MONITORING THE ENVIRONMENTAL AND ECOLOGICAL IMPACTS OF CLIMATE CHANGE ON BYLOT ISLAND, SIRMILIK NATIONAL PARK

2004-2005 ANNUAL PROGRESS REPORT

by

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INTRODUCTION

Global climatic change caused in part by the greenhouse gases released due to human activities is a major challenge faced by the earth ecosystems in this century. However, nowhere else on earth are these effects more threatening than in the Arctic. Indeed, all models predict that warming trends will be strongest in the Polar Regions as Arctic temperatures should increase by as much as 4° to 7°C over the course of the XXIth century (ACIA 2004). Precipitation is also expected to increase from 10 to 20%, as well as daily and seasonal variability in both temperature and precipitation, leading to more frequent climatic extremes. Recent analyses indicate that temperatures in the Arctic have been increasing steadily for the last three decades, and the extent and thickness of sea ice has been reduced considerably (Moritz et al. 2002, ACIA 2004).

Several long-term studies in different parts of the globe have detected ecological changes due to climate warming, such as alterations in geographical and breeding ranges, flowering dates, breeding dates, and migration schedules (reviewed by McCarty 2001, ACIA 2004, Berteaux et al. 2004). Impacts of climatic changes on arctic ecosystems are expected to be particularly strong because community structure is increasingly dominated by abiotic factors as we move closer to the poles and the climate becomes harsher (Hansell et al. 1998). Disruption of close ecological linkages, such as trophic interactions among plants-herbivores and herbivores-predators, will affect a significant proportion of the species assemblages in these depauperate communities (Gauthier et al. 2004). Thus, the simple ecological communities of the arctic may be at great risk.

Yet, evidences of these changes and of their impacts on biological communities are still scarce in the Arctic, mainly because few sites have adequate long-term data sets to address these questions. Our ongoing, long-term ecological research program on Bylot Island, Sirmilik National Park, Nunavut has been running for 16 years and has become one of the longest, most comprehensive, and rigorous long-term biological monitoring program in Nunavut. We have been monitoring the abundance and reproduction of several key species of birds, mammals, and plants. In addition, we have been continuously recording the most significant climatic variables through a network of automated weather stations. Hence, this program offers an exceptional opportunity to fill important knowledge gaps on climate/ecosystem status and may help to improve future ecological monitoring programs at other sites in the Arctic.

OBJECTIVES

The overall aim of our project is to measure changes occurring in Arctic ecosystems, analyse temporal trends, and evaluate to what extent these changes are driven by climate warming. This is achieved by continuing and expanding for the period 2004-2008 the climatic and ecological monitoring already in place on Bylot Island, and involving local communities into our research activities. Our specific objectives are as follows:

1) Expand the climate monitoring of Bylot Island and examine temporal trends.
2) Continue the monitoring of breeding activities of some bird populations and expand it to other species.
3) Expand the monitoring of lemming populations.
4) Continue the monitoring of the breeding activities of Arctic and Red Foxes.
5) Continue the monitoring of plant production in wetland communities.
6) Develop an Inuit Knowledge Component to our monitoring program in order to get a more complete understanding of the ecosystem and of the ecological impacts of climate change.
7) Hold an annual community workshop in Pond Inlet to discuss the project findings and future work.
8) Present study results to high school students in Pond Inlet.
9) Hire and train individuals from local communities.

METHODS

STUDY AREA

All field work is conducted on the south plain of Bylot Island at the northern tip of Baffin Island (Fig. 1). The island is a Migratory Bird Sanctuary and is also included in the Sirmillik National Park. Our activities are conducted primarily at 2 sites on the island, the Qarlikturvik Valley (73° 08' N; 80° 00' W) and the main goose nesting colony (72° 53' N, 79° 55' W; Fig. 1). At both sites, lowlands are covered by a mixture of wetlands and mesic tundra, and uplands are largely dominated by mesic tundra (Gagnon et al. 2004).

CLIMATIC DATA

We have 7 automated environmental monitoring stations at our study site. Our network includes 3 full climatic stations that record data on an hourly basis, year-round. One is in operation since 1994 (elevation: 20 m ASL), another one since 2001 (340m ASL) and the most recent one since 2004 (21 m ASL). The 2 oldest stations are 3-m high towers that record air temperature and humidity (at 2 m), soil temperature (at 2, 5 and 10 cm), wind speed and direction (at 3 m), direct solar radiation, and snow depth. The newest one is a 10-m meteorological tower that hosts more recording instruments and over a greater height range above the ground. In compliance with recognized standards, we record air temperature (at 5 m), wind speed and direction (at 10 m), full solar radiation (i.e. far infrared, photosynthetic active radiation, albedo, and net solar radiation; UV-B radiation to be added 2005), barometric pressure, soil temperature (at 5 and 10 cm; 2 sites each), snow depth and air humidity. A fourth station monitors ground surface temperature (at 2 cm) at 5 paired sites (each pair has a site protected from goose grazing by an exclosure and a nearby site exposed to grazing). Finally, 3 additional stations record permafrost temperature at various depths down to 3 m (2 sites) or 11 m (1 site). All automated stations were visited during the summer 2004 to download data and were found to be operating normally. A few damaged sensors (especially those recording ground temperatures) were replaced.

Daily precipitation is recorded manually during the summer (1 June to 20 August) using a pluviometer. Snowmelt is monitored from 1 June until snow disappearance using 2 methods: 1) by measuring snow depth at 50 stations along two 250-m transects at 2-day intervals, and 2) by visually estimating the proportion of snow cover on the study area every 2-3 days.

BIOLOGICAL DATA

Birds

Greater Snow Geese.— We monitor the reproduction of Greater Snow Geese (*Chen caerulescens atlantica*) annually on Bylot Island since 1989. Goose nests are searched extensively in the Qarlikturvik Valley and at the main goose nesting colony where several thousands geese nest every year. All nests monitored are positioned with a GPS receiver. Each nest, are visited several times during the nesting period. On every visit we determine the number of eggs and/or goslings (dead or alive) and from these data we are able to determine the following parameters: total clutch laid (total number of egg laid by the female during nesting), clutch size at hatch, number of goslings leaving nest, laying and hatching dates, and nesting success.

Snowy Owls and Lapland Longspurs.— We also monitor the reproduction of Snowy Owls (*Nyctea scandiaca*) and Lapland Longspurs (*Calcarius lapponicus*) since 1993. Every year, we search systematically for owl nests in our two study areas (Qarlikturvik Valley and the main goose nesting colony). Longspur nests are found in the Qarlikturvik Valley only while walking throughout the study area for other activities since 1995, often when females are flushed from their nest. The position of all nests found is recorded with a GPS receiver and nests are revisited periodically to determine their fate. For both Snowy Owl and Lapland Longspur nests, we determine laying and hatching dates, total clutch laid, and nesting success.

Other bird species.— Our monitoring of bird populations has expanded over the years and information on the reproductive activity of other bird species is also collected opportunistically. These species include mainly jaegers (*Stercorarius* spp.), Glaucous Gull (*Larus hyperboreus*), Sandhill Crane (*Grus canadensis*), King Eiders (*Somateria spectabilis*) and Long-tailed Ducks (*Clangula hyemalis*). Starting in 2004, more systematic data collection was initiated on gulls and jaegers, and more species will be added in 2005 (especially shorebirds).

Mammals

Lemmings.— We monitor the populations of Collared (*Dicrostonyx groenlandicus*) and Brown Lemmings (*Lemmus sibiricus*) using 2 techniques: deadly trapping, which has been conducted at two sites since 1994, and live trapping, a new sampling program that we developed in 2004. The deadly trapping monitoring takes place in July and follows the protocol of the small-mammal survey coordinated across the Northwest Territories and Nunavut by the Northwest Territories Renewable Resources office in Yellowknife (Shank 1993). This trapping is carried out in two study plots of the Qarlikturvik Valley (one in wetlands, one in mesic tundra) since 1994, and at a third study plot in mixed wetland/mesic tundra at the main goose nesting colony since 1997. We use Museum Special® traps baited with peanut butter and rolled oats. At each site, we use 50 traps set at 10-m intervals along two parallel transect lines 100 m apart (25 traps/transect) and left open for a period of 10 or 11 days for a total of ~500 trap-nights (50 traps × 10 nights) per plot. Traps are checked daily; all lemmings caught are identified at the species and sprung traps are reset.

Our new sampling program based on live-trapping of lemmings uses 2 grids (300 × 300 m) laid out in the Qarlikturvik Valley (one in wetlands and one in mesic tundra), each with 100 Longworth® traps baited with apples and set at each grid intersection every 30-m. In 2004, we trapped during 5 consecutive days every 20 days on each grid from early July to mid-August. All trapped animals were identified, sexed, weighed and marked with electronic PIT tags (or checked for the presence of such tags).

***Arctic and Red Foxes*.—** We monitor the breeding activity of Arctic (*Alopex lagopus*) and Red Foxes (*Vulpes vulpes*) at dens annually since 1993. Until 2002, den monitoring only occurred in the Qarlikturvik Valley and the vicinity of the main goose nesting colony (about 100 km^2). Dens were found opportunistically and their position recorded with a GPS receiver. The number of dens found thus gradually increased from 1993 to 2002. In 2003, we expanded the covered area to about 600 km^2 by conducting a systematic survey of fox dens, which considerably increased the number of known dens. All dens are visited at least once or more in June or early July and any signs of fox activity is noted (e.g. fresh digging, new hairs, fresh prey). Dens showing signs of activity are re-visited later in the summer to determine the presence of a litter and the number of pups in each litter. Litter size data are the minimum number of pups observed at dens, which may sometimes be lower than the true number of pups present. All observations of adults near dens are also noted, and the species of fox identified.

Plant monitoring

***Annual exclosures*.—** We monitor the annual plant production in wetlands and the impact of goose grazing at 3 sites on Bylot Island (see Fig. 1): the Qarlikturvik Valley (monitored since 1990), the main goose nesting colony (monitored since 1998), and north of Pointe Dufour (monitored since 1998). At each site, 12 exclosures (1 × 1 m fenced areas built with chicken wire to keep geese off the plots) are installed in late June. At the end of the plant-growing season (i.e.

mid-August), we sample the vegetation inside and outside the exclosures (i.e. ungrazed and grazed areas, respectively). All live above-ground plant biomass is cut, sorted out into sedges (*Eriophorum scheuchzeri* or *Carex aquatilis*), grasses (mostly *Dupontia fisheri*), and forbs, dried, and weighed. Above-ground biomass of vascular plants includes all green material and white basal stems buried in mosses. Live above-ground biomass in mid-August is a good measure of annual graminoid production (Gauthier et al. 1995).

Long-term exclosures.— We installed 18 permanent goose exclosures (4 × 4 m) in polygon fens in spring 1994. Within each exclosure, a 2 × 2 m area located in one corner was further protected from lemming grazing in late summer 1995 using a welded wire fence 60 cm high and buried 15 cm into the ground. No signs of goose or lemming activity (i.e. grazing and/or feces) were observed in areas where each species had been permanently excluded. During the first 5 years after goose exclusion (i.e. 1994 to 1998), we sampled vascular plants annually in the exclosure section where only geese were excluded using the same method as for annual exclosures. We also sampled mosses by cutting mosses turf above the root system of vascular plants; we then separated into brown and green portions, dried, and weighed the material. We defined above-ground biomass (standing crop) of mosses as the loose individual stems of mosses above the network of roots, rhizomes and rhizoids of the organic turf. In 2004, we repeated the sampling using the same method in both the area where geese only had been excluded (after 11 years of goose exclusion) and the area where both geese and lemmings had been excluded (after 9 years of lemming exclusion).

INUIT TRADITIONAL ECOLOGICAL KNOWLEDGE

In fall 2004, we initiated an Inuit Traditional Ecological Knowledge (TEK) study. We want to integrate TEK with Western science to develop a more complete understanding of arctic ecosystems and of the ecological impacts of climate change on Bylot Island and in the North Baffin Island area. Inuit TEK will be gathered in the communities of Pond Inlet and Arctic Bay and will be used at two levels: first, at a specific level, TEK will help us to document long-term trends in abundance and distribution of some key wildlife species (e.g. geese and fox species), and relate these changes to long-term climatic data; second, at a more general level, TEK will be used to understand the past and current status of ecosystems in the North Baffin area, to identify key ecosystem processes, and to document long term environmental change that have been observed by Inuit.

A first part of the project was to prepare an inventory of TEK available on similar topics in the area. This was completed in fall and winter and included a visit to several agencies in Iqaluit and Igloolik from 17 to 23 October 2004 to collect this information. In a second part, Vicki Sahanatien and Catherine Gagnon organized two workshops with 16 Elders of Pond Inlet as well as with representatives for the Sirmilik Joint Park Management Committee to inform the community about the project as well as to receive advices, recommendations, and approval for the project. These workshops were held on the 26 and 28 February 2005 at the Nattinak Center of Pond Inlet.

PRESENTATIONS AND COMMUNITY WORKSHOP

We organized a full day workshop on ecological monitoring on Bylot Island with representatives from the community of Pond Inlet on 1 March 2005. Invited representatives were from the Joint Park Management Committee (Pond Inlet and Arctic Bay members), the Hamlet of Pond Inlet, the Mittimatalik Hunters and Trappers Organization (HTO), the Government of Nunavut, the Nattinak Center of Pond Inlet, the Elders of Pond Inlet, and the RCMP. The workshop was co-organized by Gilles Gauthier and Vicki Sahanatien and held at the conference room of the Nunavut Government building, Pond Inlet. Two researchers (Gilles Gauthier and Michel Allard) and one student (Catherine Gagnon) from southern universities attended the meeting. The workshop was followed by an evening public consultation at the Nattinak Center, Pond Inlet, where everybody from the community was invited to attend. Simultaneous Inuktitut/English translation was available during the workshop. On the following day (2 March), Gilles Gauthier and Michel Allard gave talks to the students of the Pond Inlet High School. The school principal, M. Dave Parkes, organized the schedule of these talks.

Several other outreach activities also took place during the year. On 29 June 2004, Gilles Gauthier gave a public conference at the Parks Canada building in Pond Inlet to officially launch our new web site (http://www.cen.ulaval.ca/bylot/) on environmental monitoring on Bylot Island. On 27 July 2004, Dominique Berteaux also gave a public conference at the Government of Canada Building in Iqaluit on Arctic and Red Fox ecology. Finally, on 4 March, Gilles Gauthier and Michel Allard also gave public conference at the Government of Canada Building in Iqaluit on ecological monitoring on Bylot Island (GG) and on the fossil forest and geomorphological studies on Bylot Island (MA).

RESULTS

CLIMATIC DATA

The data retrieved from our automated environmental stations in 2004 spanned the period from summer 2003 to summer 2004. All data were compiled, validated (e.g. missing or erroneous values were excluded), and archived. We present here an overview of the most important climatic variables during the last year, and an update of the long-term trends.

Air Temperature

The year 2003 (the last year for which we have a complete record) was the second warmest year of the past 9 years on Bylot Island (mean annual temperature: -13.6°C, which is 0.8°C above the long-term average). However, there is no detectable trend yet in annual air temperature (Fig. 2). Summer and fall 2003 temperatures were near average but winter 2003-2004 and spring 2004 were below average. There was no trend observed in temperature for any of the seasons at Bylot Island (Fig. 3). The number of thawing degree-days was near long-term average in 2003-2004, both on an annual and seasonal basis (Fig. 4).

Snow cover and precipitations

The snow pack in spring 2004 was relatively thin with an average snow depth of 22.0 cm on 1 June compared to a long-term average of 31.3 cm. Snow depth varied greatly among years, but no trends were detected (Fig. 5). The percentage of snow cover recorded in the lowlands of the Qarlikturvik Valley on 5 June was 55%, slightly lower than the long-term average. Snow cover varied similarly to snow depth, with no evidence of a temporal trend (Fig. 6). Despite the thin snow pack, snow-melt was relatively slow this year, likely due to a cool spring as noted above (Fig. 7). Again, there were large inter-annual differences in the speed of snowmelt, and no temporal trend was found.

The summer 2004 was the wettest on record on Bylot Island, with 142 mm of rainfall compared to a long-term average of 94 mm. We found no evidence of temporal trends in summer rainfall but there was a weak decreasing trend in rainfall for the month of June and an increasing trend for the month of July (Fig. 8). Average June rainfall decreased by 22.3 mm over 10 years while July rainfall increased by 30.0 mm over the same period.

Wind speed

Mean annual wind speed in 2003 was 2.0 m s^{-1} on Bylot Island, which was near the long-term average (Fig. 9). Summer 2003 and spring 2004 wind speed were near average but fall 2003 and winter 2003-2004 were below average (Fig. 10). We found no detectable trends in wind speed either on an annual or seasonal basis.

BIOLOGICAL DATA

Birds

Greater Snow Geese.— Overall, the median date that the first egg was laid in goose nests (i.e. egg-laying date) in 2004 was 11 June, which is close to the long-term average (12 June). A high proportion of geese nested in association with Snowy Owls, which showed a massive reproduction this year (see below). This led to an unusually high spatial variation in laying dates, as geese nesting in association with owls started laying on average on 10 June (n = 511) whereas those nesting away from owls started laying around 16 June (n = 132). There was thus a bi-modal distribution of laying dates this year, with a smaller late peak. Mean egg-laying date showed relatively large inter-annual variations (from 6 to 20 June but analyses revealed no temporal trend in egg-laying dates; Fig. 11A). However, it should be noted that in the 4 years following the instauration of a spring hunt for geese in Québec (1999), egg-laying dates were all late or very late. The spring hunt disrupted the accumulation of fat by geese in spring, and this had a negative impact on subsequent reproduction (reduced reproductive effort and delayed phenology; Mainguy et al. 2002, Bêty et al. 2003, Féret et al. 2003, Reed et al. 2004).

Because incubation has a set time length in birds (23-24 days in snow geese), egg hatching dates followed annual trends similar to laying dates. In 2004, hatching date was 7 July (n = 437), 2 days earlier than the long-term average (9 July). There was no detectable long-term trend in hatching date (Fig. 11B).

The mean number of eggs per nest (i.e. total clutch laid) was 3.65 ± 0.05 eggs (n = 621) in 2004, very close to the long-term average (3.70; Fig. 12). Clutch size was higher in nests located near owls (3.74, n = 490) than far away (3.30, n = 125). We did not find any temporal trends in clutch size.

Nesting success (proportion of nests hatching at least one egg) in 2004 was fairly good (78%, n = 638) and above the long-term average (64%; Fig. 13). Nesting success was higher in the Qarlikturvik Valley (92%, n = 158) than at the main goose nesting colony (74%, n = 480). We did not find any temporal trends in nesting success.

Snowy Owls and Lapland Longspurs.— Snowy Owls only nest in peak lemming years, which occur every 3-4 years on Bylot Island (see below). After 3 years of nesting absence, owls were nesting again in 2004. Their reproductive effort was an all time high with 13 nests in the Qarlikturvik Valley and 9 at the goose colony (Table 1). The number of owls nesting at the goose colony was exceptional compared to previous lemming peaks when only 1 or 2 nested there. Mean laying and hatching dates of owls in 2004 were 18 May and 19 June (n = 17), respectively, which is slightly earlier than the long-term average (21 May and 22 June). The mean clutch size was 7.1 eggs ± 0.4 (n = 20), close to the long-term average (7.3 eggs). Nesting success in 2004 was good (95%, n = 21) and higher than their last nesting year in 2000 (85%, n = 13). The intermittent nesting of owl precluded the examination of temporal trend in the data.

In 2004, we found a record number of Lapland Longspur nests (27, Table 1). Large annual variations in number of nests found in part reflect variations in sampling effort among years. Egg-laying and hatching dates of longspurs in 2004 were the latest on record: 24 June (n = 8; long-term average: 18 June) and 9 July (n = 8; long-term average: 3 July), respectively. No temporal trends were detected for both laying and hatching dates. The clutch size was 5.2 ± 0.2 eggs (n = 26), slightly below the long-term average (5.4; Table 1) and no temporal trend was detected. Nesting success was good (75%, n = 20) and above the long-term average (59%).

Other bird species.— In 2004, we found 17 nests of jaegers in the Qarlikturvik Valley and 6 at the goose colony, and 5 nests of gulls at each study site (Table 1). Mean egg laying dates of jaeger nests 15 June and mean hatching date 10 July. Mean clutch size was 1.8 ± 0.1 eggs in jaegers and 2.3 ± 0.2 in gulls. The expansion of our monitoring program to these species in 2004 does not allow comparison with previous years. We also found 2 nests of Sandhill Cranes, 4 of King Eiders and 2 of Long-tailed Ducks (Table 1).

Mammals

Lemmings.— As commonly observed in the Arctic, lemming populations have been going through marked cycles of abundance on Bylot Island. Our longest record in the Qarlikturvik Valley indicated that cycles lasted 3 to 4 years, with peak abundance occurring in 1993, 1996 and 2000 (Fig. 14). Trapping conducted at the main goose colony suggested that the two sites generally fluctuated in synchrony except for the last population peak which occurred a year later than in the Qarlikturvik Valley (2001 vs. 2000, respectively; Fig. 14). After 2 to 3 years of low numbers, we expected that 2004 would be a peak in the lemming cycle. Although lemming increased over last year, their abundance, as indicated by our trapping index, appeared much lower than in previous peak years.

The abundance of the two lemming species differed between the two sites as Brown Lemmings were higher than Collared Lemmings in the Qarlikturvik Valley but both were equally abundant at the goose colony in 2004 (Fig. 15). In the Qarlikturvik Valley, the site with the highest density of wetlands, Brown Lemmings have always been more abundant than Collared, whereas at the main goose colony, where mesic tundra is most abundant, the reverse was true, except during the 2001 lemming peak. The large annual fluctuations in lemming abundance precluded the examination of long-term trend in abundance.

Our new live-trapping monitoring program for lemming populations was very successful in its first year, with a total of 165 different lemmings trapped, of which 101 were recaptured more than once (Table 2). We captured 83 Brown Lemmings and no Collared Lemmings in wetlands, and 55 Brown Lemmings and 27 Collared Lemmings in mesic tundra. A graduate student is currently developing capture-recapture models to use these data to estimate seasonal population abundance and survival rate of individuals.

Arctic and Red Foxes.— In 2004, we visited 114 dens during the summer and we detected signs of activity (fresh digging and/or footprints) at 50 of them. The breeding activity of foxes was high as we found 16 litters (15% of known denning sites with a different litter), 15 of Arctic Foxes and 1 of Red Foxes. This level of use is close to the percentage of fox dens used in previous years of peak lemming abundance (17%; Fig. 16). Minimum litter size varied between 1 and 10 pups for Arctic Foxes (mean of 5.1 pups ± 0.8, n = 15) and was 6 for the single Red Fox. These values are higher than the long-term average litter size (Arctic Fox: was 3.7 pups; Red Fox: 4.7 pups; Table 3). We did not find any temporal trend in either percentage of dens used by each species or litter sizes.

Plant monitoring

Annual exclosures.— Wetland communities on Bylot Island are largely dominated by graminoid plants (i.e. >90 % by sedges and grasses), and thus only these plants are considered here. Among the 3 sites where wetland plants are monitored on Bylot Island, the longest time series comes from the Qarlikturvik Valley, a major brood-rearing site for geese. Above-ground biomass of graminoid plants in the valley reached 43.7 ± 5.6 g m^{-2} in ungrazed areas in mid-August 2004, almost identical to the long-term average (43.4g m^{-2}; Fig. 17). *Dupontia fisheri* accounted for 63 % of the graminoid biomass, i.e. 27.5 ± 3.7 g m^{-2} in ungrazed areas (long-term average: 27.2 g m^{-2}) while *Eriophorum scheuchzeri* represented 33% with a production of 14.4 ± 2.9 g m^{-2} in ungrazed plots (long-term average: 13.9 g m^{-2}).

Wetland plant monitoring at the two other sites (main goose nesting colony and Pointe Dufour) has been conducted since 1998 only. The above-ground biomass of graminoids at the end of the summer was 25.5 ± 4.4 g m^{-2} in ungrazed areas of the main goose nesting colony, which is lower than the long-term average (32.0g m^{-2}; Fig. 15). Graminoid biomass was also dominated by *Dupontia fisheri*, with an annual production of 14.7 ± 3.1 g m^{-2} (i.e. 58% of the total biomass) followed by *Eriophorum scheuchzeri* with 9.8 ± 2.8 g m^{-2} (i.e. 38% of the total biomass) both of which are lower than their long-term average (19.0g m^{-2} and 11.5 g m^{-2}, respectively). Due to shortage of helicopter time and bad weather, we could not sample plants at Dufour Point (another brood-rearing site) this year (Fig. 19). Over the period 1998-2003 when sampling was carried out at the 3 sites, we note that plant production was comparable in the Qarlikturvik Valley and Pointe Dufour (56.0 ± 3.5 and 50.6 ± 4.3 g m^{-2}, respectively) but lower at the main goose colony (33.1 ± 3.5 g m^{-2}).

For the first time, goose grazing in the wet meadows of the Qarlikturvik Valley was undetectable in mid-August 2004 (Fig. 17). In a typical year, geese removed about 34% of the total annual production in those wetlands (39% for *Eriophorum* and 31% for *Dupontia*). At the main colony, a grazing impact was detected with 37% of the graminoid biomass (46% of *Eriophorum* and 33 % of *Dupontia*) removed by geese (Fig. 18). These values are higher than the long-term average (30%, 34% and 26%, respectively). Similar values are not available at Pointe Dufour in 2004 but, on average, geese removed 26% of both *Eriophorum* and *Dupontia* produce there (Fig. 19).

Long-term exclosures.— Long-term exclusion of geese from this ecosystem showed that moderate but chronic goose grazing had an effect on wetland plant communities. After 5 years of goose exclusion, *Eriophorum* biomass was 4.2 times higher than at the beginning, whereas the biomass of *Dupontia* had increased 2.7 times (Fig. 20). During the same period, the biomass in annual exclosures (i.e. treatment 1-year (C) in Fig. 20), which can be used as control for the long-term exclosures, showed a similar increase for *Dupontia* (2.5 times; year 1: 13.6 ± 1.8 g m^{-2}, year 5: 35.0 ± 6.2 g m^{-2}) but only a weak increase for *Eriophorum* (1.9 times; year 1: 6.6 ± 1.3 g m^{-2}, year 5: 12.5 ± 3.7 g m^{-2}). Flower head density of *Eriophorum* also showed different temporal trends in annual and permanent exclosures, but not those of *Dupontia*. Flower head density of *Eriophorum* in permanent exclosures was similar to annual exclosures during the first 3 years of goose exclusion but showed a sudden and marked increase after 4 and 5 years compared to annual exclosures (145.6 ± 50.1 and 102.9 ± 33.4 vs. 4.2 ± 2.8 g m^{-2}, respectively, Fig. 21). Hence, after 5 years of goose exclusion, *Eriophorum* was the dominant plant in exclosures (> 50% of biomass), whereas initially it accounted for only 36% of the biomass.

The differences observed after 5 years tended to disappear after a longer period of goose exclusion, as the biomass of *Eriophorum* had decreased in long-term exclosures after 11 years. At that time, the above-ground biomass of *Eriophorum* was only 1.5 times higher than in annual exclosures (22.5 ± 4.1 vs. 14.4 ± 2.9 g m^{-2}, respectively), whereas there was still no difference for *Dupontia* (Fig. 20). After 9 years of goose and lemming exclusion, biomasses of both *Dupontia* and *Eriophorum* were similar to that in annual exclosure (*Dupontia*: 28.1 ± 4.7 vs. 27.5 ± 3.7 g m^{-2}; *Eriophorum*: 16.7 ± 3.8 vs. 14.4 ± 2.9 g m^{-2}, respectively; Fig. 20). Flower head density of *Eriophorum* also decreased considerably after 11 years of goose exclusion compared to the peak values observed after 4 years, although it was still higher than in the annual exclosure (36.1 ± 17.3 g m^{-2} after 11 years vs. 18.8 ± 12.7 g m^{-2} in control; Fig. 21). After 11 years of goose exclusion, flower head density of *Dupontia* was lower than in the annual exclosure (65.3 ± 22.7 vs. 106.3 ± 25.0 g m^{-2}, respectively) but in that case this was due to an increase in the annual exclosures compared to 6 years ago. After 9 years of goose and lemming exclusion, flower density of *Eriophorum* was similar to annual exclosures but considerably lower for *Dupontia* (29.2 ± 12.8 g m^{-2} after 9 years vs. 106.3 ± 25.0 g m^{-2} in control; Fig. 21).

Exclusion of geese also resulted in an increase of vascular plant litter, which almost doubled after 3 years (Fig. 22). In 2004, vascular plant litter was similar after 11 years of goose exclusion or 9 years of goose and lemming exclusion (23.9 ± 3.7 g m^{-2} vs. 25.9 ± 4.7 g m^{-2}, respectively). These values were lower compared to the period 1996-1998 but were still about 1.3 times higher than initially.

INUIT TRADITIONAL ECOLOGICAL KNOWLEDGE

During the fall, Catherine Gagnon and Vicki Sahanatien visited the following agencies: the Nunavut Research Institute (Iqaluit and Igloolik), the Canadian Wildlife Service (Iqaluit), the Department of Fisheries and Oceans (Iqaluit) and the Nunavut Wildlife Management Board (Iqaluit). They were also able to access the large database of the Igloolik Oral History Project which was helpful in establishing a literature review of existing TEK. This in-depth review was completed by Catherine Gagnon as of 15 February 2005 and two copies of the report were given to the Nunavut Field Unit office of Parks Canada in Iqaluit.

In order to facilitate the workshops held in late February, an agenda and a general abstract of the project were provided to the Elders in both English and Inuktitut, and discussions were simultaneously translated by a hired translator. The purpose of the first workshop was to present the goals of the project and to discuss them with the Elders. During the second meeting, Elders had had time to think about the project; therefore, the focus was on gathering ideas and priorities as well as comments on the best way to proceed, and names of local experts to contact. During this second workshop, each Elder also presented an abridged personal resume: where and when they were born, where they lived and which area they knew best. Information gathered during these workshops helped identifying key informants among the Elders as well as major areas and subjects that Elders would like to see investigated. More importantly, these workshops helped to establish a first contact with key members from the community of Pond Inlet and ensure that concerns and comments were expressed. The project received approval and support from the Elders but concerns about the necessity for the TEK investigator to learn Inuktitut and live with the community were also expressed.

Finally, in order to inform a broader public about our upcoming TEK project, a radio show led by Catherine Gagnon and Vicki Sahanatien was broadcasted over the Pond Inlet community radio on 1 March in the evening, with the assistance of a translator. The radio show presented the project and its main objectives, and an open phone line was made available to allow public discussion over the project at the end. However, no comments were received.

COMMUNITY WORKSHOP

The workshop was highly successful, with 19 participants (14 from northern communities) attending it (the list of participants and their affiliation is given in Appendix 1).

Among invited representatives, only those from the Mittimatalik HTO did not attend. There was 7 presentations (3 by Gilles Gauthier, 2 by Michel Allard, 1 by Vicki Sahanatien and 1 by Catherine Gagnon; see schedule in Appendix 2) supported by visual material (Power Point presentations are available upon request), and considerable time was devoted to questions and discussions with participants. We also presented the recent video produced by the ACIA team entitled *Impact of a warming climate* (AICA 2004). The purpose of the workshop was to inform the community of the ecological monitoring activities currently in place on Bylot Island, review the most recent results, present the proposed monitoring activities in the coming years, and especially seek feedbacks and suggestions on these issues. A table summarizing the current and expanded monitoring on Bylot Island was distributed (see Appendix 3) and used as a basis for the discussions. The feedbacks received were very positive and everybody was supportive of the ecological monitoring in place on Bylot Island. The new web site on ecological monitoring on Bylot Island was also much appreciated. Participants were especially pleased that southern researchers took the time to visit them during the winter and listen to their comments. Participants suggested that Traditional Ecological Knowledge be integrated in our monitoring, a topic that is currently addressed by Catherine Gagnon in our group. The evening consultation with the general public was the only activity that was not successful during the workshop as only 1 person came even though the activity had been well publicised in the community (by posters and on the community radio).

The talks given at the high school were also successful. The whole school was divided into 4 groups, and Michel Allard and Gilles Gauthier met with all of them. They had each prepared a 45-minute talk supported by visual material (Power Point) on environmental studies on Bylot Island, which they repeated 4 times (to 2 groups of Senior High and 2 groups of Junior High). Gilles Gauthier also introduced the web site to the students. Thus, in total, over 80 students attended both presentations. Students and teachers enjoyed the talks and our presentation generated several questions from the students. The teachers were especially enthusiasts about the web site, which could be integrated into the science curriculum. Although time constraint prevented the presentation of the ACIA video *Impact of a warming climate* to the students, a school teacher made a copy of the DVD in order to use it subsequently.

Other talks given by the researchers in Pond Inlet or Iqaluit during the summer or after the workshop were also appreciated and 10 persons or more attended these presentations.

HIRING AND TRAINING OF INDIVIDUALS FROM LOCAL COMMUNITIES

We hired 5 persons from the Pond Inlet community to work with us for various lengths of time (about 2 weeks each) during the summer 2004: James Inootik, Aaron Pitseolak, Ernest Merkosak, David Panipakoocho and Ronnie Qiyuapik. All these people received valuable training in environmental studies while working with us. In addition, two patrol persons from Parks Canada (Terry Kallut and Adam Ferguson) also joined our crew for two weeks to receive a similar training.

PRELIMINARY CONCLUSIONS

So far, few temporal trends were observed in the climatic data collected on Bylot Island over the last decade. Even though 2003 was the second warmest year of the last decade at our site, air temperatures has varied greatly from year to year and no trend were detected either on an annual or seasonal basis. The weak decreasing trend in the spring thawing degree-days (TDD) is entirely due to the extremely high TDD value recorded in 1994, a year with virtually no snow cover during the winter. The absence of temporal trends in air temperatures on Bylot Island is likely related to our short time series (i.e. 11 years) as Gagnon et al. (2004) were able to detect warming trends in the summer, spring and fall temperatures of Pond Inlet and Nanisivik over the past 3 decades. Interestingly, our data suggests some trends in summer precipitation with a decrease in early summer (June) and an increase in mid summer (July). The summer 2004 was very wet, especially the month of July with record rainfall.

In 2004, Snow Geese nested at usual dates, but their reproductive effort was relatively low (i.e. low nesting density). However, many geese benefited from their association with Snowy Owl which enable them to have a high nesting success in spite of the high abundance of nest predators (i.e. foxes and jaegers). The relatively low reproductive effort of geese is somewhat surprising as a low reproductive effort is usually associated with late nesting and reduced clutch size. We suggest 3 factors that may have contributed to the low reproductive effort of geese this year. First, the spring harvest continued in Québec and this may have had a negative impact on the body condition of geese at departure for the Arctic as we reported before (Féret et al. 2003). Second, geese may have encountered severe climatic conditions during the migration as spring temperatures in Northern Québec were cold and the snow-melt was very late this year. This may have delayed their migration and arrival date, or further reduced their condition. Third, despite a relatively thin snow-pack and moderate snow cover in early June, temperatures throughout June were cold and snow-melt was relatively slow. This, in combination with the previous two factors, may have negatively impacted the nesting activity of geese. Geese nesting activities is currently our longest and most detailed data set on Bylot Island. A graduate student (Marie-Hélène Dickey) is currently analysing in details long-term trends in goose reproduction and especially the links with climatic variables. This work should be completed in the coming year.

Our long-term data on lemming abundance show that the population dynamics of the two lemming species found on Bylot Island differ. Indeed, the population of Brown Lemmings has been going through much deeper cycles than the one of Collared Lemmings at our two study sites. During peak years, abundance of Brown Lemmings was almost 10 times higher than Collared Lemmings, but in low years that species was equally scarce (in the Qarlikturvik Valley) or rarer (at the nesting colony) than Collared Lemmings. Although population cycles were much more obvious in Brown than Collared Lemmings, the abundance of both species tended to fluctuate synchronously. However, results from our annual lemming trapping were ambiguous as to whether 2004 was a peak in lemming abundance or not. Two lines of evidence nonetheless suggest that 2004 was a genuine lemming peak and that our trapping underestimated its amplitude. First, we had a very high reproduction of all predators (foxes, owls, jaegers), typical of a high lemming year, and their breeding success was apparently high. Second, we captured many lemmings in our live-trapping (however, given that this trapping was conducted for the first year, we cannot compare our data to previous years). If this interpretation is correct, it remains puzzling why we caught so few lemmings in our snap traps. We offer two explanations. First, trapping in the Qarlikturvik Valley was conducted during a period with several days of heavy rain (e.g. on 30 July we had 27 mm of rain, an all time record for a single day), and this may have negatively affected trapping success. Second, given the record number of predators like owls, it is possible that lemmings suffered from a very high mortality during the summer and that populations were declining rapidly by late July.

The decreasing trend in production of wetland plants observed since 2000 did not continue in 2004. However, the most striking feature of plant production has been a somewhat cyclic fluctuation since 1990, with a low in 1994 and a high in 2000. We do not know the cause of these fluctuations but in coming years we will examine more closely possible links with the climate and grazing pressure. For the first time, our long-term monitoring of vegetation did not detect any impact of goose grazing in wetlands of the Qarlikturvik Valley in a year where goose breeding was not a total failure (though an impact was detected at the main nesting colony). We have no satisfactory explanation for this surprising result. It is possible that broods are slowly changing their habitat use pattern and are abandoning some traditionally used areas. However, this would be surprising given that plant production is still high in those sites. Perhaps more likely, the heavy rain in late summer caused extensive flooding in low-lying areas. This may have hampered our sampling, and encouraged broods to move away from these areas toward upland habitat.

Our long-term experiment on goose exclusion also revealed some surprising results. We had previously reported that *Eriophorum*, the preferred food plant of geese on Bylot Island, benefited from the absence of grazing during the first 5 years of our experiment as its biomass and reproduction were considerably enhanced. However, results obtained in 2004 indicate that this was partly a transient effect that subsided after a longer period of goose exclusion (i.e. 11 years). A possible explanation for that may be that chronic grazing by geese suppresses reproduction in this plant and interferes with the accumulation of belowground reserves (Beaulieu et al. 1996). Once grazing is stopped, plants may need several years to accumulate enough belowground reserves to flower, as tillers of arctic graminoids often require 3 to 5 years of vegetative growth before flowering (Mattheis et al. 1976). This could have contributed to highly synchronous flowering, and a concomitant increase in biomass, a few years after goose grazing was stopped. The absence of any effect in *Dupontia* is probably because this species is grazed less intensively by geese. Excluding lemmings in addition to geese for a period of 9 years had little impact on wetland plants. Hence, lemming grazing appears to have a minimal effect on plants in this community.

Our TEK project had a good start in 2004, including very productive meetings with the community. The discussions that we had with Elders from Pond Inlet allowed us to better define the research priorities and the questions that were of most interest to them. Interviews and actual data gathering with members of the community will start next summer.

Even though funding was awarded for this project when the 2004 field season was well under way, we were able to add new components to our monitoring program on Bylot Island (e.g. more bird species were monitored, live-trapping of lemmings was implemented, and a TEK project was initiated). In 2005, these new monitoring activities will be continued in combination with those that were already in place. Furthermore, other monitoring activities could be implemented (e.g. installing new sensors to record additional climatic parameters, monitoring the breeding activities of shorebirds, monitoring of plants in mesic tundra, etc) pending additional funding.

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Table 1. Data on the reproduction of Snowy Owls, Lapland Longspurs, Jaegers (mostly Long-tailed), Glaucous Gulls, Sandhill Cranes, King Eiders and Long-tailed Ducks on Bylot Island, from 1993 to 2004.

Species		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Snowy Owls	N of nests [a]	12 / 0	0 / 0	0 / 0	7 / 3	0 / 0	0 / 0	0 / 0	12 / 1	0 / 0	0 / 0	0 / 0	13 / 9
	Laying date	21 May	- [b]	-	16 May	-	-	-	29 May	-	-	-	18 May
	Hatching date	22 June	-	-	17 June	-	-	-	30 June	-	-	-	19 June
	Clutch size	7.6	-	-	7.9	-	-	-	6.4	-	-	-	7.1
	Nesting success	-	-	-	-	-	-	-	85%	-	-	-	95%
Lapland Longspurs	N of nests	-	-	23	5	13	18	7	22	18	13	18	27
	Laying date	-	-	16 June	13 June	23 June	13 June	22 June	19 June	16 June	16 June	7 June	24 June
	Hatching date	-	-	1 July	29 June	9 July	30 June	8 June	4 July	2 July	1 July	23 June	9 July
	Clutch size	-	-	5.7	5.2	4.7	5.6	5.3	5.6	5.1	5.8	5.5	5.2
	Nesting success	-	-	75%	-	40%	38%	50%	82%	-	50%	-	75%
Long-tailed Jaegers	N of nests	-	-	-	-	6	3	-	9	9	-	-	17 / 6
	Laying date	-	-	-	-	-	-	-	-	-	-	-	15 June
	Hatching date	-	-	-	-	-	-	-	-	-	-	-	10 July
	Clutch size	-	-	-	-	-	-	-	-	-	-	-	1.8
Glaucous Gull	N of nests	-	-	-	-	3	5	7	5	4	1	-	5 / 5
	Clutch size	-	-	-	-	-	-	-	-	-	-	-	2.3
Sandhill Crane	N of nests	-	-	-	2	1	1	2	3	1	-	1	2 / 0
King Eider	N of nests	-	-	-	-	-	2	2	7	3	1	2	2 / 2
Long-tailed Duck	N of nests	-	-	-	-	-	1	-	5	1	-	-	1 / 1

[a] Qarlikturvik Valley / main goose nesting colony; otherwise, number of nests combines both sites (except for Lapland Longspurs, Qarlikturvik Valley only)
[b] no data available

Table 2. Number of Brown and Collared Lemmings captured and recaptured during the live-trapping program on Bylot Island in 2004.

	Wetlands		Mesic tundra	
Species	Brown Lemming	Collared Lemming	Brown Lemming	Collared Lemming
Number captured	83	0	55	27
Number recaptured[1]	57	0	34	10

[1] number of individual recaptured more than once

Table 3. Average litter size of Arctic and Red Foxes on Bylot Island from 1993 to 2004.

Year	Average litter size	
	Arctic Fox	Red Fox
1993	2.0	-[a]
1994	-	-
1995	-	-
1996	5.6	6.0
1997	5.0	-
1998	2.9	2.0
1999	2.0	4.0
2000	3.2	5.0
2001	3.3	5.0
2002	-	-
2003	4.3	-
2004	5.1	6.0
Long-term average	3.7	4.7

[a] no data available

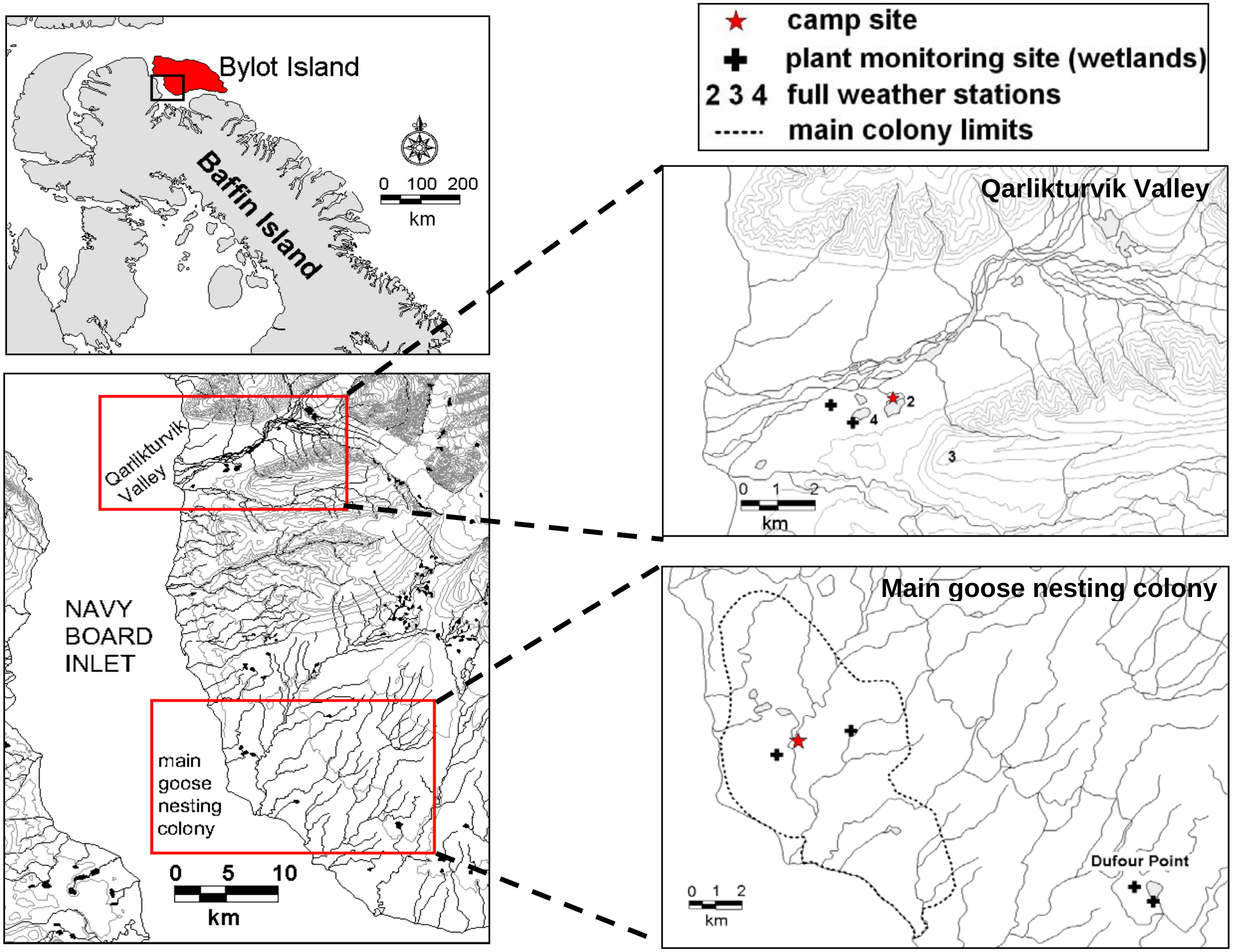

Figure 1. General location of the study area, Bylot Island, Nunavut, and of the two main study sites (Qarlikturvik Valley and the main goose nesting colony) on the South plain of the island. Enlarged maps on the right present these study sites in more details, including camp locations, sampling sites and our three full weather stations.

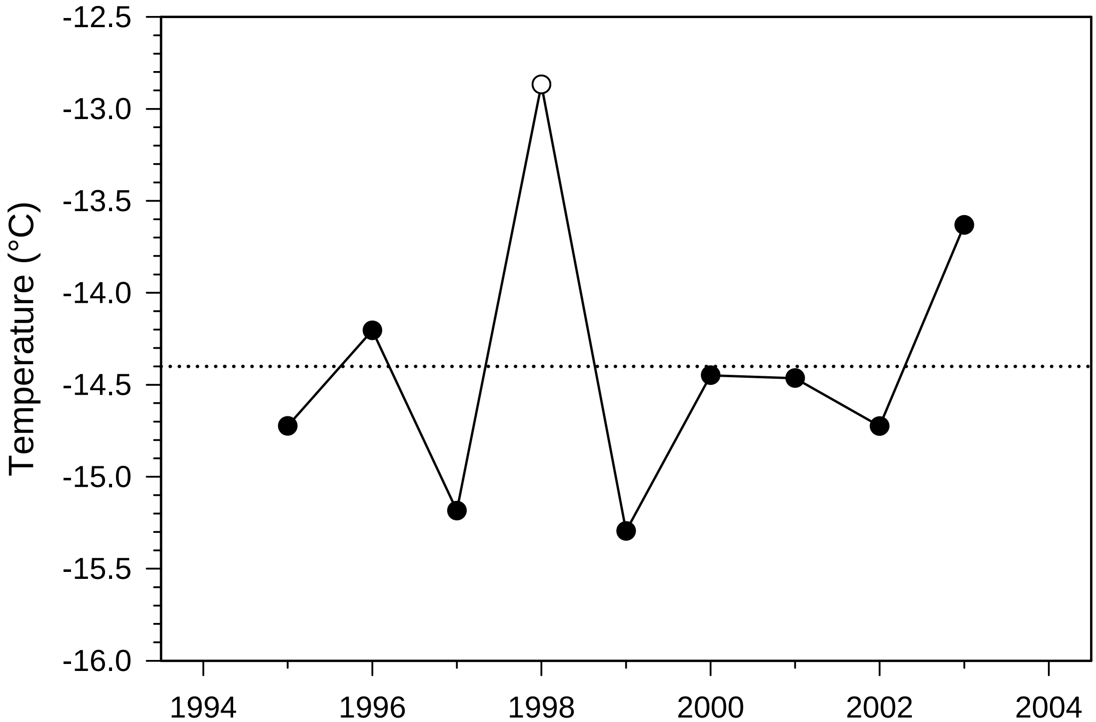

Figure 2. Average annual air temperature in the Qarlikturvik Valley lowlands of Bylot Island from 1995 to 2003. The dotted line shows the mean for the whole period. Air temperature for 1998 is represented by a white circle as it was extrapolated for part of the year from the relation between the air temperatures at Bylot Island and Pond Inlet due to missing values.

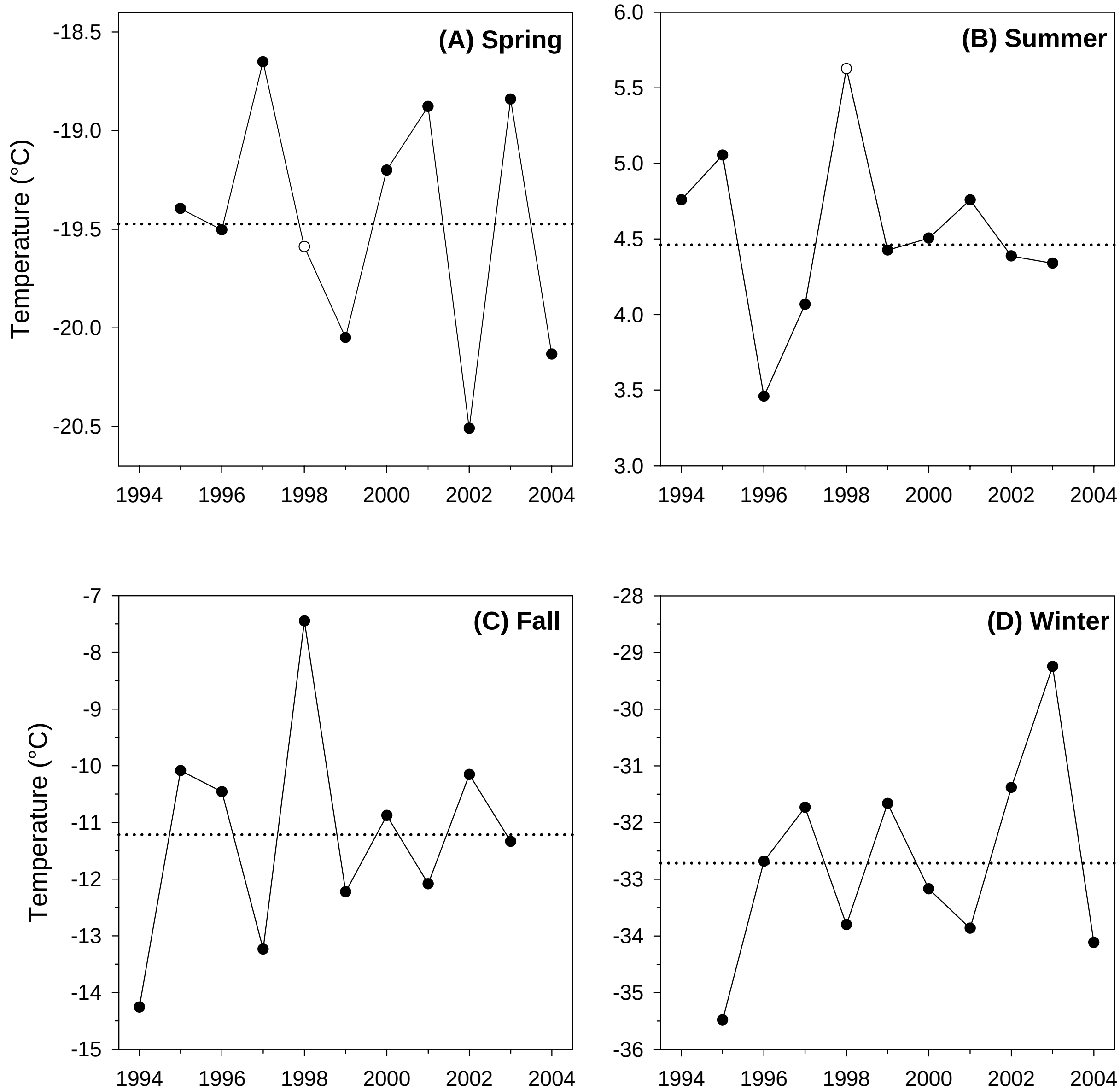

Figure 3. Average air temperature in the Qarlikturvik Valley lowlands of Bylot Island from 1994 to 2004 for (A) spring (March to May), (B) summer (June to August), (C) fall (September to November) and (D) winter (December to February). The dotted line shows the mean for the whole period. Air temperature for the spring and summer 1998 is represented by a white circle as it extrapolated from the relation between the air temperatures at Bylot Island and Pond Inlet.

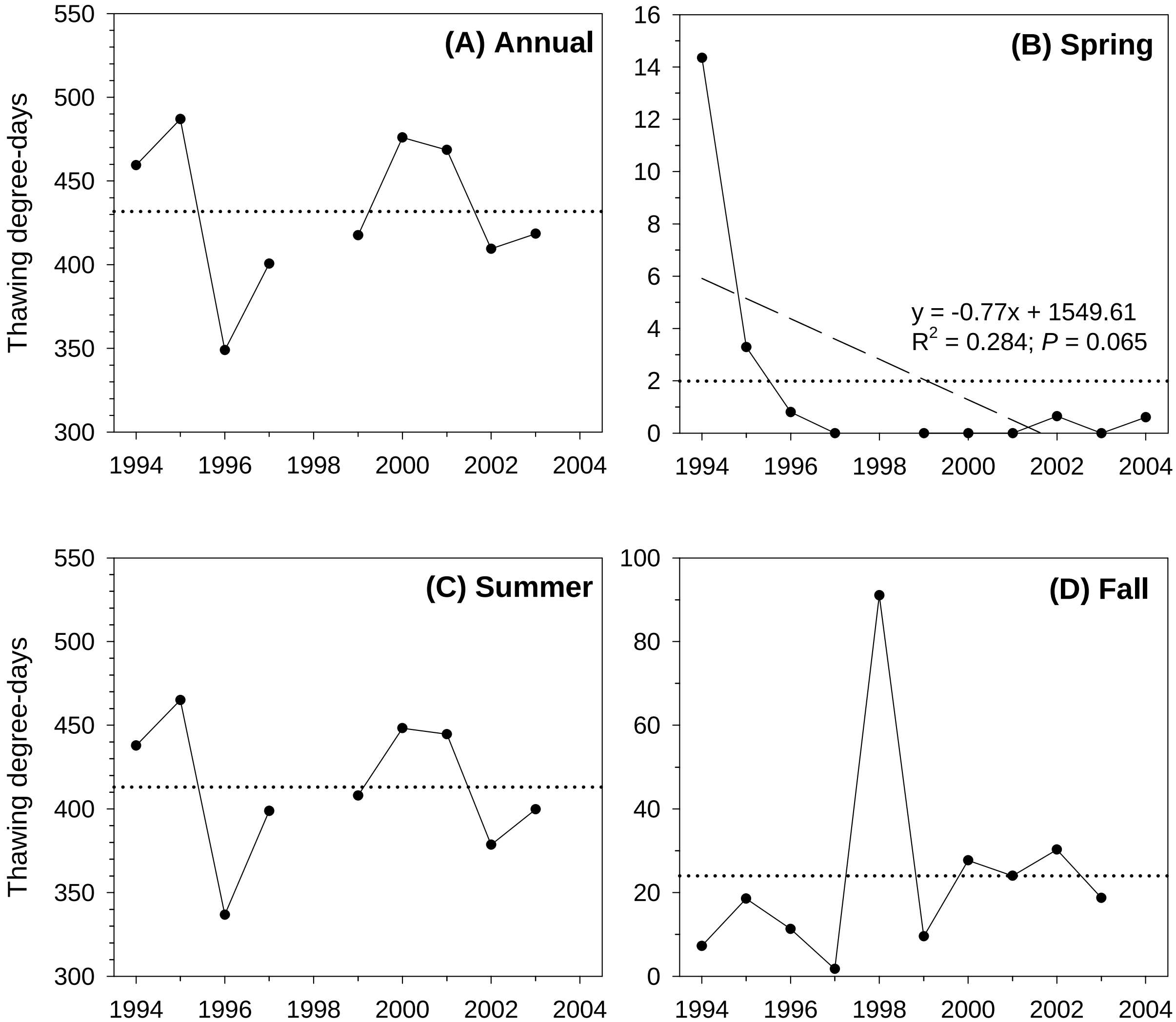

Figure 4. Number of thawing degree-days in the Qarlikturvik Valley lowlands of Bylot Island from 1994 to 2004 for (A) entire year, (B) spring (March to May), (C), summer (June to August) and (D) fall (September to November). Temporal trends are represented by a dashed line when approaching significance (0.05 < *P* < 0.15). The dotted line shows the mean for the whole period.

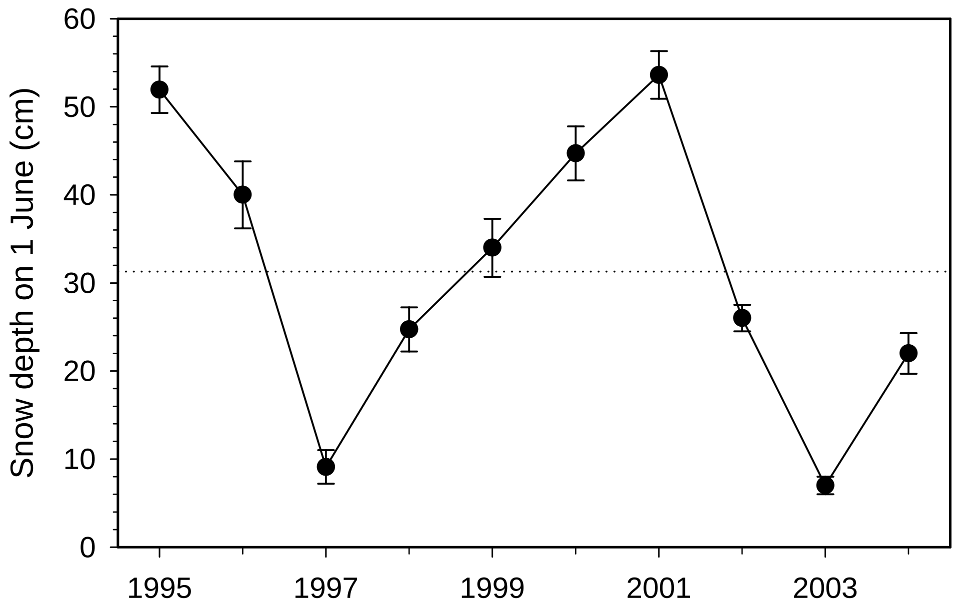

Figure 5. Average snow depth (mean ± SE) on the ground on 1 June in the Qarlikturvik Valley lowlands of Bylot Island from 1995 to 2004. The dotted line shows the mean for the whole period.

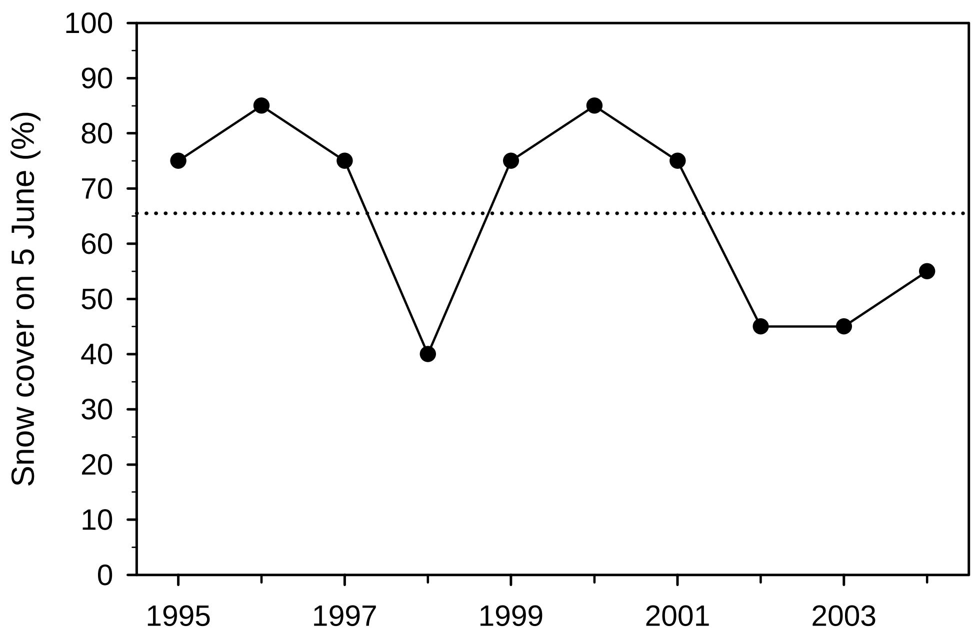

Figure 6. Average percentage of snow cover on the ground on 5 June in the Qarlikturvik Valley lowlands of Bylot Island from 1995 to 2004. The dotted line shows the mean for the whole period.

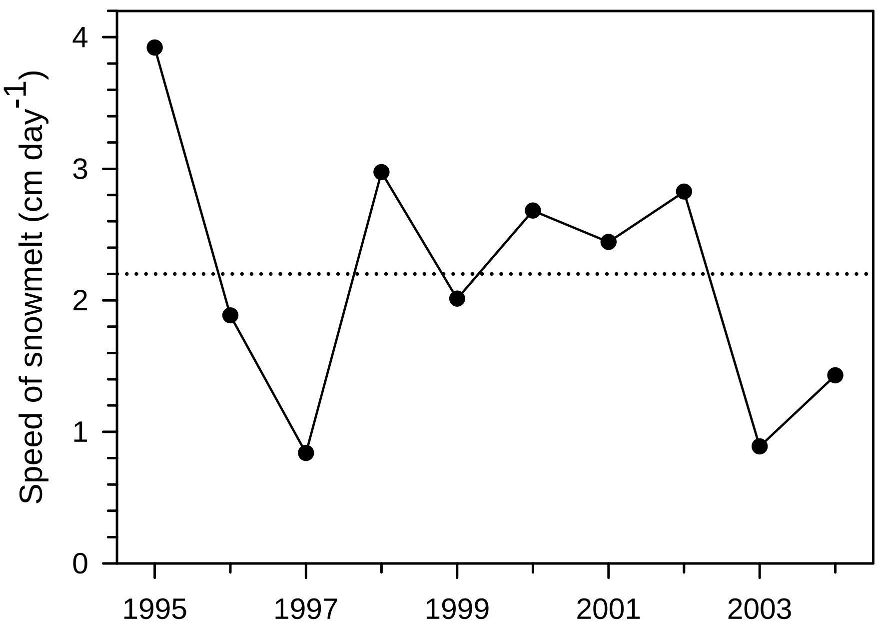

Figure 7. Average speed of snowmelt during the month of June in the Qarlikturvik Valley lowlands of Bylot Island from 1995 to 2004. The dotted line shows the mean for the whole period.

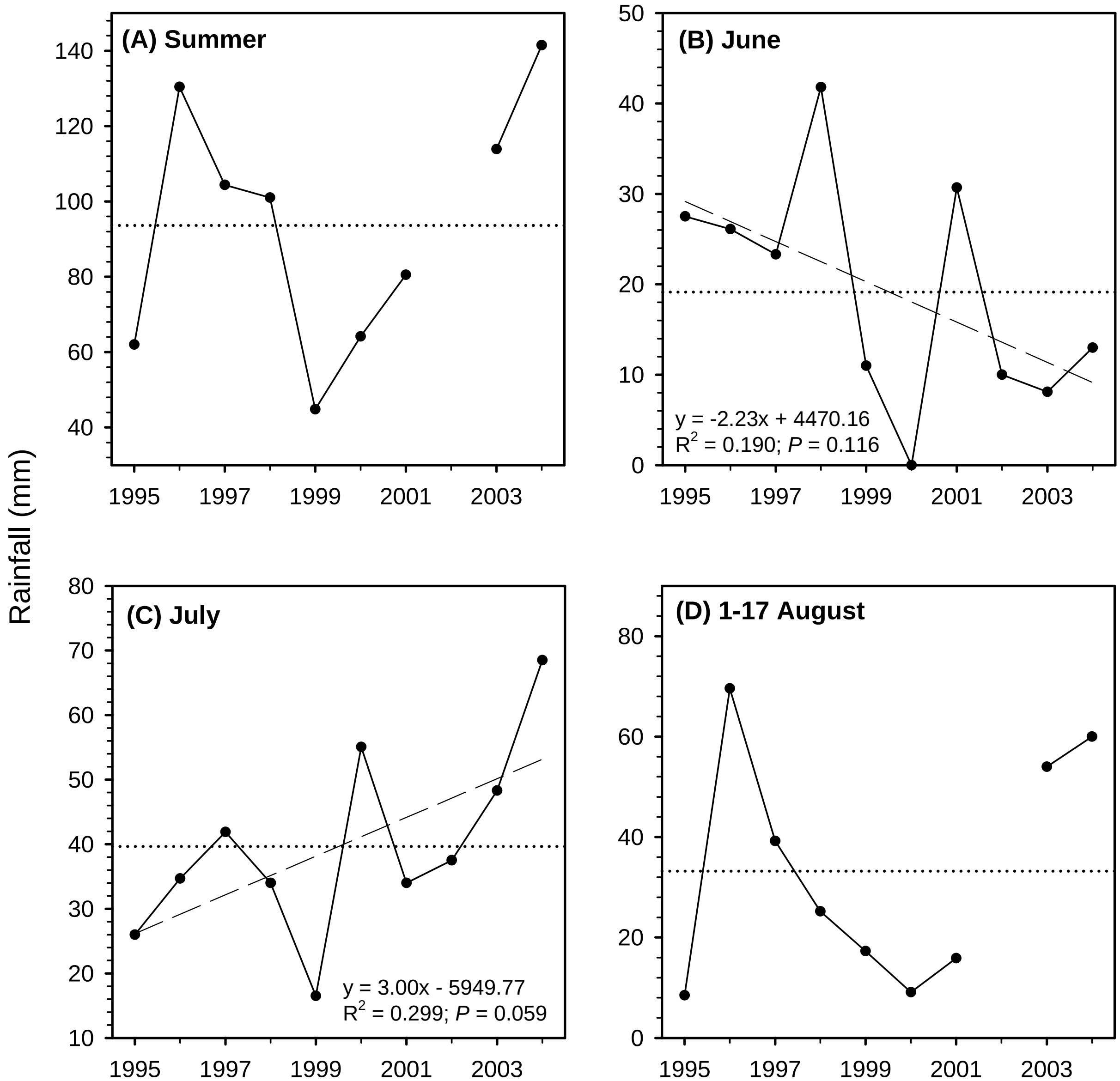

Figure 8. Average summer and monthly rainfall in the Qarlikturvik Valley lowlands of Bylot Island from 1995 to 2004. Temporal trends are represented by a dashed line when approaching significance ($0.05 < P < 0.15$). The dotted line shows the mean for the whole period.

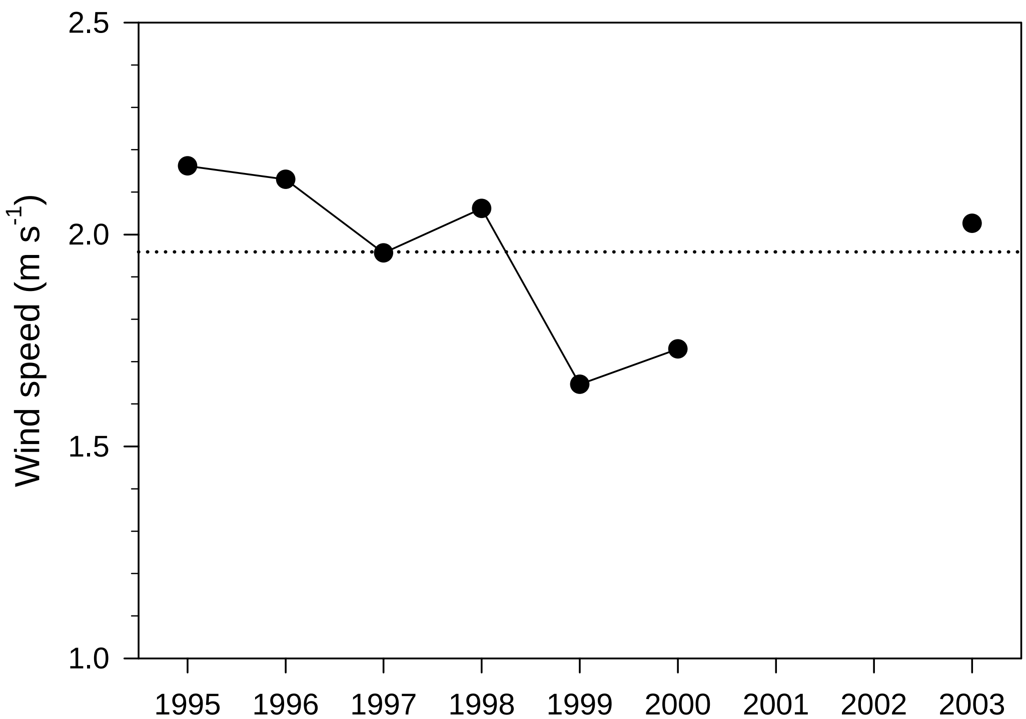

Figure 9. Average annual wind speed in the Qarlikturvik Valley lowlands of Bylot Island from 1995 to 2003. The dotted line shows the mean for the whole period.

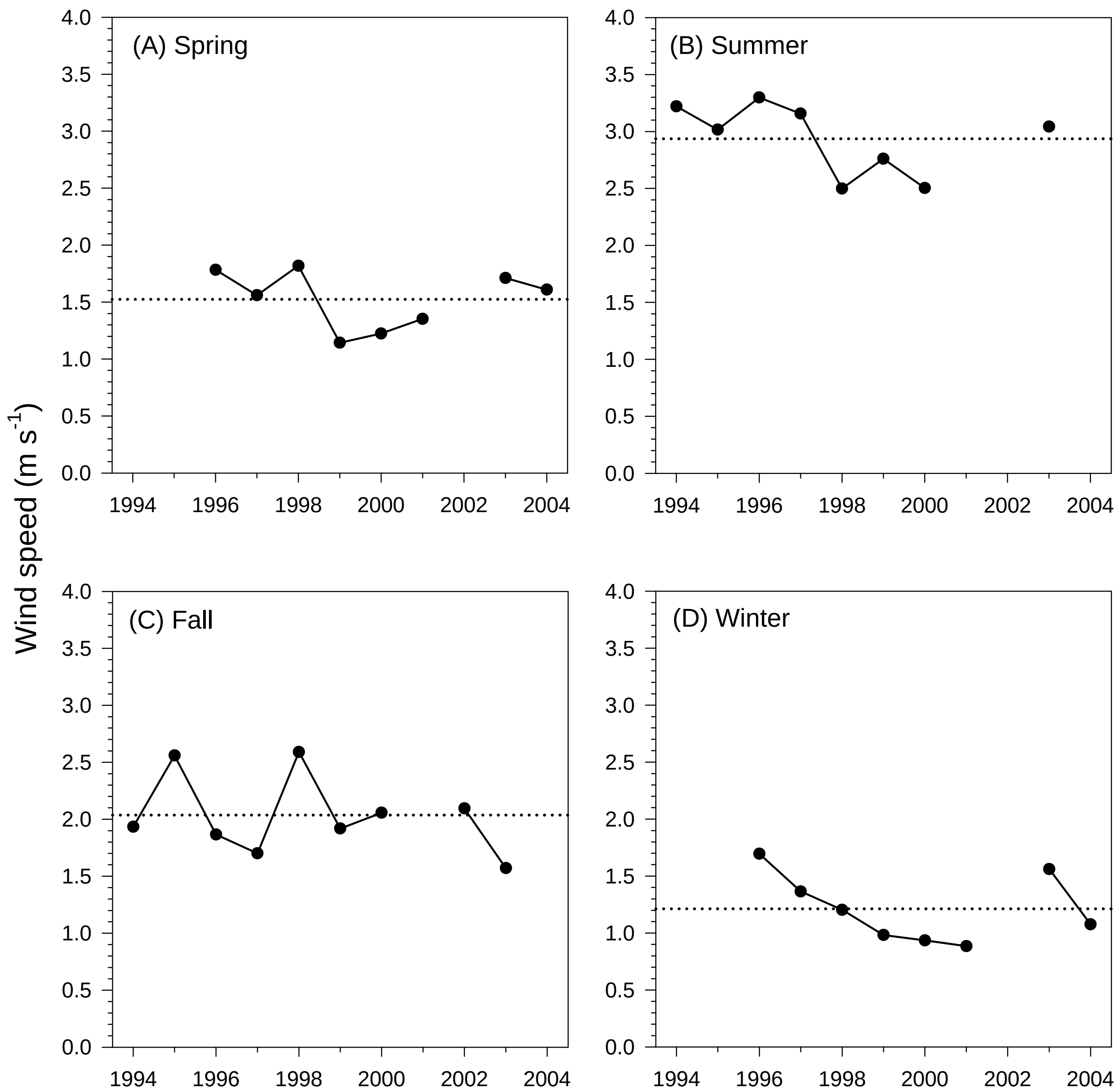

Figure 10. Average wind speed in the Qarlikturvik Valley lowlands of Bylot Island, from 1994 to 2004 for (A) spring (March to May), (B) summer (June to August), (C) fall (September to November) and (D) winter (December to February). The dotted line shows the mean for the whole period.

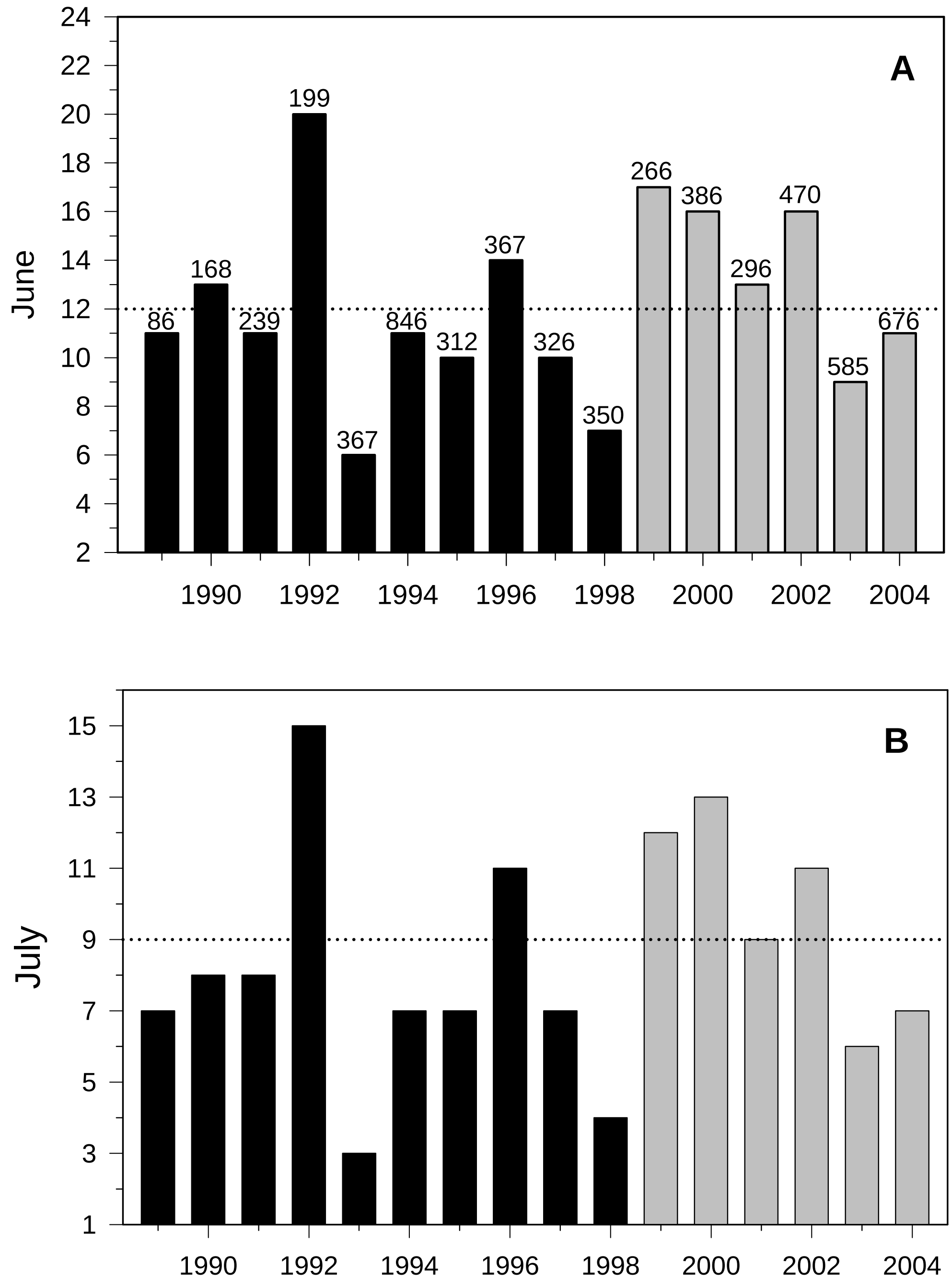

Figure 11. Median annual (A) egg-laying dates and (B) egg-hatching dates of Greater Snow Geese on Bylot Island from 1989 to 2004. Grey columns represents years during which a spring hunt occurred in Quebec. The dotted line shows the mean for the whole period. Numbers on top of bars in panel A indicate the number of nests monitored each year.

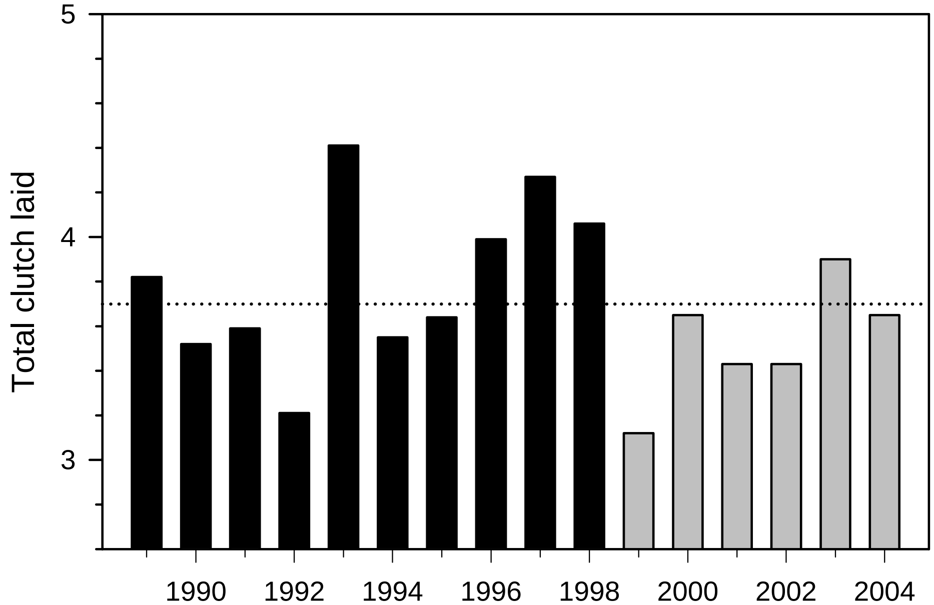

Figure 12. Annual total clutch laid of Greater Snow Geese on Bylot Island from 1989 to 2004. Grey columns represents years during which a spring hunt occurred in Quebec. The dotted line shows the mean for the whole period.

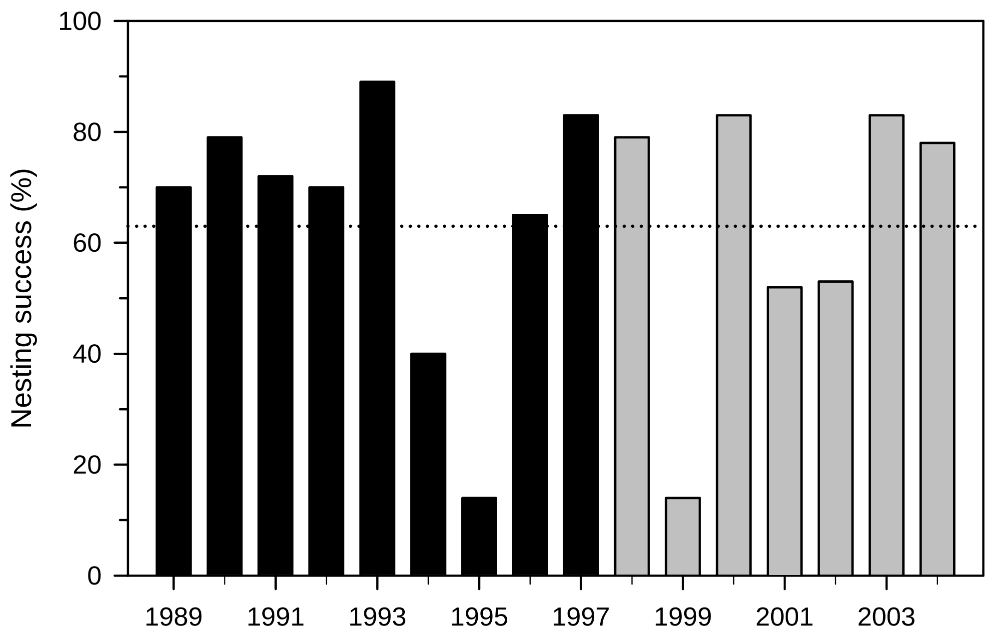

Figure 13. Annual nesting success (percentage of nests where at least one egg hatched) of Greater Snow Geese on Bylot Island from 1989 to 2004. Grey columns represents years during which a spring hunt occurred in Quebec. The dotted line shows the mean for the whole period.

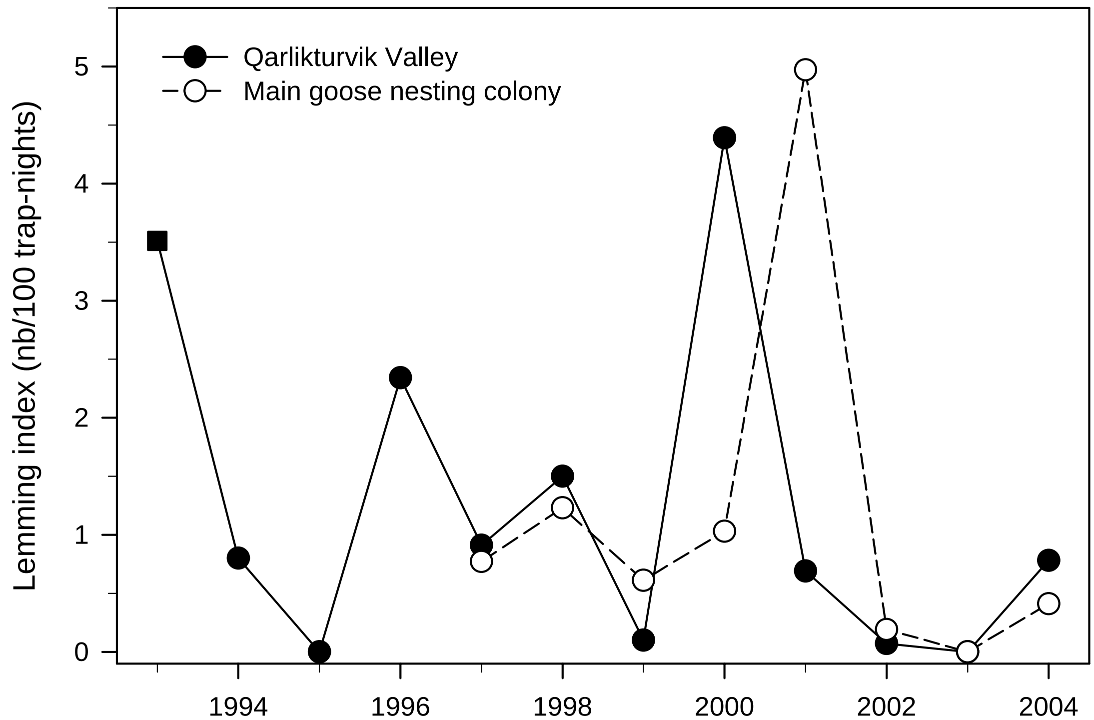

Figure 14. Index of lemming abundance (number caught per 100 trap-nights) in the Qarlikturvik Valley and the main goose nesting colony of Bylot Island from 1993 to 2004. Although no lemmings were trapped in 1993, an estimate was derived based on a winter nest survey.

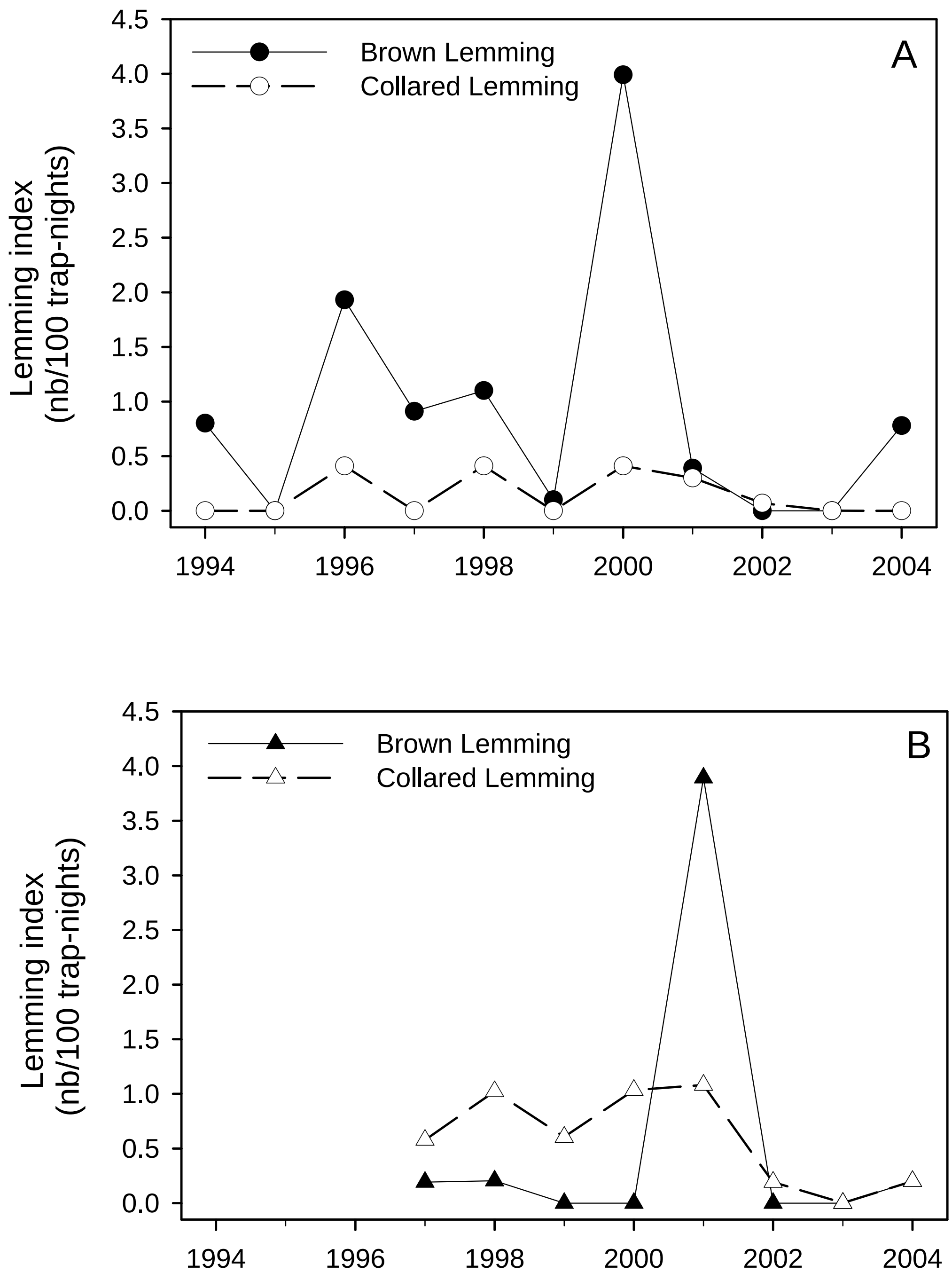

Figure 15. Index of Brown and Collared Lemmings abundance (number caught per 100 trap-nights) in (A) the Qarlikturvik Valley and (B) the main goose nesting colony of Bylot Island from 1994 to 2004.

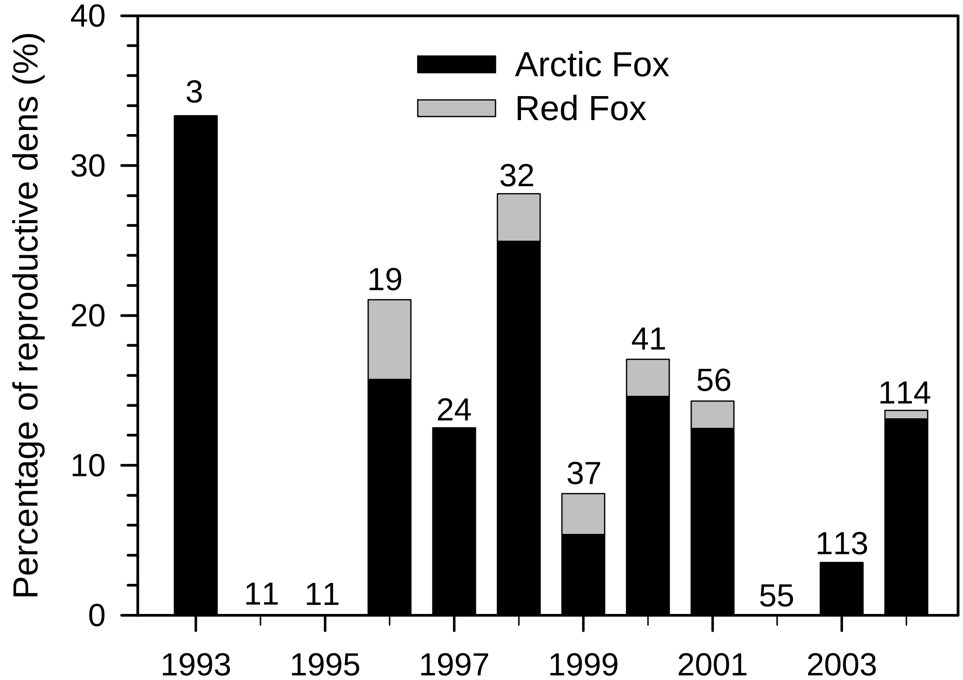

Figure 16. Annual percentage of Arctic and Red Fox dens with presence of pups on Bylot Island from 1993 to 2004. Numbers on top of bars indicate the number of dens monitored each year.

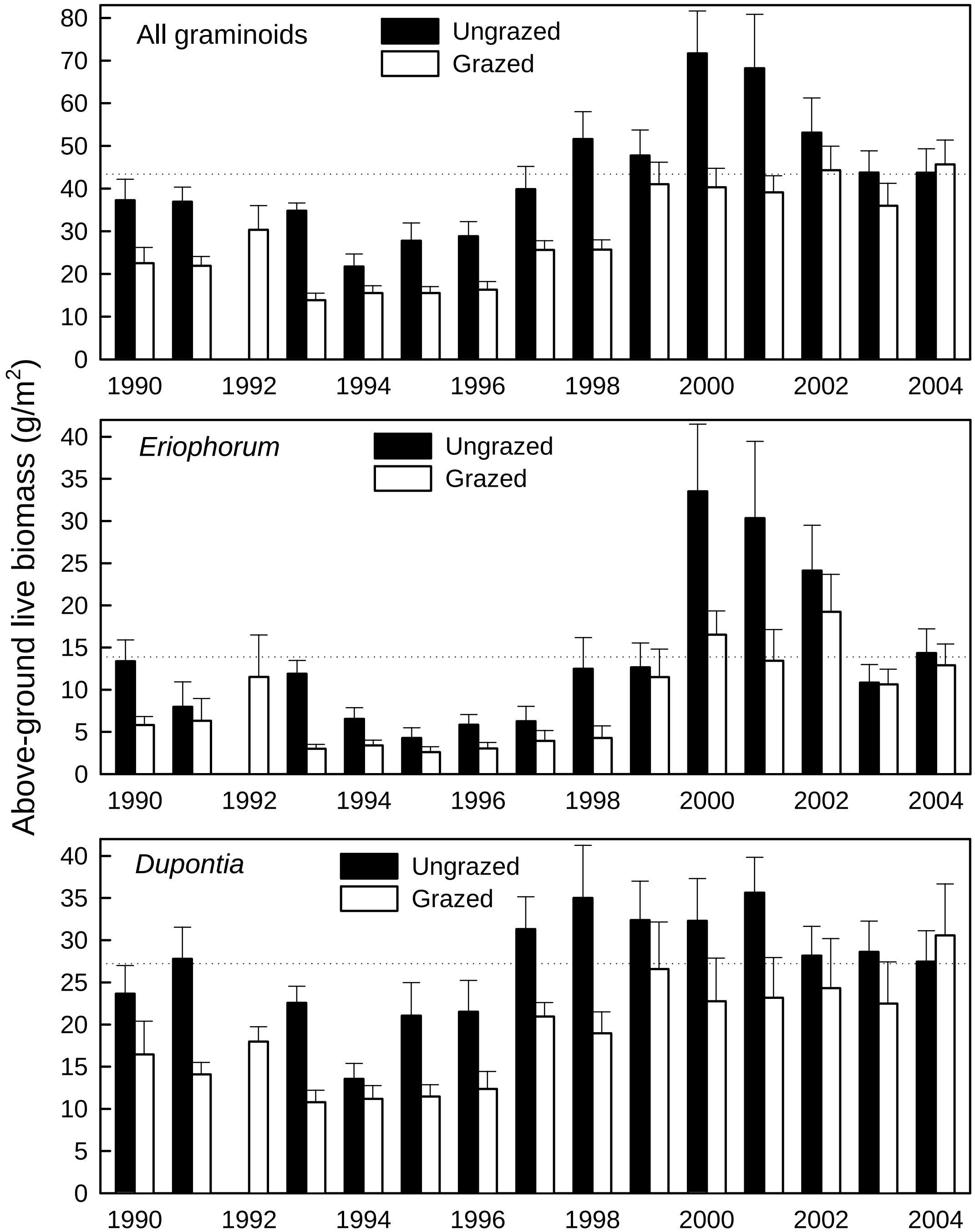

Figure 17. Live above-ground biomass (mean ± SE, dry mass) of (A) all graminoids, (B) *Eriophorum scheuchzeri* and (C) *Dupontia fisheri* around 15 August in grazed and ungrazed wet meadows of the Qarlikturvik Valley, Bylot Island, from 1990 to 2004 (n = 12 each year). There is no data from ungrazed area in 1992. The dotted line shows the mean plant production for the whole period.

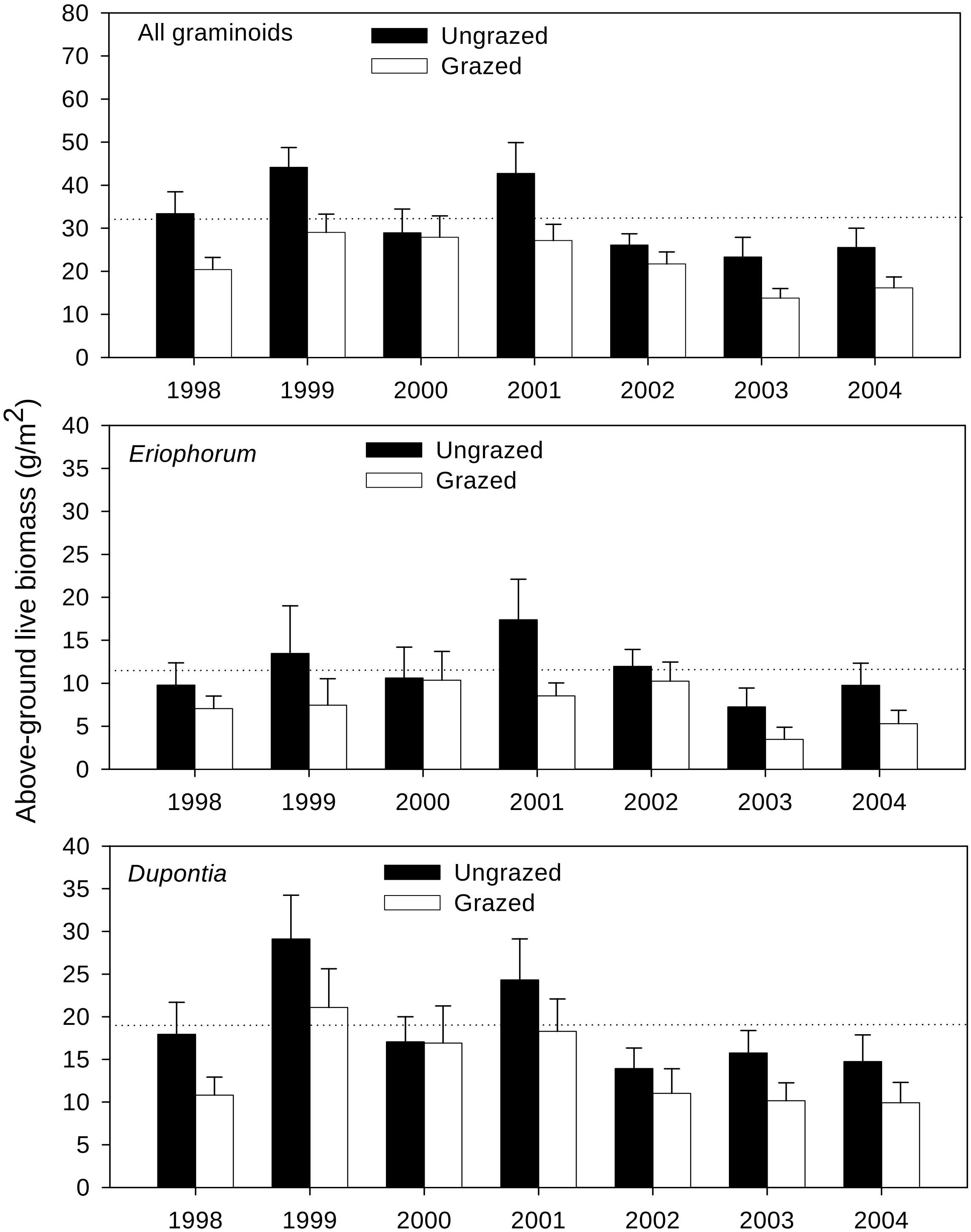

Figure 18. Live above-ground biomass (mean ± SE, dry mass) of (A) all graminoids (B) *Eriophorum scheuchzeri* and (C) *Dupontia fisheri* around 15 August in grazed and ungrazed wet meadows of the main nesting goose colony, Bylot Island, from 1998 to 2004 (n = 12 each year). The dotted line shows the mean plant production for the whole period.

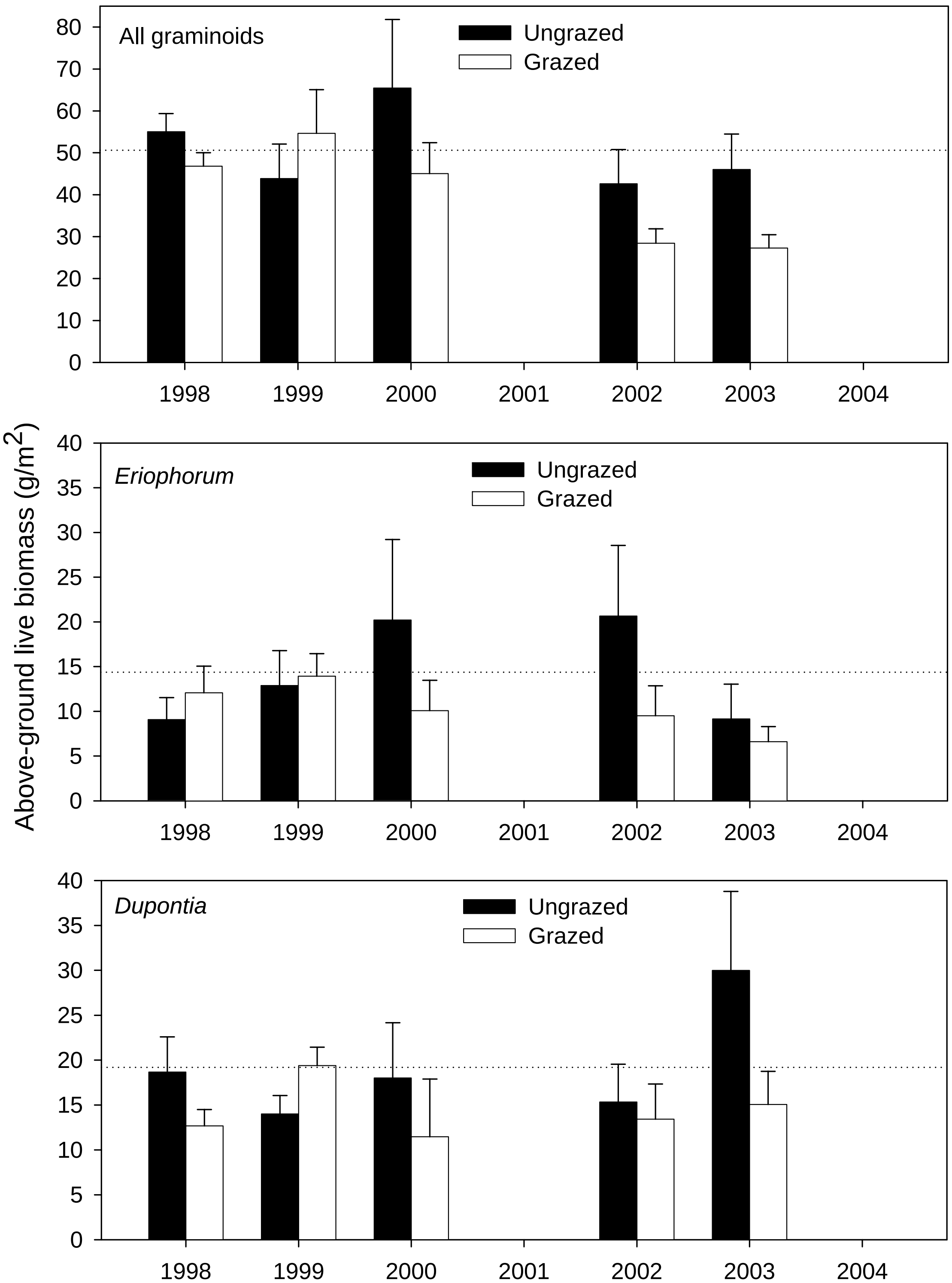

Figure 19. Live above-ground biomass (mean ± SE, dry mass) of (A) all graminoids (B) *Eriophorum scheuchzeri* and (C) *Dupontia fisheri* around 15 August in grazed and ungrazed wet meadows of Pointe Dufour, Bylot Island, from 1998 to 2004 (*n* = 12 each year). No sampling took place in 2001 and 2004. The dotted line shows the mean plant production for the whole period.

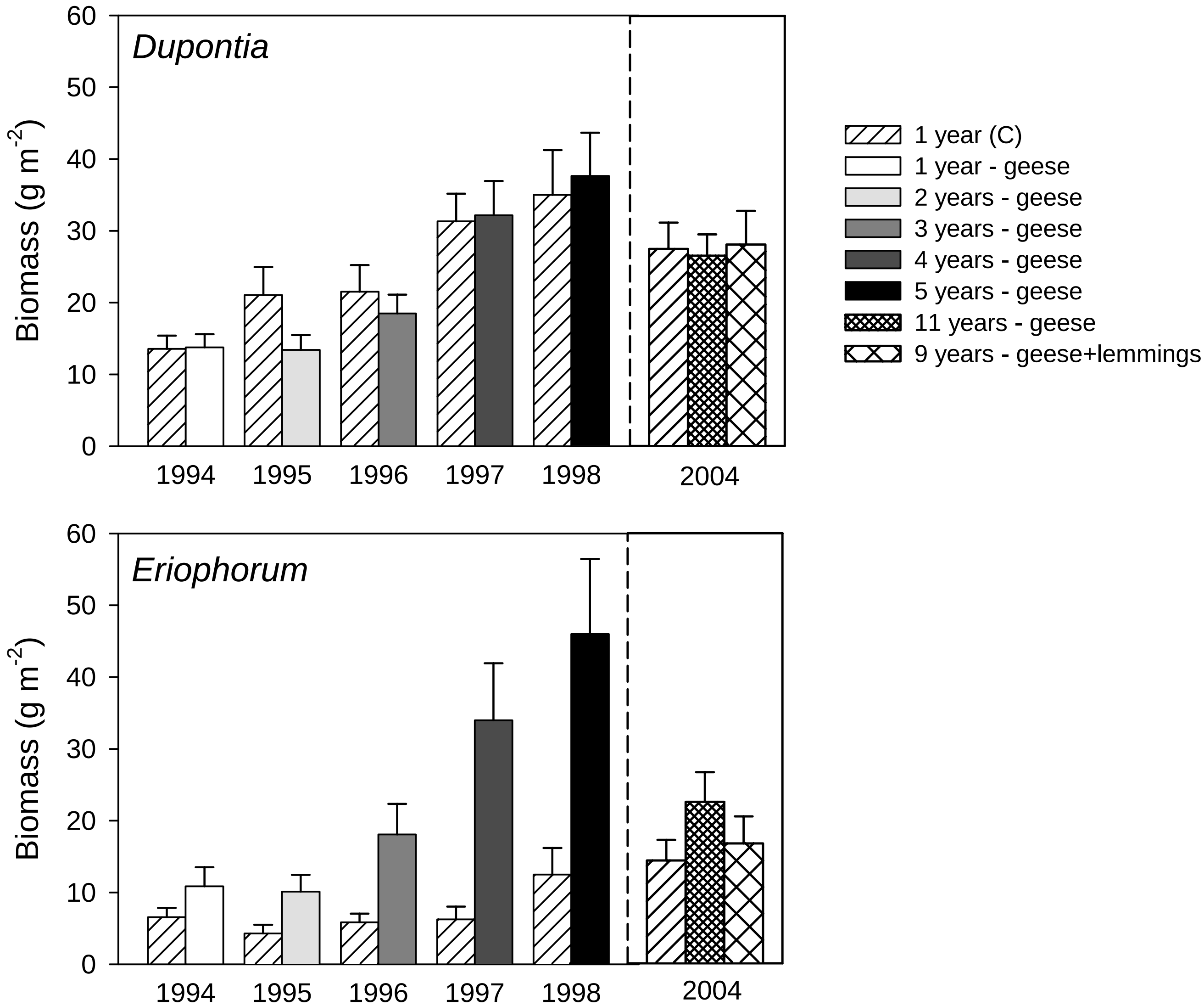

Figure 20. Live above-ground live biomass (mean ± SE, dry mass) of *Dupontia fisheri* and *Eriophorum scheuchzeri* in early August in long-term exclosures (n = 18) permanently protected from goose and goose+lemming grazing, and in annual exclosures that have been protected from goose grazing only for 1 year (Control, C, n = 12), Qarlikturvik Valley, Bylot Island, from 1994 to 2004.

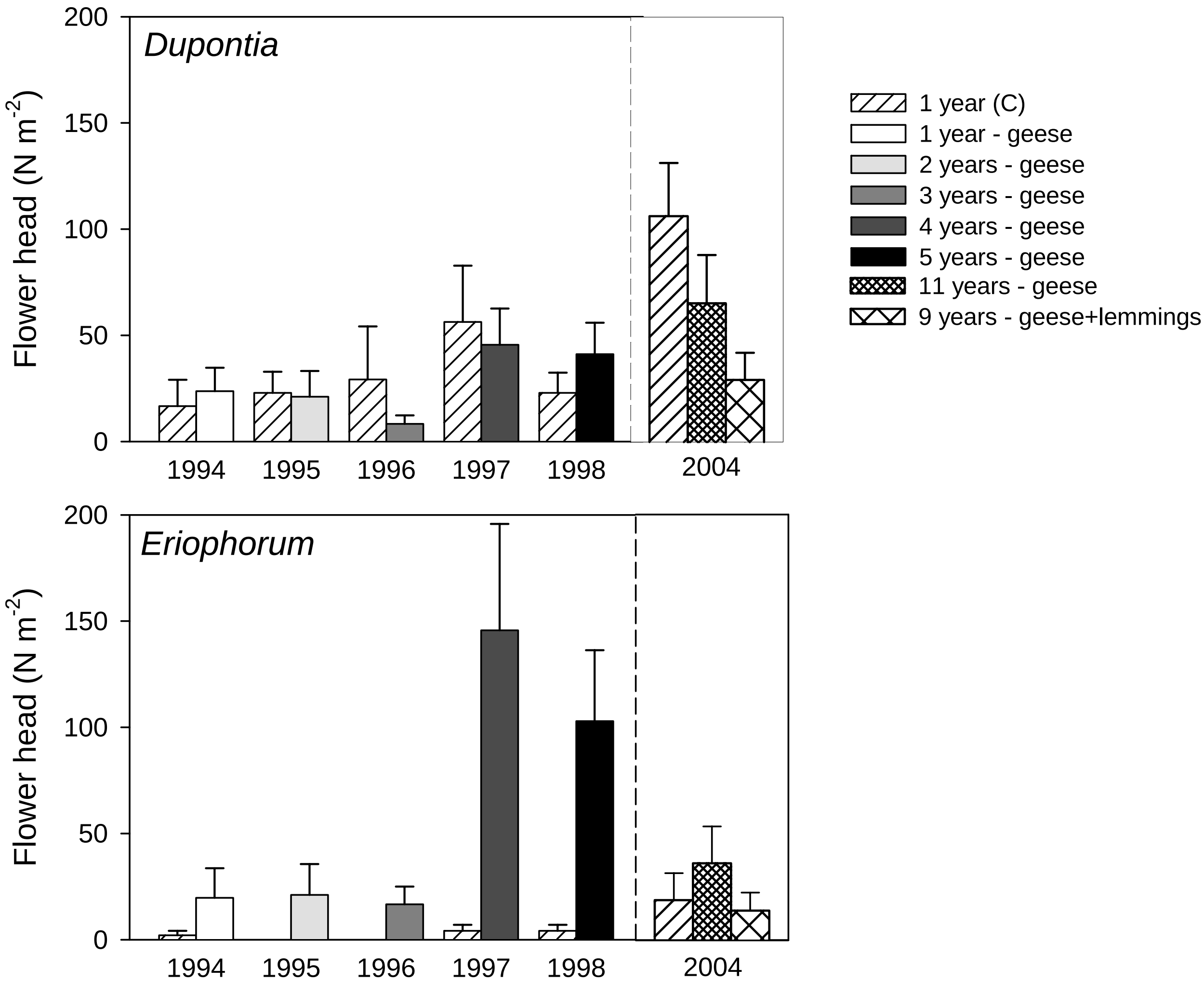

Figure 21. Flower head density (mean ± SE) of *Dupontia fisheri* and *Eriophorum scheuchzeri* in early August in long-term exclosures (n = 18) permanently protected from goose and goose+lemming grazing, and in annual exclosures that have been protected from goose grazing only for 1 year (Control, C; n = 12), Qarlikturvik Valley, Bylot Island, from 1994 to 2004.

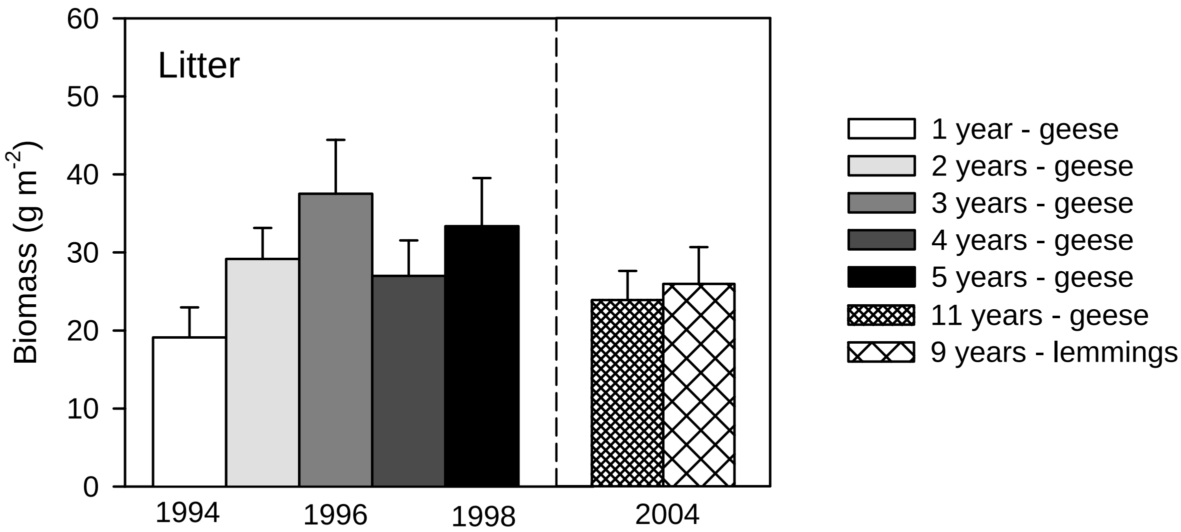

Figure 22. Dead above-ground biomass (i.e. litter; mean ± SE, dry mass) of vascular plants in early August in long-term exclosures (n = 18) permanently protected from goose and goose+lemming grazing, Qarlikturvik Valley, Bylot Island, from 1994 to 2004.

APPENDIX 1. List of attendees to the Bylot Island Research and Monitoring Workshop on 1 March 2005 at the conference room of the Nunavut Government building, Pond Inlet.

Name	Affiliation	Telephone
Vicki Sahanatien	Parks Canada – Iqaluit	867-975-4672
Gigor Hope	Dept Environ GN – Pond Inlet	867-899-8775
David Qamaniq	JPMC – Pond Inlet	867-899-8092
Natalino Maktar	Hamlet of Pond Inlet	--
Tommy Tatutuapik	JPMC – Arctic Bay	867-439-8235
Geesoonie Killiktee	JPMC – Pond Inlet	867-899-8734
Michel Allard	Université Laval – Ste-Foy, QC	418-656-5416
Cpl Gavin Nash	RCMP – Pond Inlet	867-899-0123
Gilles Gauthier	Université Laval – Ste-Foy, QC	418-656-5507
Elijah Nashook	JPMC – Pond Inlet	867-899-8086
Jayco Peterloosie	Elder – Pond Inlet	867-899-8439
Cornelius Natarak	Elder – Pond Inlet	867-899-8693
Lucy Quasa	Nattinak Visitor Centre – Pond Inlet	867-899-8225
Sara Pitseolak	Dept Envioron GN – Pond Inlet	867-899-8033
Louise Primeau	Char, EDT&E, Hamlet of Pond Inlet	867-899-8977
Chatherine Gagnon	Université du Québec à Rimouski – Rimouski, QC	418-736-5721
Carey Elverum	Parks Canada – Pond Inlet	867-899-8092
Samson Erkloo	Parks Canada – Pond Inlet	867-899-8092
Brian Koonoo	Parks Canada – Pond Inlet	867-899-8092

APPENDIX 2. Schedule of the workshop on ecological monitoring on Bylot Island, Sirmilik National Park, Pond Inlet, 1 March 2005.

8:45-9:00	**Gilles Gauthier** & **Vicki Sahanatien** Welcome word
9:00-10:00	**Gilles Gauthier** Ecological studies on Bylot Island: an overview
10:00-10:15	**Gilles Gauthier** Web site on ecological monitoring on Bylot Island
10:15-10:30	CoffeeBreak
10:30-11:00	**Michel Allard** The fossil forest on Bylot Island
11:00-11:30	**Michel Allard** Geomorphological studies on Bylot Island
11:30-12:00	**Vicki Sahanatien** Parks Canada Northern Biome Monitoring Program
12:00-13:30	LUNCH TIME
13:30-13:50	**Video: Impact of a warming climate** Arctic Climate Impact Assessment Report
13:50-14:30	**Gilles Gauthier** Planned environmental monitoring on Bylot Island
14:30-15:00	**Catherine Gagnon** Traditional Ecological Knowledge study
15:00-15:15	Coffee Break
15:15-16:45	**Discussion** Perspective of workshop participants on planned monitoring on Bylot Island
16:46-17:00	**Vicki Sahanatien** & **Gilles Gauthier** Wrap-up and conclusion
17:00-19:00	DINNER TIME

19:00-19:10	**Gilles Gauthier** & **Vicki Sahanatien** Welcome word to the public evening session
19:10-19:30	**Video: Impact of a warming climate** Arctic Climate Impact Assessment Report
19:30-19:45	**Gilles Gauthier** Web site on ecological monitoring on Bylot Island
19:45-20:00	**Gilles Gauthier** Planned environmental monitoring on Bylot Island
20:00-21:30	Questions and discussion

APPENDIX 3. Summary of the current and expanded ecological monitoring on Bylot Island.

Current monitoring		Monitoring expansion	
Species/Sites	**Component**	**Species/Sites**	**Component**
Climate			
4 automated stations	• Temperature (air, soil) • Wind speed/direction • Solar radiation • Barometric pressure • Precipitation • Snow depth		• UV radiation
Permafrost			
3 automated stations	• Ground temperature from 0 to 3 m deep	Permafrost degradation	• Periodic measures of ground benchmarks
Birds			
Snow Goose Snowy Owls Lapland Longspurs	• Nesting activity • Nest distribution • Nesting parameters - Laying date - clutch size - nesting success • Banding - Survival - Other demographic data	Jaegers Glaucous Gulls Shorebirds Other birds? (Cranes) (other waterfowl)	• Nesting activity • Nest distribution • Nesting parameters - Laying date - clutch size - nesting success • Banding - Survival - Other demographic data
Snow Goose	• Neck-collaring - Movements - Other demographic data		
Mammals			
Lemmings	• Snap-traps - Annual abundance	Lemmings	• Live-trapping and marking - Seasonal abundance - Survival - Reproduction
Arctic and red foxes	• Distribution • Use of dens • Reproductive activity • Number of pups • Marking - Movement - Survival		
Plant Species			
Wetlands (3 sites)	• Annual production • Grazing impact of geese • Grazing impact of lemmings	Wetlands	• Annual flowering • Simulate impact of climate warming
Uplands (mesic)	• Annual flowering • Grazing impact of geese • Grazing impact of lemmings	Uplands (mesic)	• Simulate impact of climate warming