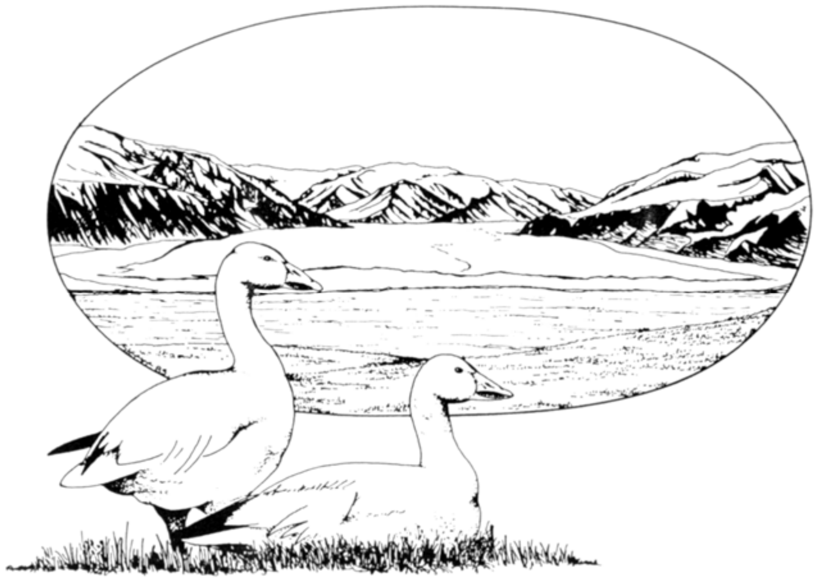
POPULATION STUDY OF GREATER SNOW GEESE AND ITS NESTING HABITAT ON BYLOT ISLAND, NUNAVUT IN 2010: A PROGRESS REPORT



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INTRODUCTION

In 2010, 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 2010 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) Monitor the level of intestinal parasite infestations in goslings.
5) Monitor the abundance of lemmings and study their demography.
6) Monitor the breeding activity of other bird species and in particular avian predators (Snowy Owls, jaegers and Glaucous Gulls).
7) Monitor the breeding activity of foxes at dens.
8) Capture and mark adults Arctic Foxes and their pups with ear-tags to study their movements and demography.
9) Sample plants in exclosures to assess annual production and the impact of goose grazing on plant abundance in wet meadows.
10) Maintain our automated environmental and weather monitoring system.

FIELD ACTIVITIES

Field camps. — In 2010, we operated two camps on Bylot Island: the main field station, located at 6 km from the coast in the largest glacial valley on the island ("Qarlikturvik Valley", 73° 08' N, 80° 00' W), was occupied from 17 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 26 May to 19 July (Fig. 1). Finally, eighteen fly camps were also established for 4-7 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 19 depending on the period. Members of our field party included project leaders Gilles Gauthier, Joël Bêty, and Josée lefebvre and several graduate students whose thesis projects addressed many of the objectives mentioned above: Guillaume Souchay (PhD student, objectives 1 and 2), Madeleine Doiron (PhD student, objective 3), Frédéric Bilodeau (PhD, objective 5), Jean-François Therrien (PhD, objective 6), Sandra Lai (PhD, objective 8) and Élisabeth Tremblay (MSc, objectives 7). Several other students assisted them in the field, including: Meggie Desnoyers, Arnaud Tarroux, Camille Morin, Vincent Lamarre, Hugo Mailhot Couture, Julien Rosa-Francoeur, Francis Taillefer, Christine Chicoine and Aude Lalis. Other people in the field included Gérald Picard, a technician in charge of the banding operation (objective 3); Marie-Christine Cadieux, a research professional in charge of plant sampling (objective 9); and Denis Sarrazin, a research professional responsible of the maintenance of the weather stations (objective 10); and Josée Lefebvre, a biologist from the Canadian Wildlife Service (Quebec region). Finally, we hired 2 persons from Pond Inlet to work with us: Bernard Maktar (marking goslings in nests: 3-14 July and goose banding: 5-14 August) and Phillip Awa (goose banding: 5-14 August).

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 (MSc student), Étienne Godin (PhD student) and Alexandre Guertin-Pasquier (MSc student), who studied plant ecology, the permafrost and the geomorphology of the island; Jean-François Lamarre (MSc student), Émilie Chalifour (MSc student) and Philip Bertrand 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 Catherine Girard, Karita Negandhi and Lennie Boutet, who studied the carbon cycle in ponds. Finally, several other persons visited our camp during the summer. Andy McMullen (Bearwise), Daniel Innuarak and Terry Milton (both from Pond Inlet) finished the work on the new camp infrastructure; Gesoni Killiktee (*Sirmilik* JPMC chairman), Jayko Alooloo (HTO chairman), James Atagootak (HTO board member) and Brian (HTO manager) visited the main field station; Carey Elverum (chief warden of *Sirmilik National Park*) and Andrew Maher (park warden) inspected both camps; finally, Claus Vogel, a freelance travel photojournalist working for the First Air in-flight magazine Above & Beyond visited our field station in the Qarlikturvik Valley.

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, snow accumulation on the ground, 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 except for one of the station at low elevation (the oldest one). Water infiltrated in the housing of the datalogger, which unfortunately resulted in the loss of the datalogger and its data for the entire year. 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 Qarlikturvik Valley, both at 2-day intervals.

Monitoring of goose arrival and nesting. — We monitored goose arrival in the Qarlikturvik 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 main field station and the Camp-2 between 8 and 18 June. Nests are found by systematic searches conducted over various areas in the field. In the Qarlikturvik 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.

Goose banding. — From 5 to 12 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 Qarlikturvik 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. Since 2004, we also sample lemming abundance using live-traps. We trapped on 2 permanent grids (330×330 m) in the Qarlikturvik 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 Qarlikturvik 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 the nests of 15 owls, 5 hawks and 10 jaegers 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 Qarlikturvik 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 Qarlikturvik Valley and once at the end of the season at the Camp-2 area.

PRELIMINARY RESULTS

***Weather conditions.* —** Temperature in spring was warm. Air temperature averaged 0.22°C between 20 May and 20 June (0.26°C above normal), which corresponds to the period of goose arrival and egg-laying, and 1.87°C (0.49°C above normal) during 1-15 June, the normal pre-laying and laying periods. The snow pack at the end of winter was high (snow depth was 41.6 cm on 31 May) due to high snowfall during the winter. Despite the rapid snow-melt that took place in early June due to the warm weather, this resulted in a snowmelt that was about one week later than normal in the lowlands (Fig. 2). The summer was generally warm and sunny, especially in June and early July, and precipitations were below normal (cumulative rain: 84 mm, long-term average: 92 mm). The wettest month was August with 39 mm over 18 days, including 31 mm received during a single raining event (less than 24 hours).

Goose arrival and nesting activity. — The number of geese counted on the hills surrounding the Qarlikturvik Valley (main field station), usually the first area used by geese upon arrival, was very high at our first count on 2 June (365 pairs). Number of geese peaked at 584 pairs on 8 June, one of the highest numbers recorded, and still numbered at 430 on 22 June, the last day of counting (Fig. 3). This suggests that goose arrival on Bylot Island was early this year. Two factors may explain why numbers stayed high passed mid June. First, the delay in snow-melt may have delayed the movement of geese to their lowland nesting areas of the Camp-2 area as in previous years. Second, the unusually high nesting effort of geese in the Qarlikturvik Valley, which was a consequence of the abundance of Snowy Owls in the area (see *Monitoring of other bird species* below).

The distribution of goose nests was indeed unusual this year due to a high nesting activity of Snowy Owls throughout Bylot Island (see below). Most geese moved away from the main colony (Camp-2) and nested in small clusters around owl nests over a large portion of the island, including in the Qarlikturvik Valley, normally only used as a brood-rearing area. This led to a lower density of nests in the central part of the colony, a situation somewhat similar to what happened in 2004, another year of high nesting activity for Snowy Owls (Table 1). This rendered difficult the estimation of the global nesting activity of geese on the island but the widespread distribution of goose nests indicates a good overall nesting effort this year.

Overall, median egg-laying date was 13 June, which is very close to the long-term average (Table 1). However, there was an unusually high spatial variation in laying dates as geese nesting in association with owls in the Qarlikturvik Valley started laying on average on 11 June (n = 41) whereas those nesting at the main colony started laying around 14 June (n = 230). This was probably due to a combination of differences in topography and timing of snowmelt between the colony and the sites where snowy owl nested because owls prefer to nests along ridges that are freed of snow earlier than the lowlands of the colony around Camp-2. For instance, on 11 June 55% of the slopes of the Qarlikturvik Valley where geese nested in association with owls were snow free while more than 95% of the Camp-2 area was still covered by snow. Overall, mean clutch size was 3.68, very close to the long-term average (Table 1). As expected, clutch size was higher in nests located in the Qarlikturvik Valley (4.08, n = 63), where laying was earlier, than at the main colony (3.49, n = 221), where it was delayed.

Nesting success of geese. — Nesting success (proportion of nests hatching at least one egg) was high this year in the colony (80%, a value well above the long-term average, Table 1). Activity of Arctic Foxes and avian predators around goose nests was relatively low. During the summer, 85 neck-collared birds were sighted, a low number compared to last year (399). This is a consequence of the low density of nesting geese around the Camp-2 where most collar reading usually takes place. Peak hatch was on 10 July, which is close to the long-term average (Table 1). We tagged 1386 goslings in nests at hatch, 1189 in the Camp-2 area and 197 in the Qarlikturvik Valley. Overall, nesting conditions of geese in 2010 were therefore fairly good.

Density of broods. — In 2010, the density of goose faeces at the end of the summer in wet meadows of the Qarlikturvik Valley was one of the lowest ever recorded (3.4 ± 1.1 [SE] faeces/m^2, Fig. 4). Accumulation of faeces was delayed until 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 (2.8 ± 1.0 faeces/m^2; long-term average: 3.5 ± 0.4). The low density of faeces in 2010 is easier to explain in the Camp-2 area (likely related to the low density of nesting geese in the colony this year, see above) than in the Qarlikturvik Valley, typically a good brood-rearing area. However, the extensive distribution of nesting geese over the island may have reduced the post-hatch movements of geese toward this brood-rearing area and could explain its low use.

Goose banding. — The banding operation was successful this year. We conducted 8 drives in our core banding area, i.e. in the lowlands and hills bordering the main field station to the south and north (<8 km), and 3 additional drives further away, between the Camp 2 and the Qarlikturvik Valley. We banded a total of 4267 geese, including 540 adult females marked with neck-collars and 46 young that had been marked with web-tags at hatch. In addition, we had 230 recaptures of adults banded in previous years. The gosling:adult ratio among geese captured at banding (1.18:1) was higher than last year and above the long-term average (Table 1). In contrast, mean brood size toward the end of brood-rearing (2.39 young, SD = 1.03, n = 221; counts conducted from 30 July to 4 August) were similar to last year and below the long-term average. By combining information on brood size and young:adult ratio at banding, we estimated that 98% of the adults captured were accompanied by young, a high value. Overall, these results are indicative of a good production of young on Bylot Island by the end of the summer. Finally, we collected 11 intestines from goslings that died accidentally during banding to examine their level of parasite infection.

Small mammals. — During our survey using snap traps, we cumulated 1920 trap-nights at our 2 trapping sites of the Qarlikturvik Valley from 24 to 31 July, and 720 trap-nights at the Camp-2 from 12 to 14 July. In the Qarlikturvik sites, we caught 4 Collared Lemmings (*Dicrostonyx groenlandicus*) and 13 Brown Lemming (*Lemmus sibiricus*), which yielded a combined index of abundance of 0.92 lemmings/100 trap-nights, a moderate value (Fig. 5). The estimated abundance was similar in the Camp-2 area, as 2 Collared Lemming and 5 Brown Lemmings were caught, for an index of 0.99 lemmings/100 trap-nights. The live-trapping survey conducted throughout the summer in the Qarlikturvik Valley area revealed a somewhat different picture. Overall, we captured 310 different lemmings (265 Brown and 45 Collared), including 164 that were captured more than once, for an index of 8.88 lemmings/100 trap-nights (excluding recaptures), a very high number compared to last year (0.46 lemmings/100 trap-nights). A formal estimation of density using capture-recapture analytical methods indeed showed that we had a peak of lemming abundance in 2010 (Fig. 6). The number of lemming winter nests found along our transects (n = 60) was also extremely high compared to the previous year as 261 were found in 2010 compared to 9 in 2009.

Breeding activity of foxes at dens and marking. — We found 2 new fox dens on the island in 2010, bringing the total to 108 known denning sites still intact. Among these dens, we found signs of activity (fresh digging and/or footprints) at 21 of them, a relatively low number. However, the breeding activity of foxes was high as we found 17 different litters (16% of known denning sites) of Arctic Foxes, a considerable increase over last year (4 litters found in 2009) and none of Red Foxes. This value is typical of the proportion of fox dens used in previous years of high lemming abundance (average: 18%). Minimum litter size of Arctic Fox varied between 1 and 13 pups (6 pups on average). A total of 26 adults and 40 juveniles were captured during trapping sessions and marked with ear-tags. Seventeen of the adults captured were new individuals and nine of them had been marked in previous years. All adults and 1 juvenile 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. — After only one year of absence, Snowy Owls were again nesting in abundance on Bylot Island in 2010, as we found 34 nests compared to 20 in 2008. There were 11 nests in the Qarlikturvik Valley (compared to 9 in 2008), 11 in the Camp-2 area (1 in 2008), 6 scattered between our two camp sites (10 in 2008) and 6 toward the Pointe Dufour area (not surveyed in 2008). One of the adult female Snowy Owl marked with a satellite transmitter in 2007 returned to the Camp-2 area to nest. We recaptured her at her nest using a bow-net trap to remove the transmitter, 1.8 km from where she nested in 2007. The same female was nesting near Angajurjualuk Lake on Baffin Island in 2008 and at the northern tip of Greenland in 2009. We also found 25 nests of Glaucous Gulls (vs. 32 in 2009), 58 nests of Long-tailed Jaegers (vs. 1 in 2009), 3 nests of Parasitic Jaegers (vs. 6 in 2009) and 21 nest s of Rough-legged Hawks (vs. 4 in 2009). All predators that typically show a strong numerical response to lemming abundance (Snowy Owl, Rough-legged Hawk and Long-tailed Jaeger) were thus abundant in 2010. Finally, we found 116 nests of Lapland Longspurs compared to 127 in 2009. Average clutch size was 6.4 eggs for owls (vs. 7.0 in 2008), 2.3 eggs for gulls (vs. 2.7 in 2009), 2.0 eggs for jaegers (vs. 1.6 in 2009), 3.8 eggs for hawks and 5.2 eggs for longspurs (vs. 5.9 in 2009). Nesting success (proportion of nests successful in fledging at least one young) was high for owls (88% vs. 100% in 2008), gulls (88% vs. 26% in 2009), Long-tailed Jaegers (93% vs. none in 2009), and moderately high for longspurs (60% vs. 43% in 2009). Success was unknown for Parasitic Jaegers and hawks.

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. 7). Above-ground biomass of graminoid plants in the Qarlikturvik Valley reached 62.8 ± 11.4 [SE] g/m^2 in ungrazed areas in mid-August compared to 54.3 ± 9.0 in 2009 (long-term average since 1990: 46.9 g/m^2). At the nesting colony (Camp-2 area), graminoid biomass in 2010 was also much higher than last year (76.4 ± 12.2 vs. 53.0 ± 10.0 g/m^2 in 2009; Fig. 8) and was the highest value recorded since the beginning of the monitoring more than 10 years ago.

For only the second time over the past 20 years, goose grazing in the wet meadows of the Qarlikturvik Valley was undetectable in mid-August (Fig. 7). On average, geese remove about 32% of the annual production at this site. The absence of a grazing impact on the vegetation is consistent with the very low number of broods that used this area during the summer according to our faecal counts (Fig. 4). At the Camp-2 area (nesting colony), a grazing pressure was detected but was very low with only 7% of the graminoid biomass removed by geese compared to 19% in 2009 (long-term average at this site: 26%; Fig. 8).

CONCLUSIONS

The production of young geese on Bylot Island was high in 2010 and several factors contributed to this. First, the phenology of migration appeared to be early since birds were already present in large numbers upon our arrival. Second, even though snow-melt was delayed due to a very deep snow pack, temperature was very mild in early June. Third, the abundance of Snowy Owls offered a considerable number of safe breeding sites for geese in upland areas, away from the colony, where the snow disappeared earlier than elsewhere. These conditions allowed geese to nest near normal dates (despite a large spatial variation in laying dates) and to lay a good clutch size. Even though nest density in the colony was low, it was compensated by the extensive distribution of nesting geese across the island and thus, overall, the breeding effort of the population appeared fairly good. Geese experienced a very high nesting success, as is usually the case when lemming abundance is high, because lemmings are the preferred prey of predators such as foxes, gulls and jaegers. Under such conditions, predators prey less on bird eggs as they concentrate their foraging on lemmings. The large number of geese that nested in association with Snowy Owls also contributed to this high success since owls are very aggressive and exclude other predators from the surrounding of their nest, thereby providing a predator refuge for geese.

Based on the young:adult ratio recorded at banding on Bylot Island, we anticipated a proportion of young in the fall flock around 28%, above the long-term average (23%). However, the proportion of young measured during juvenile counts conducted in southern Québec this fall (20%, n = 26,901) was lower than our prediction. Thus, either young survival during the migration from the Arctic to southern latitudes was low, or the good breeding conditions observed on Bylot Island did not prevail across the breeding range of the population. For instance, it is possible that the high abundance of lemmings and Snowy Owls, one of the key reason for the high production of young on Bylot Island this year, was not generalised throughout the breeding range of Greater Snow Geese, as this was apparently the case in 2008. The scale of spatial synchrony in lemming cycles remains poorly known. In 2009, the proportion of young in the fall flock was also lower than what was predicted from the data collected on Bylot Island and we had evidence that breeding conditions further north (Ellesmere Island) and possibly further south (central Baffin Island) had been worse than on Bylot Island, thereby possibly explaining the discrepancy. However, similar field observations at other arctic sites were not available in 2010.

Plant production in the wet meadows of Bylot Island was good in 2010, presumably because of the sunny and warm conditions that prevailed throughout most of the plant growing season. Production was among the highest values reported over the past 2 decades, which is consistent with the long-term trend of increasing plant production that we observed at our site. The low grazing pressure observed at the nesting colony (Camp-2) can be explained by the smaller number of geese that nested there this year. However, the very low use of the brood-rearing areas of the Qarlikturvik Valley, our long-term monitoring site, and the absence of a detectable grazing impact are more difficult to explain. We previously showed that the high density of geese nesting at the main colony and the relatively high grazing impact that occurs there early in the season are major factors promoting the movements of broods away from the colony toward areas such as the Qarlikturvik Valley (Valery et al. 2010). However, the highly dispersed nesting effort of geese across much of the island this year may have reduced the need for them to move long-distances to traditional brood-rearing areas. Instead, they may have used isolated wetland patches scattered across the island, which could explain why we had to go further away from the main field season to band geese this year. A low predation pressure by foxes and gulls due to the high abundance of lemmings may also have reduced the need for geese to concentrate in large wetland patches with abundant predator refuges (i.e. ponds) such as those found in the Qarlikturvik Valley.

PLANS FOR 2011

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 2011, 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 2011, at least 4 graduate students will be involved in the Bylot Island snow goose project. **Guillaume Souchay** (PhD) will continue his study of spatial variations in snow goose demographic parameters in the High Arctic and the impact of parasites on gosling survival. **Émilie Chalifour** (MSc) will continue to 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. **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.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	**2010**	Average[2]
Number of nest monitored	296	470	585	676	346	393	494	466	405	**372**	--
Nest density (nb/ha)	2.70	5.17	8.87	1.10	3.90	2.57	3.00	4.34	4.17	**2.47**	3.45
Median date of egg-laying	13 June	16 June	9 June	11 June	12 June	14 June	16 June	10 June	12 June	**13 June**	12 June
Clutch size	3.43	3.43	3.90	3.65	3.60	3.68	3.91	4.10	3.38	**3.68**	3.71
Nesting success[1]	57%	53%	82%	78%	66%	42%	82%	74%	74%	**80%**	66%
Median date of hatching	9 July	11 July	6 July	7 July	8 July	10 July	11 July	6 July	9 July	**10 July**	9 July
Number of geese banded	3430	2650	5259	3617	5304	4603	4260	3395	5417	**4267**	--
Ratio young:adult at banding	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	**1.18:1**	1.04:1
Brood size at banding	2.37	1.67	2.74	2.50	2.42	2.20	2.90	3.07	2.35	**2.39**	2.51
Proportion of adults with young at banding	87%	97%	96%	75%	86%	67%	77%	72%	91%	**98%**	82%

[1] Mayfield estimate
[2] Period 1989-2010

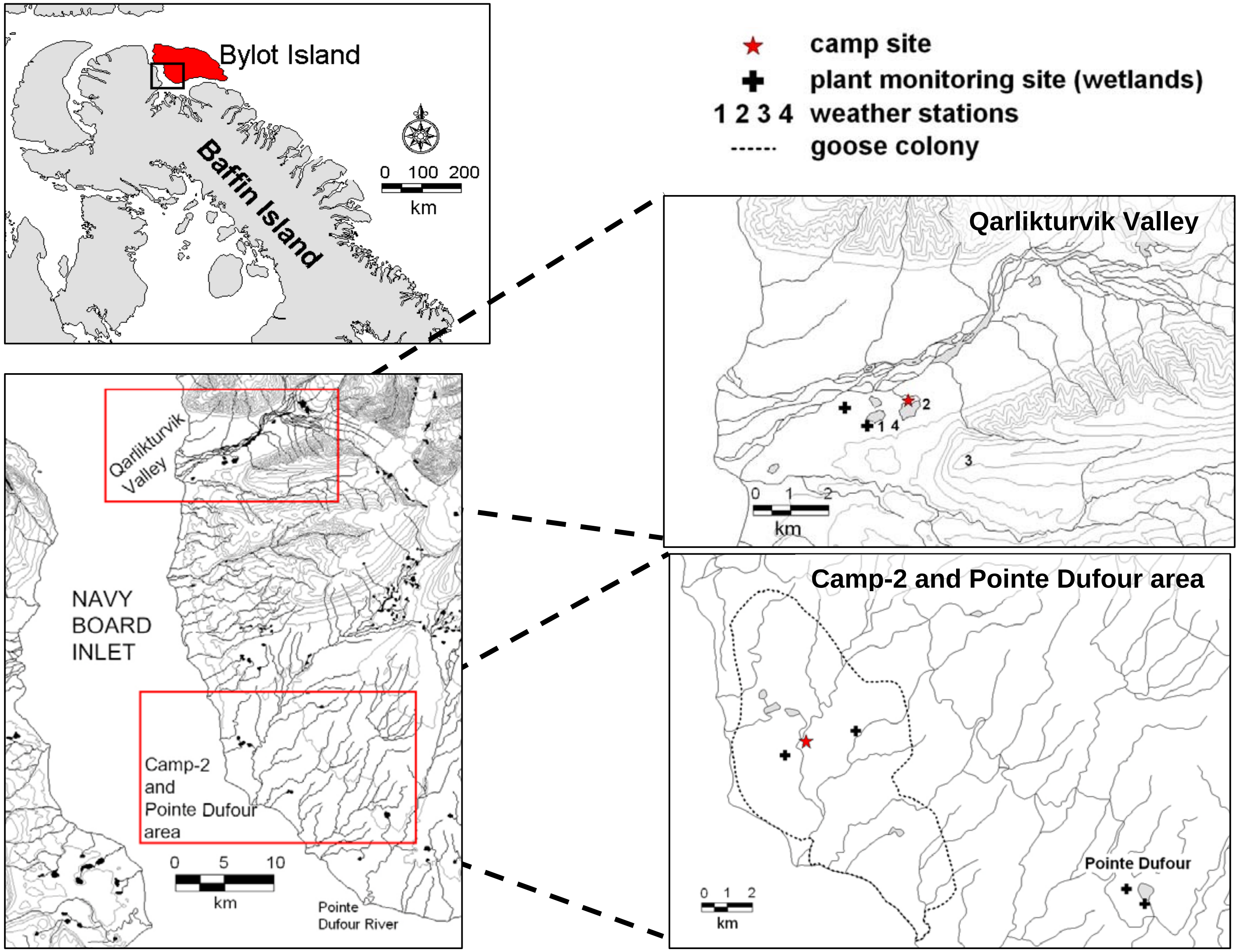

Figure 1. General location of the study area, Bylot Island, Nunavut, and of the two main study sites (Qarlikturvik Valley and the Camp-2 area) on the South plain of the island. Enlarged maps on the right present these study sites in more details, including camp locations, sampling sites and our four weather stations. Pointe Dufour was not sampled in 2010.

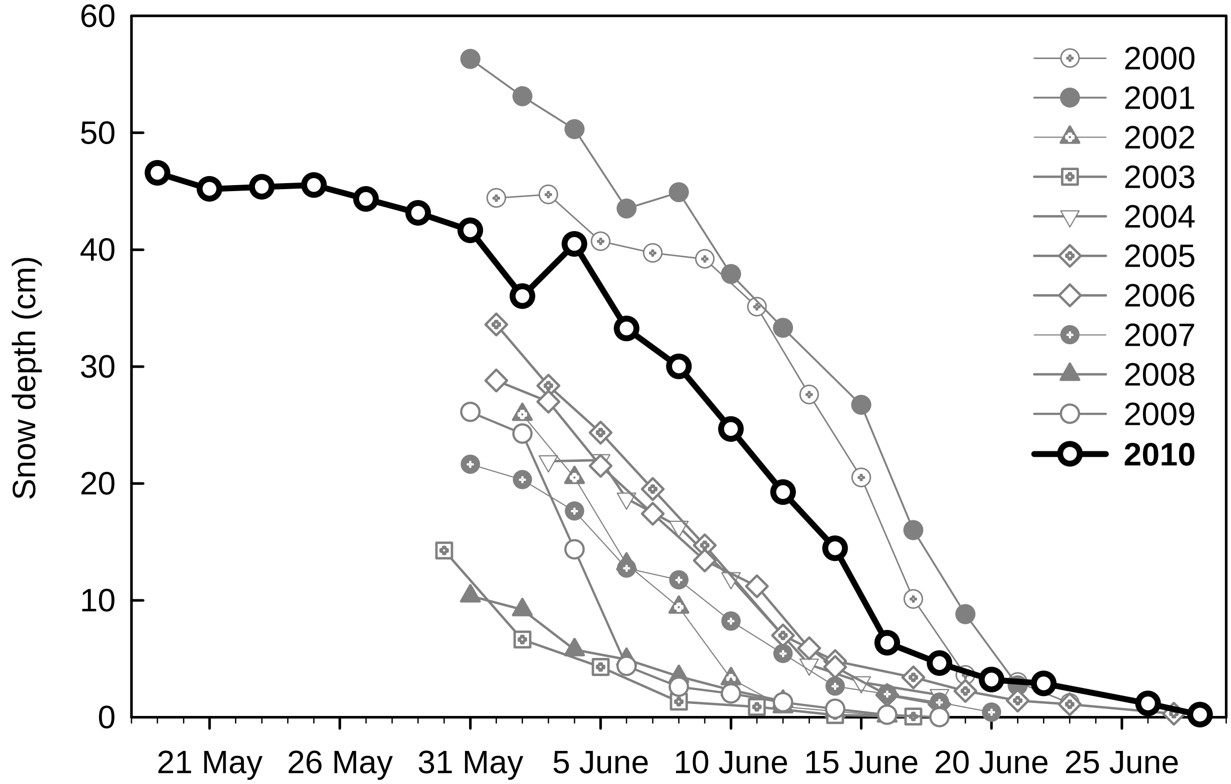

Figure 2. Average depth of snow along 2 transects showing the rate of snowmelt in the lowlands of Bylot Island (*n* = 50 stations).

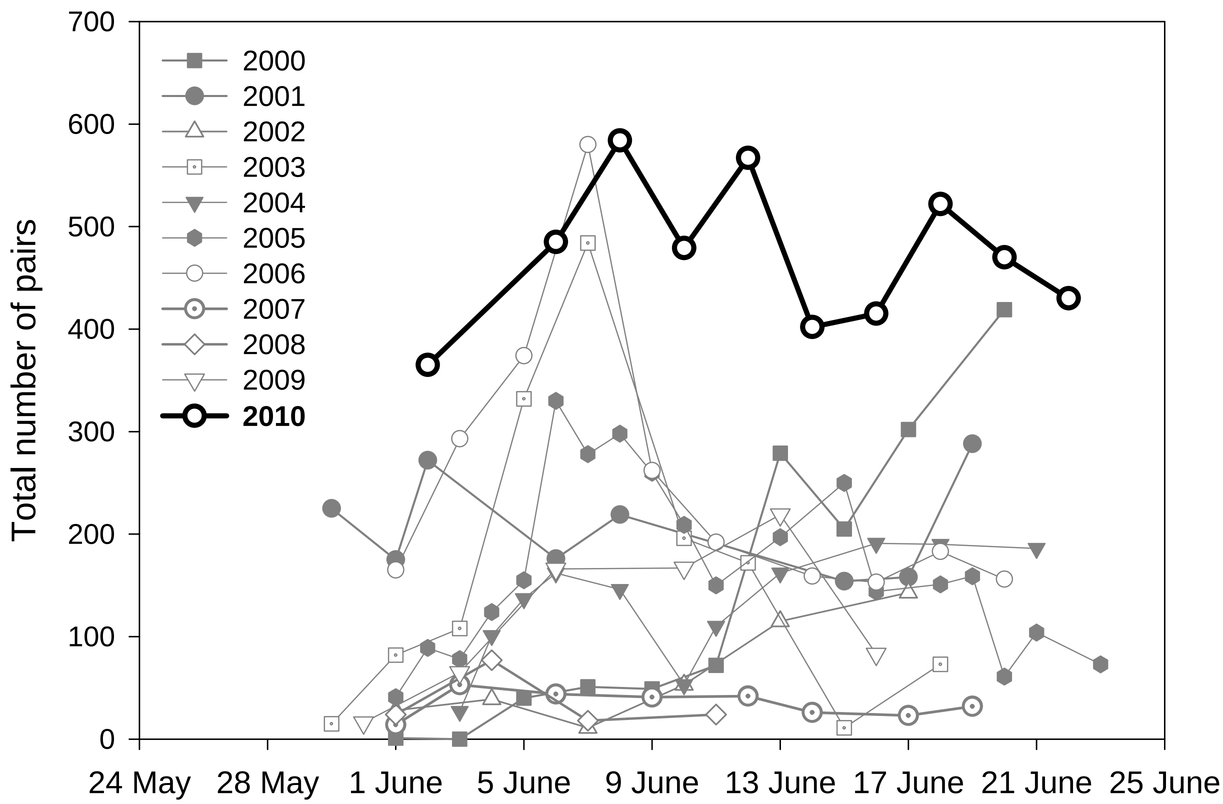

Figure 3. Total number of goose pairs counted in the Qarlikturvik Valley from arrival of our crew on Bylot Island until the end of snowmelt.

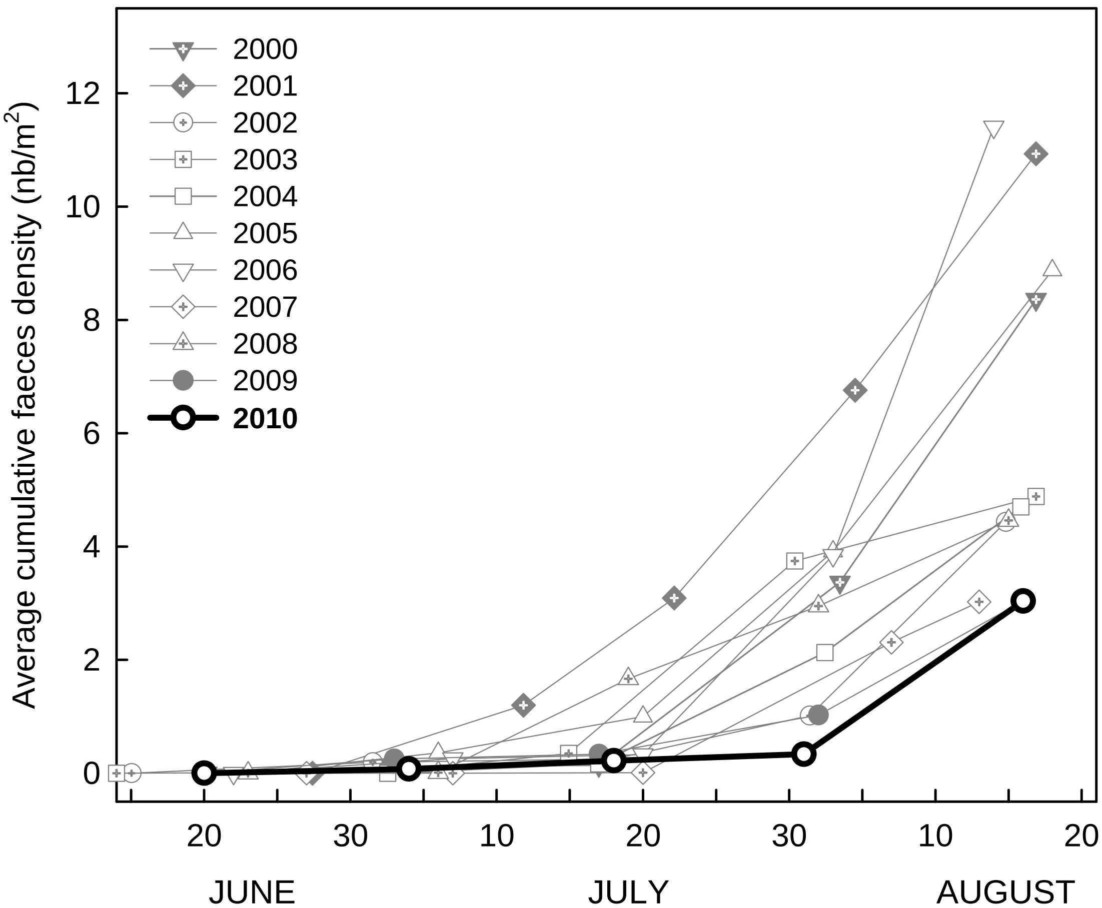

Figure 4. Average cumulative faeces density showing the use of the Qarlikturvik Valley by Greater Snow Goose families on Bylot Island throughout the summer (n = 12 transects of 1 x 10 m).

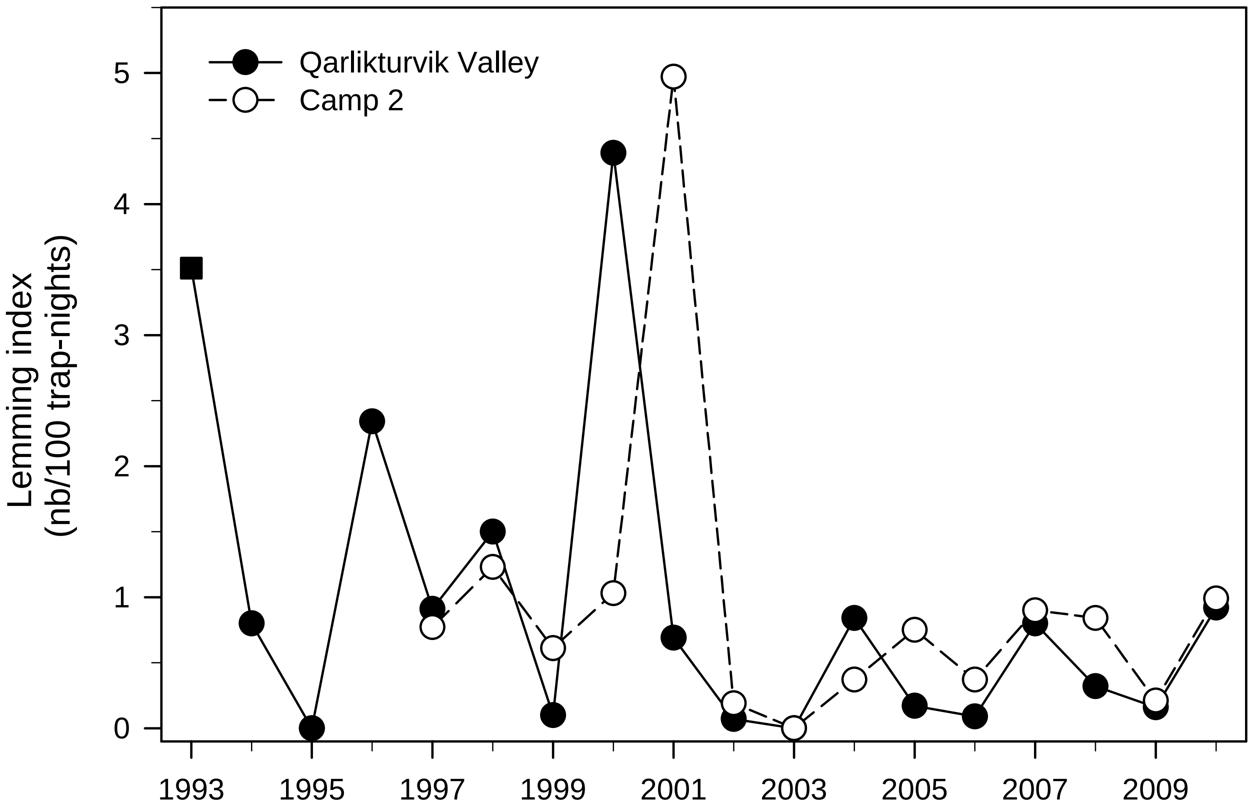

Figure 5. Annual index of lemming abundance at two study areas (Qarlikturvik Valley and Camp-2) located 30 km apart on Bylot Island.

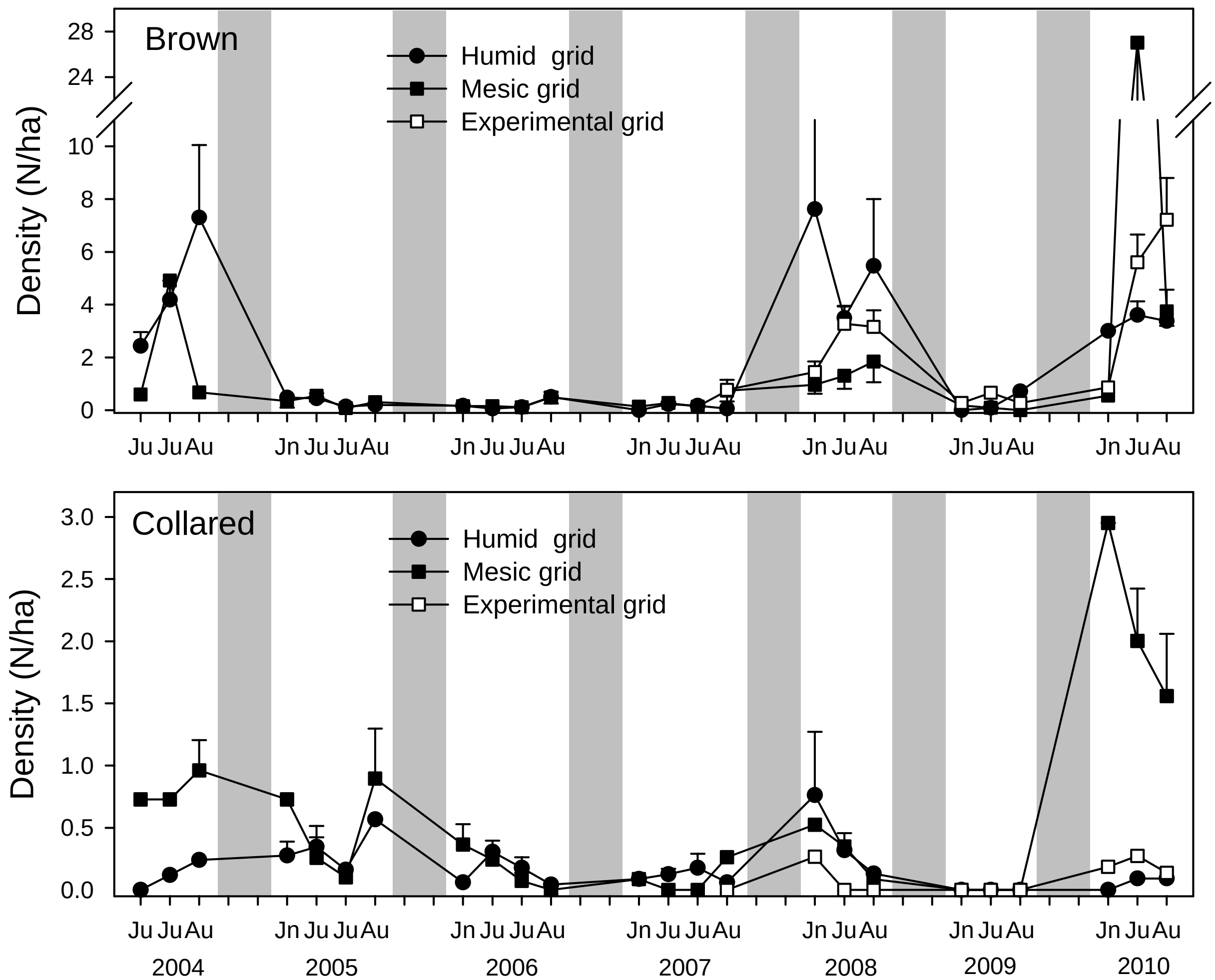

Figure 6. Summer density of Brown and Collared Lemmings on 3 trapping grids located in the Qarlikturvik Valley of Bylot Island (snow cover was increased on the experimental gid). The gray area indicates winter. Jn = mid June, Ju = July (early and late for 2004-2007; mid-July since 2008), Au = mid-August.

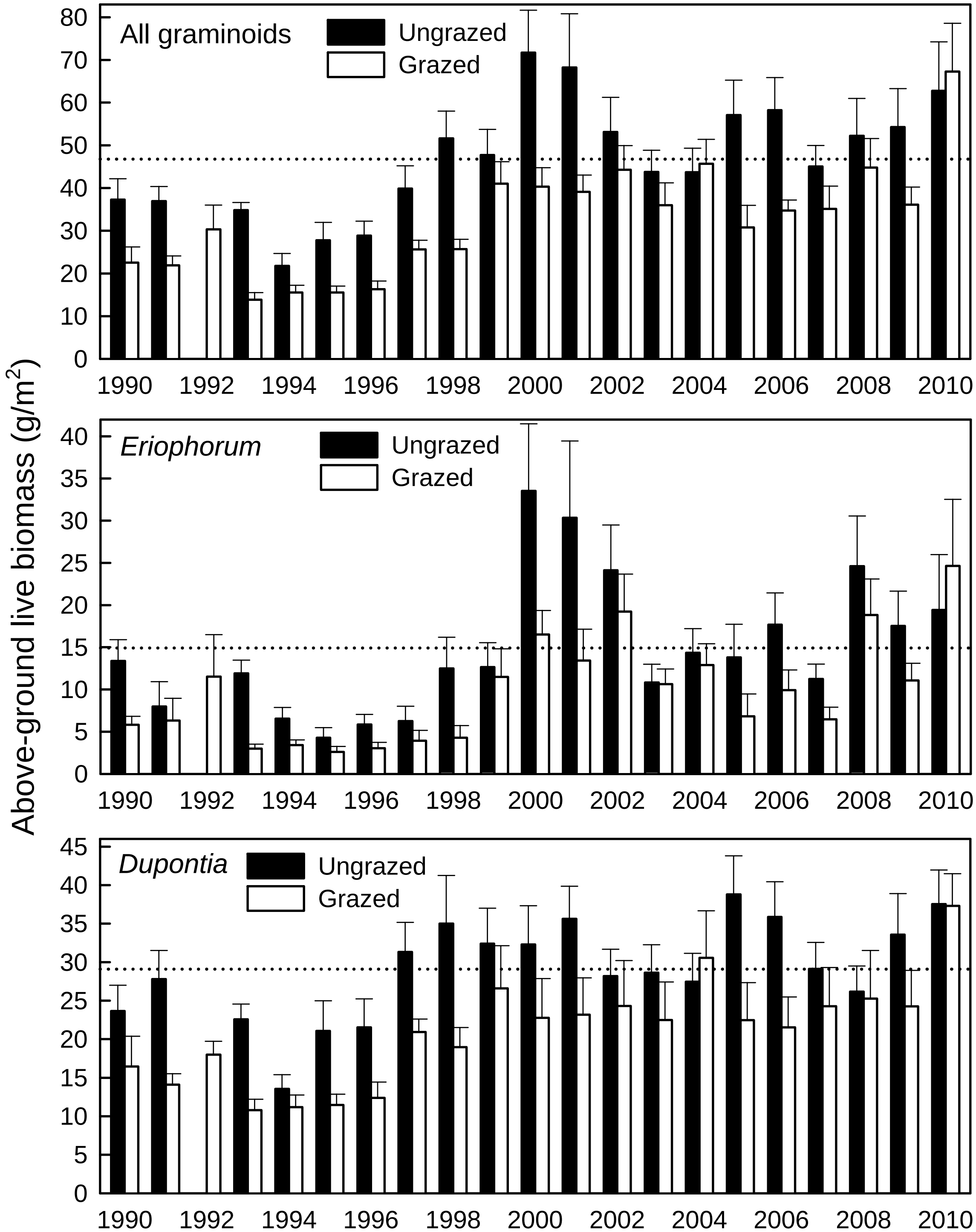

Figure 7. Live above-ground biomass (mean + SE, dry mass) of graminoids on 14 August in grazed and ungrazed wet meadows of the Qarlikturvik Valley, Bylot Island (*n* = 12). Total graminoids include *Eriophorum scheuchzeri*, *Dupontia fisheri* and *Carex aquatilis*. There is no data from ungrazed area in 1992. The dashed line is the long-term average for ungrazed area.

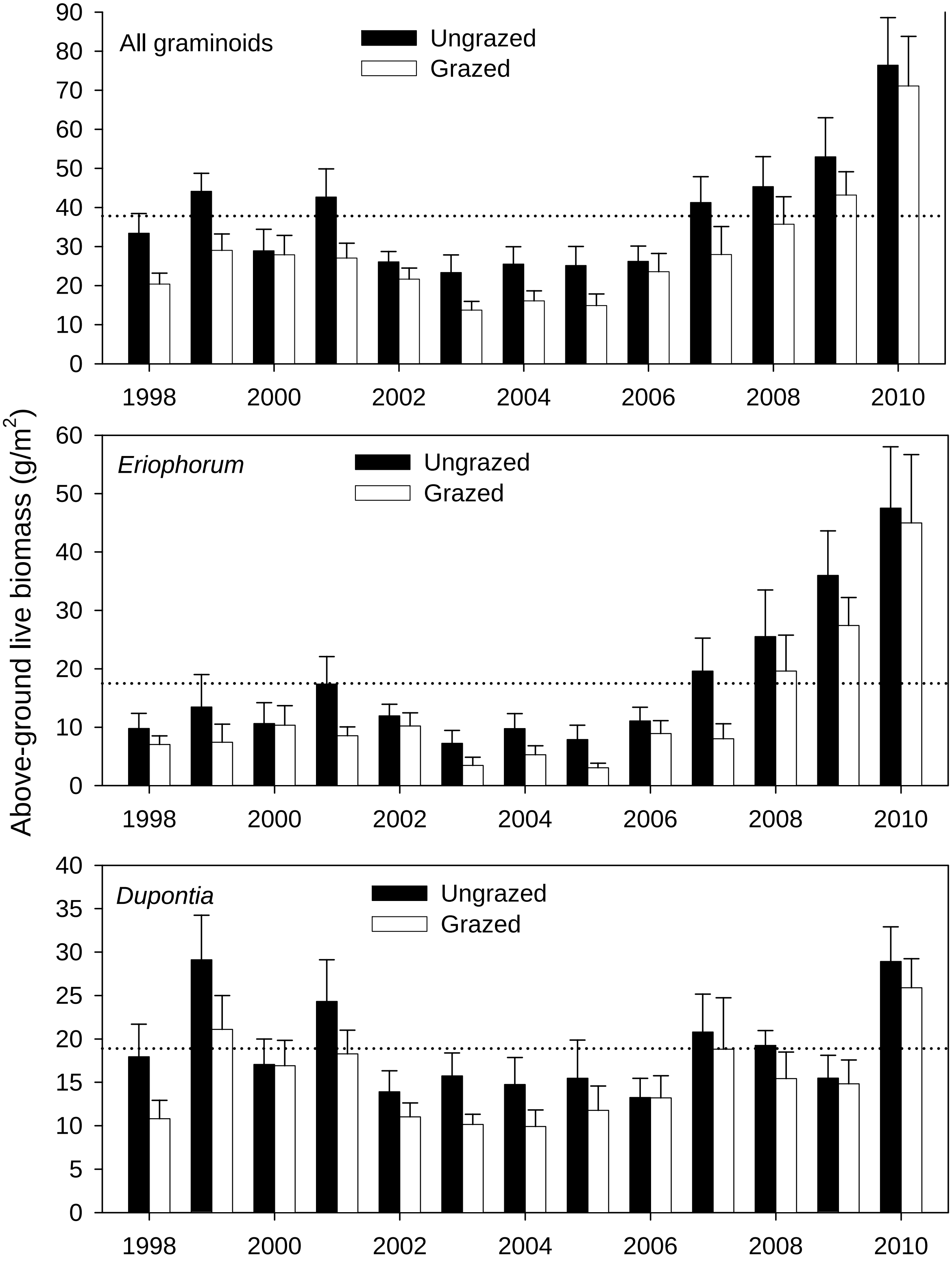

Figure 8. Live above-ground biomass (mean + SE, dry mass) of graminoids on 12 August in grazed and ungrazed wet meadows of the Camp-2 (goose colony), Bylot Island (n = 12, except in 2008 where n = 8). Total graminoids include *Eriophorum scheuchzeri*, *Dupontia fisheri* and *Carex aquatilis*. The dashed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

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