île-aux-Oies in 2008 and 2009). We also recaptured one Lesser Snow Geese that was originally banded as a gosling on Baffin Island in 2004. Therefore, the Greater Snow Goose productivity was very low in this region in 2009. Finally, we cumulated 786 trap-nights during our snap-trapping survey. We caught only one Collared Lemming in the mesic habitat for a combined index of abundance for both habitats of 0.13 lemming/100 trap-nights, a very low value.

CONCLUSIONS

The production of young geese on Bylot Island was relatively high in 2009 and several factors contributed to this. The phenology of migration and reproduction were normal because local climatic conditions in spring were good and snow-melt was early. The breeding effort (indexed by nest density) was high although clutch size was low. The nesting success was also quite good, which was surprising because lemming abundance was very low. Typically, nest predation rate, especially by foxes, is high in such years but apparently this was not the case in 2009. The last lemming peak was unusual in that it straddled 2 years (2007 and 2008) and was followed by a very abrupt decline, which was already apparent during the winter 2008-2009, as evidenced by the low number of winter nests found. This rapid decline may have resulted in a reduced winter survival of foxes (especially for juveniles), leading to low fox numbers in 2009, hence a low predation pressure on goose nests. The end result of this was that the proportion of young in our catches at banding was fairly high.

Based on the youg:adult ratio recorded at banding on Bylot Island, we anticipated a proportion of young in the fall flock around 25%, above the long-term average (23%). However, the proportion of young measured during juvenile counts conducted in southern Québec this fall was considerably lower than that (11%, n = 28,969). Thus, either young survival during the migration from the Arctic to southern latitudes was low, or the good breeding conditions that prevailed on Bylot Island were not generalised across the breeding range of the population. We have some evidence in favour of the latter hypothesis. Field survey conducted on Ellesmere and Axel Heiberg Islands over a 7,000 km^2 area indicated that, among the 3 200 snow geese observed, reproductive success was indeed very poor in 2009. We do not have detailed observations at this site to explain the low productivity of geese there but weather conditions in many areas of the High Arctic were apparently poor last summer, and the spring was delayed. These conditions, in combination with the low abundance of lemmings recorded on Ellesmere Island, likely explain the poor production of geese in this area. There is also evidence that similar conditions prevailed in central and south Baffin areas. It thus appears that the good reproductive conditions encountered by snow geese on Bylot Island in 2009 were not representative of the whole breeding range of the population. Interestingly, the opposite situation apparently prevailed in 2008 as the production observed on Bylot Island was lower than the overall productivity measured in fall primarily due to poor weather during the summer at this site.

Plant production in the wet meadows of Bylot Island was good in 2009, presumably because of the early onset of the growing season and the sunny and warm conditions that prevailed throughout most of the summer. The low grazing pressure observed at the nesting colony (Camp-2) suggest that relatively few geese stayed there to rear their young and that most families moved out of the colony. The moderately high grazing pressure recorded on the brood-rearing area of the Base-camp Valley is consistent with that. A recent analysis of the long-term monitoring of primary production and goose grazing impact in the wetlands of the nesting colony (Camp-2) and of distant brood-rearing areas (Base-camp Valley and Dufour Point) concluded that primary production in the nesting area was 40% lower than at the other brood-rearing areas (Valery et al., in review). This lower productivity is presumably a key factor explaining the seasonal movements of families away from the nesting colony soon after hatch. The low primary production recorded at the nesting area is likely a consequence of the high density of geese at this site and of the associated chronic grazing that occurs, especially early in the season during the nesting period. With the increase in goose numbers at the colony, there is evidence that movements of broods away from the colony also increased based on the 5-year survey of the island conducted during the 1980s and 1990s. This suggests that distant brood-rearing sites on Bylot Island have a shorter history of intense grazing than the colony itself. Nonetheless, our monitoring suggests that this situation has been stable for the last 10 years, and that primary production in the nesting colony may even show an increasing trend over the last 3 years.

PLANS FOR 2010

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 (annual plant production and grazing impact) in response to the spring conservation harvest and other special management actions implemented since 1999 in Quebec. Other aspects of the project include *i*) understanding better the links between events occurring during the spring migration and the subsequent breeding success of geese; *ii*) determining the long-term effects of geese on the arctic landscape; *iii*) expanding our estimate of the carrying capacity of Bylot Island for geese to upland habitats; *iv*) study indirect interactions between snow geese and lemmings via shared predators; *v*) study the ecology of the main predator of geese, Arctic Foxes; *vi*) examine the impact of avian predators on goose reproductive success; and *vii*) study the impact of climate change on goose reproduction. In 2010, 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 assess the growth and pre-fledging survival of goslings by their recapture in late summer.
3) 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.
4) Monitor the level of intestinal parasite infestations in goslings and study their impact on survival.
5) Monitor the abundance of lemmings and study their demography.
6) Monitor the breeding activity of other bird species, in particular avian predators (Snowy Owls, jaegers and Glaucous Gulls).
7) Monitor the breeding activity of foxes at dens and study their movements and demography.
8) Sample plants in exclosures to assess annual production and the impact of goose and lemming grazing on plant abundance in wet meadows.
9) Maintain our automated environmental and weather monitoring system.

In 2010, at least 6 graduate students will be involved in the Bylot Island snow goose project. **Madeleine Doiron** (PhD) will continue her investigation of the impact of climate change on the mismatch between plant and goose reproductive phenology and of its consequences on, gosling growth. **Guillaume Souchay** (PhD) will study spatial variations in snow goose demographic parameters in the High Arctic and the impact of parasites on gosling survival. **Émilie Chalifour** (MSc) will examine the molt migration of radio-marked geese and of the habitat used by molting geese. **Sandra Lai** (PhD) will continue her study on the annual and seasonal movements of Arctic Foxes around the goose colony using satellite telemetry. **Jean-François Therrien** (PhD) will finish his work on the movements and nesting ecology of avian predators. **Frédéric Bilodeau** (PhD) will continue to investigate the impact of winter climate and predation by weasel and foxes on the population dynamics of lemmings.

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

	2000	2001	2002	2003	2004	2005	2006	2007	2008	**2009**	Average[2]
Number of nest monitored	386	296	470	585	676	346	393	494	466	**405**	--
Nest density (nb/ha)	3.23	2.70	5.17	8.87	1.10	3.90	2.57	3.00	4.34	**4.17**	3.51
Median date of egg-laying	16 June	13 June	16 June	9 June	11 June	12 June	14 June	16 June	10 June	**12 June**	12 June
Clutch size	3.51	3.43	3.43	3.90	3.65	3.60	3.68	3.91	4.10	**3.38**	3.71
Nesting success[1]	83%	57%	53%	82%	78%	66%	42%	82%	74%	**74%**	65%
Median date of hatching	13 July	9 July	11 July	6 July	7 July	8 July	10 July	11 July	6 July	**9 July**	9 July
Number of geese banded	4269	3430	2650	5259	3617	5304	4603	4260	3395	**5417**	--
Ratio young:adult at banding	1.08:1	1.03:1	0.81:1	1.31:1	0.94:1	1.03:1	0.74:1	1.11:1	1.11:1	**1.07:1**	1.03:1
Brood size at banding	2.78	2.37	1.67	2.74	2.50	2.42	2.20	2.90	3.07	**2.35**	2.51
Proportion of adults with young at banding	78%	87%	97%	96%	75%	86%	67%	77%	72%	**91%**	82%

[1] Mayfield estimate
[2] Period 1989-2009

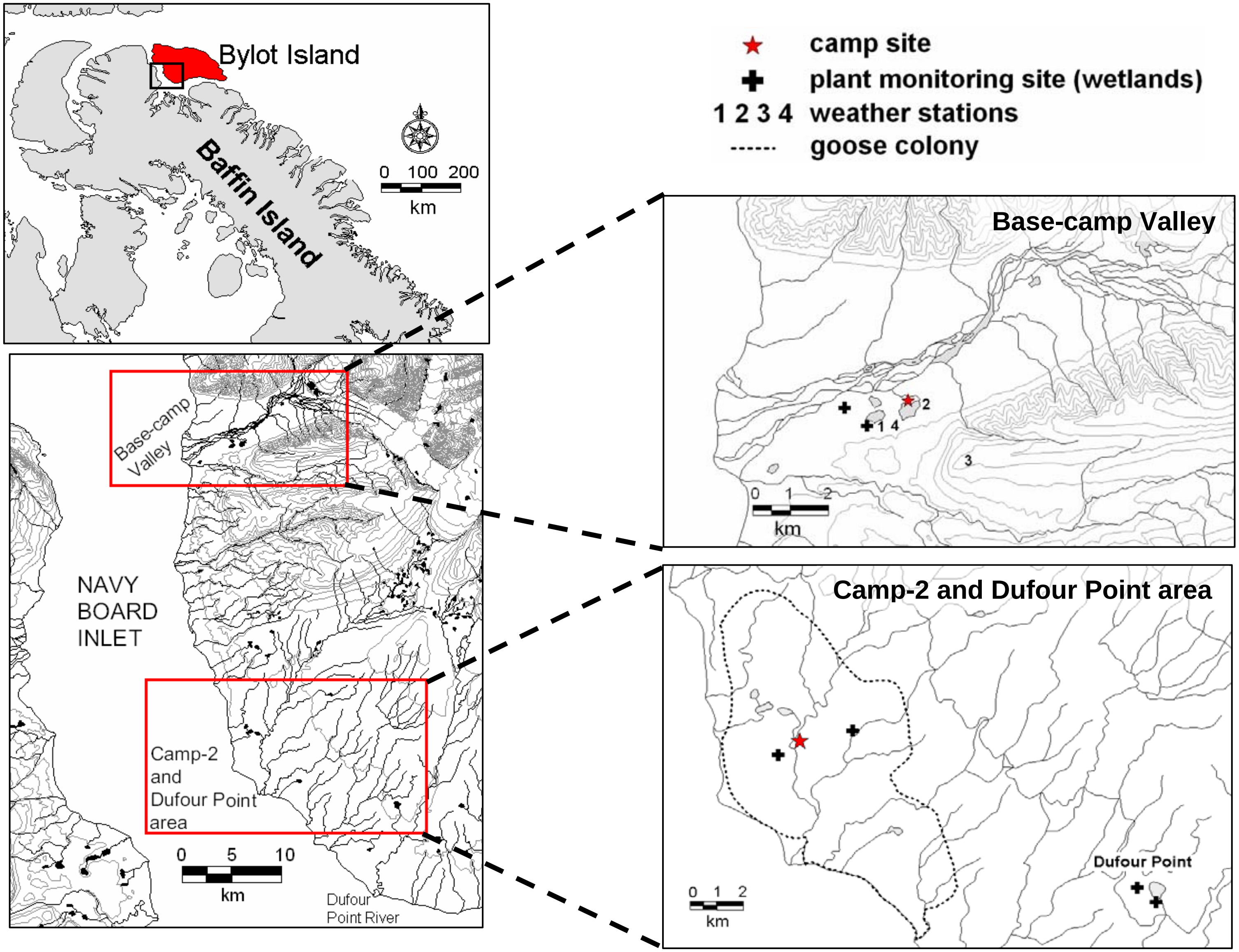

Figure 1.General location of the study area, Bylot Island, Nunavut, and of the two main study sites (Base-camp Valley and the Camp-2 area) on the South plain of the island. Enlarged maps on the right present these study sites in more details, including camp locations, sampling sites and our four weather stations. Dufour Point was not sampled in 2009.

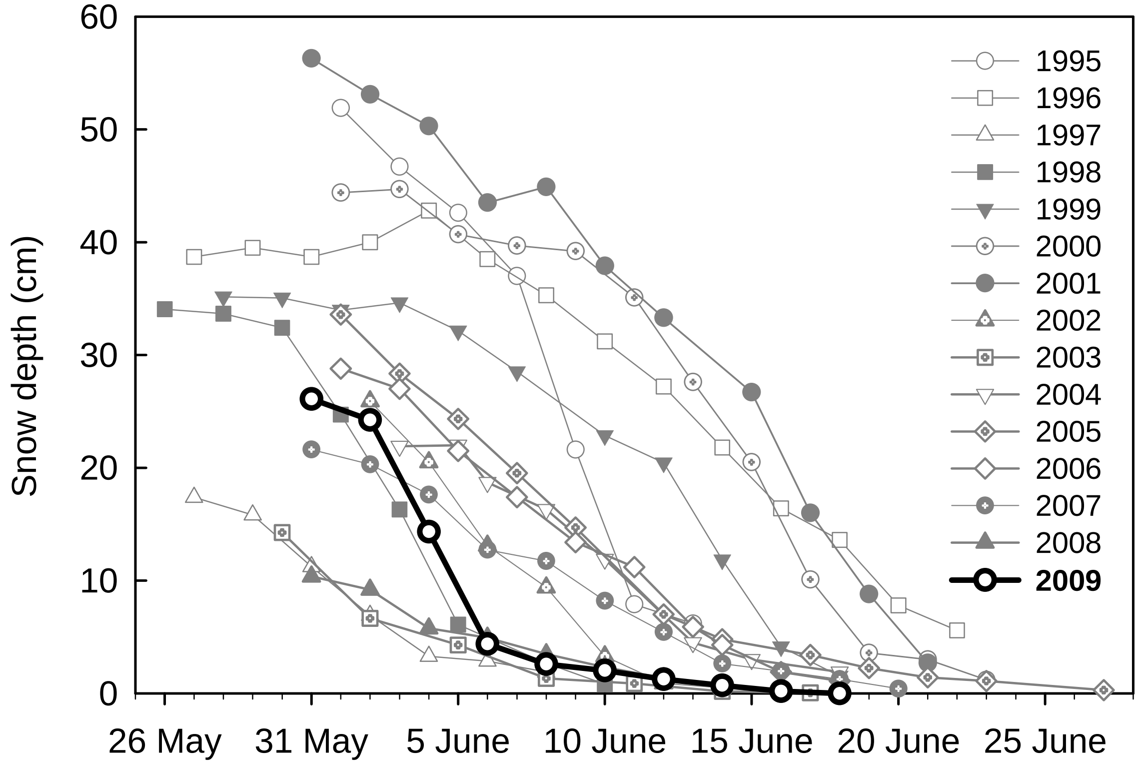

Figure 2. Average depth of snow along 2 transects showing the rate of snowmelt in Bylot Island lowlands (*n* = 50 stations).

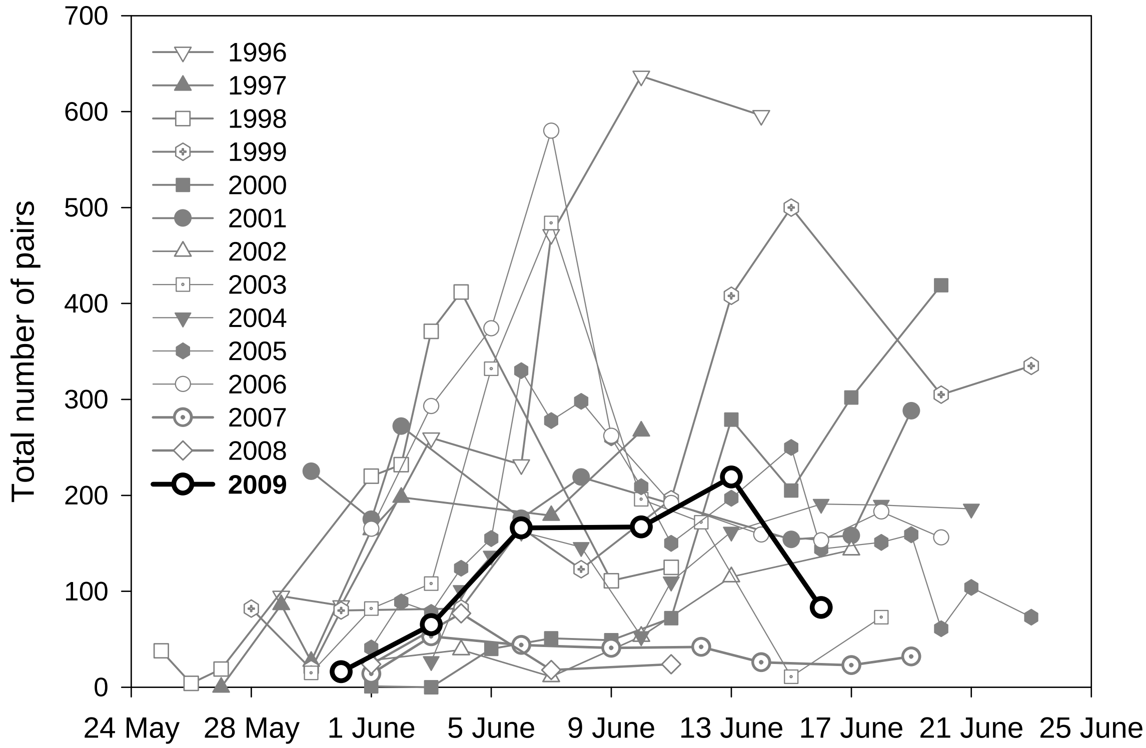

Figure 3. Total number of goose pairs counted in the Base-camp Valley from arrival of our crew on Bylot Island until the end of snowmelt.

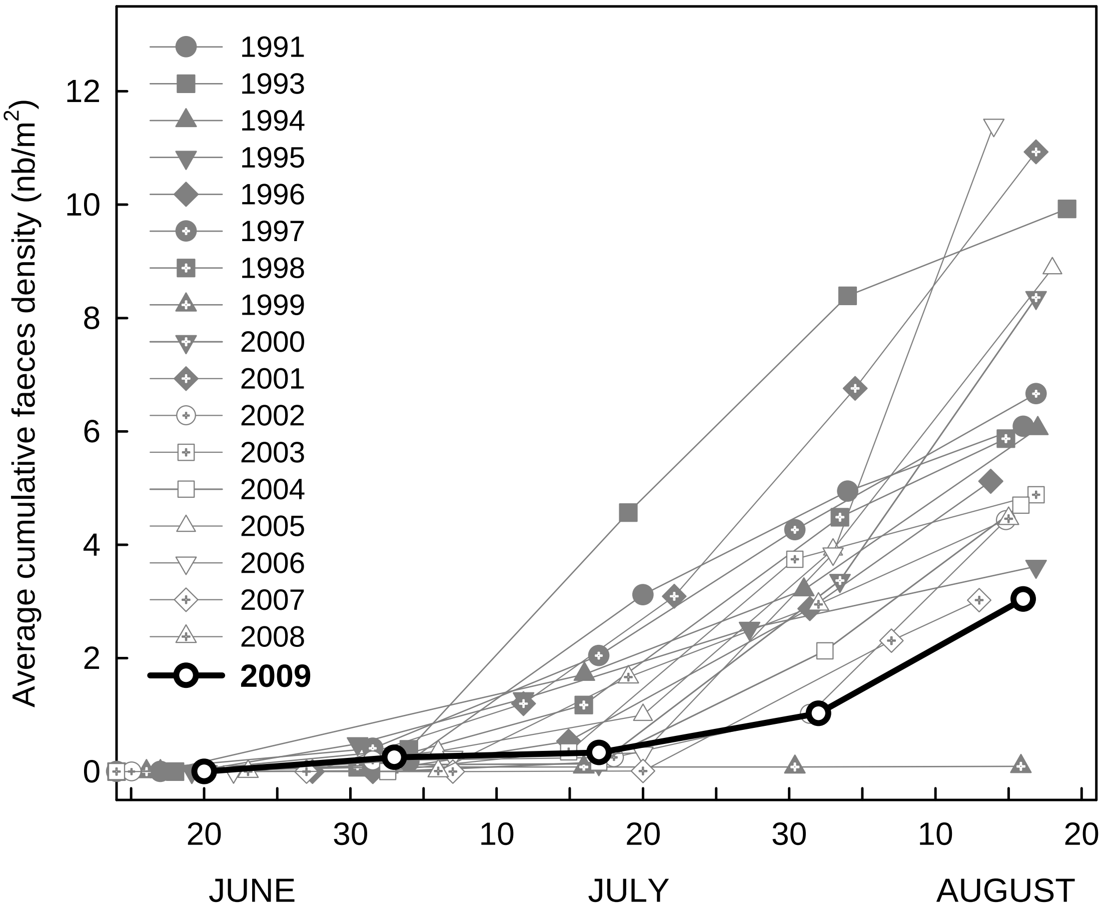

Figure 4. Average cumulative faeces density showing the use of the Base-camp Valley by Greater Snow Goose families on Bylot Island throughout the summer (*n* = 12 transects of 1 x 10 m).

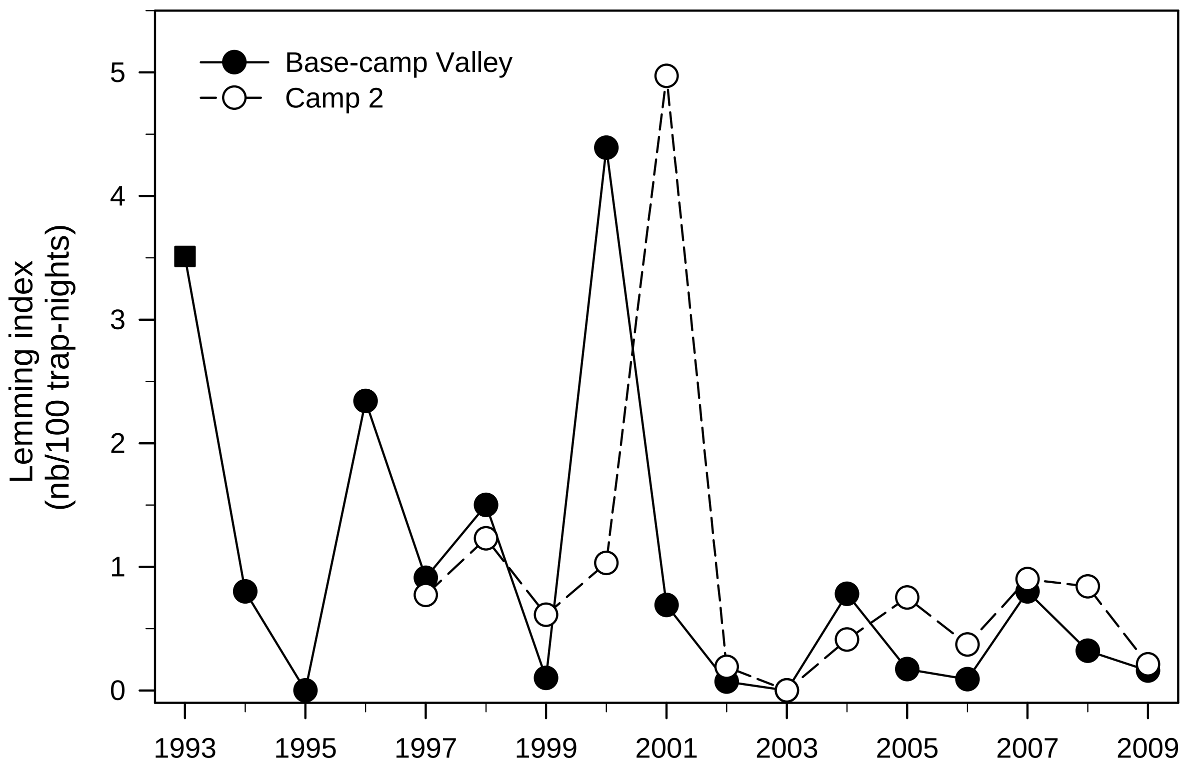

Figure 5. Annual abundance of lemmings at two study areas (Base-camp Valley and Camp-2) located 30 km apart on Bylot Island.

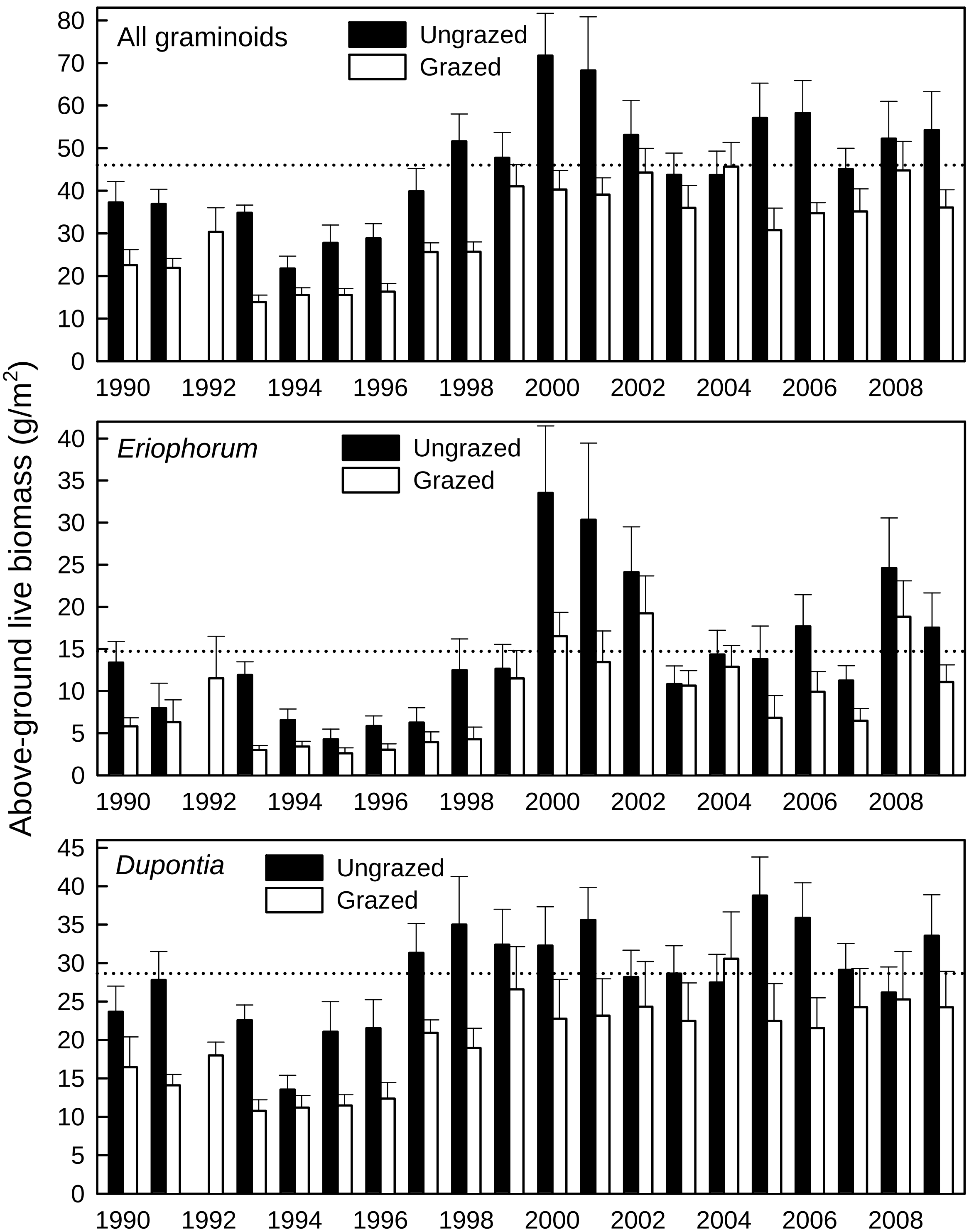

Figure 6. Live above-ground biomass (mean + SE, dry mass) of graminoids on 14 August in grazed and ungrazed wet meadows of the Base-camp Valley, Bylot Island (n = 12). Total graminoids include *Eriophorum scheuchzeri*, *Dupontia fisheri* and *Carex aquatilis*. There is no data from ungrazed area in 1992. The dashed line is the long-term average for ungrazed area.

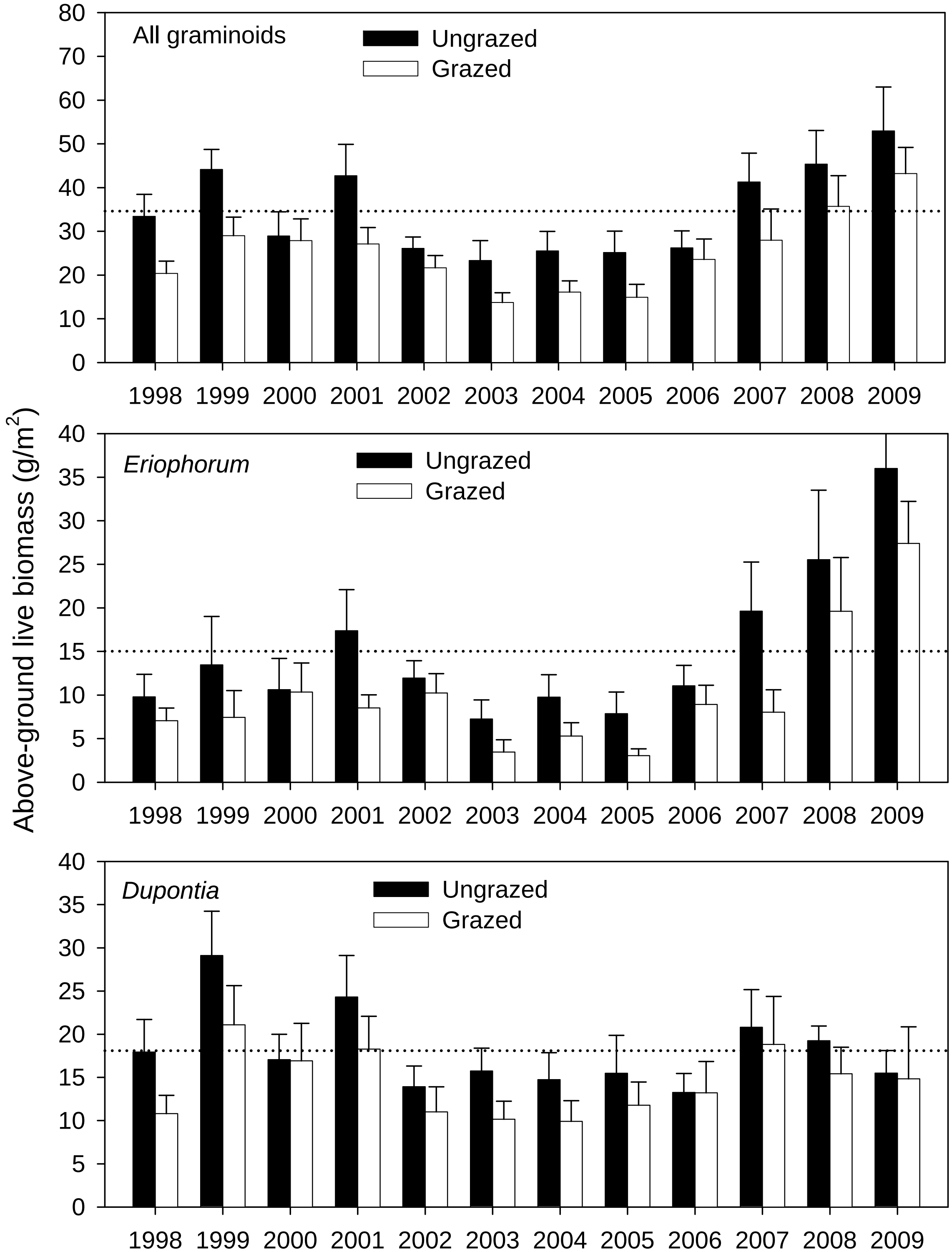

Figure 7. Live above-ground biomass (mean + SE, dry mass) of graminoids on 14 August in grazed and ungrazed wet meadows of the Camp-2 (goose colony), Bylot Island (n = 12, except in 2008 where n = 8). Total graminoids include *Eriophorum scheuchzeri*, *Dupontia fisheri* and *Carex aquatilis*. The dashed line is the long-term average for ungrazed area.

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