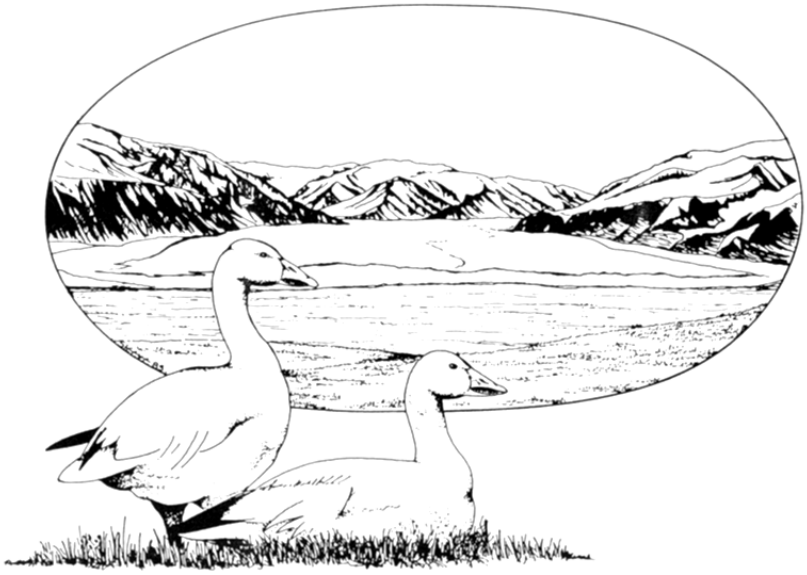
POPULATION STUDY OF GREATER SNOW GEESE AND ITS NESTING HABITAT ON BYLOT ISLAND, NUNAVUT IN 2023: A PROGRESS REPORT



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18 April 2024

INTRODUCTION

In 2023, 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 20th century. The exploding population has imposed major 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 actions during fall, winter and spring have been undertaken since 1999 in Canada and 2009 in the United States to curb the growth of this population. A synthesis report produced in 2007 evaluated the initial success of these special conservation measures. However, both the Avian Monitoring Review Steering Committee Final Report and the Greater Snow Goose Action Plan released in 2012 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) monitor changes in the demographic parameters of the Greater Snow Goose population, and especially the effects of the spring conservation harvest on those parameters, (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 2023 were as follows:

1) Monitor the productivity (egg laying date, clutch size and nesting success) and nesting distribution of Greater Snow Geese on Bylot Island.
2) Study the migration phenology of geese and its impact on reproductive success.
3) Mark goslings in the nest to provide a sample of known-age individuals to assess the growth and pre-fledging survival of goslings by their recapture in late summer.
4) Band goslings and adults at the end of the summer to continue the long-term study of demographic parameters such as survival and breeding propensity.
5) Monitor the abundance of lemmings and study their demography in relationship with snow conditions and the impact of predation on their cyclic fluctuations of abundance.
6) Monitor the breeding activity of other bird species and in particular avian predators (Snowy Owl, jaegers, Glaucous Gull, Peregrine Falcon and Rough-legged Hawk).
7) Monitor the breeding activity of foxes at dens.
8) Capture and mark adult foxes and their pups to study their movements, demography and foraging activity.
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 2023, we operated two camps on Bylot Island: the main field station, located 6 km from the coast in the largest glacial valley on the island (Qarlikturvik Valley, 73° 08' N, 80° 00' W), was occupied from 4 June to 20 August. A secondary camp, located in a narrow valley 30 km south of the main field station and 5 km from the coast ("Camp 2 area", 72° 53' N, 79° 54' W) was occupied from 22 May to 21 July (Fig. 1). Finally, 13 fly camps were also established for periods ranging from 5 to 7 days at various times throughout the island, west of Dufour Point.

***Field parties.* —** The total number of people in both camps ranged from 3 to 16 depending on the period. Members of our field party included project leaders Pierre Legagneux, Joël Bêty, Dominique Berteaux, Josée Lefebvre, Dominique Fauteux and several graduate students whose thesis projects addressed many of the objectives mentioned above: Ilona Grenztmann (PhD, objectives 1, 3 and 4), Frédéric Dulude-de Broin (PhD, objectives 7 and 8), Mathilde Poirier (PhD, objective 5), Gabriel Bergeron (PhD, objectives 5 and 6), Camille Gaudreau-Rousseau (PhD, objective 5), Matthieu Weiss-Blais (MSc, objectives 1 and 2), Mathieu Archambault (MSc, objective 7) and Louis-Pierre Ouellet (MSc, objective 8). Other students assisted them in the field, including Anne-Marie-Blanchette, Andréanne Beardsell, Marylou Beaudoin, Laurianne Dumont and Françoise Grenier. Other people in the field included Marie-Christine Cadieux, a research professionnal in charge of goose banding and plant sampling (objectives 4 and 9); Denis Sarrazin, research professionnal responsible of the maintenance of the weather stations (objective 10); and Christian Marcotte, a wildlife technician from the Canadian Wildlife Service (CWS, Quebec region). Finally, we hired two persons from Pond Inlet to work with us: James Akpaleeapik (marking goslings in nests: 5 to 15 July and goose banding: 6 to 15 August) and Floyd Tigullaraq (goose banding: 6 to 15 August.

Several other people also used our camps during the summer. They were Louis Moisan (PhD student), Laurence Gagnon (MSc student), Éliane Duchesne (research assistant), Joassie Otoovak (Pond Inlet field assistant), Éléonore Douville, Sandrine Benoît, Jonathan Brassard (research assistant at Université de Sherbrooke) and Dominique Gravel (researcher at Université de Sherbrooke), who studied shorebirds, lapland longspurs, cackling geese and insects under the supervision of Joël Bêty; the field party of Daniel Fortier (Université de Montréal), which included Élisabeth Hardy-Lachance (PhD student), who studied the permafrost and geomorphology; the field party of Esther Lévesque, Christophe Kinnard and Vincent Maire (Université du Québec à Trois-Rivières [UQTR]), which included Laurent Lessard (PhD student), Vincent Houde (MSc student), Virginie Favreau (MSc student) and Thierry Laurent-St-Pierre who studied plant ecology and hydrology; the field party of Isabelle Laurion and Jérôme Comte (Institut National de la Recherche Scientifique), which included Martial Leroy (PhD student), Emily Hallett (PhD student), Valentine Cyriaque (post-doctoral fellow), Melanie Burnett and Bonnie de Baets (PhD students at McGill University) and François Guillemette (researcher at UQTR), who studied the carbon cycle in ponds; the field party of Florent Dominé (Takuvik, Université Laval/CNRS) with Félix Lévesque-Desrosiers (PhD student) and Étienne Tremblay who studied the snow physical properties.

Other people from Pond Inlet also visited the camp for knowledge exchange or helped us with research activities. Brian Koonoo and Dennis Angnatsiak from Parks Canada guided the

research teams of Christophe Kinnard, Florent Dominé and Gilles Gauthier in snowmobiles to bring them to the main field station in early May. Bryan Koonoo, Neil Pilgrim and Patricia Panipakoocho from Parks Canada inpected both our camps on 4 July.

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 312 m ASL, respectively) where air and ground temperature, air humidity, precipitations, snow depth, solar radiation, wind speed and wind direction are recorded on an hourly basis throughout the year (Fig. 1). A fourth station measures soil surface temperature in areas grazed and ungrazed by geese (i.e. exclosures). All automated stations were visited during the summer to download data and were found to be operating normally. Daily precipitation was also recorded manually during the summer. Finally, snowmelt was monitored by measuring snow depth at 50 stations along two 250-m transects and by visually estimating snow cover in the 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 across the valley every two to three days from our arrival on the island until the end of snowmelt. Nest searches were carried out within walking distance (~6 km) of both the main field station and the Camp 2 mostly between 11 and 25 June. Nests were found by systematic searches conducted over various areas in the field. At Camp 2, where the main goose colony is located, nest searches were conducted using two methods: 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 4-ha plots randomly located throughout the colony. Nest density was calculated over a fixed 20-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. Nests of other goose species, and in particular Cackling Geese (*Branta hutchensii*), were also systematically recorded during our field activities throughout Bylot Island.

Tracking of geese radio-marked in the south. **—** During spring staging in Quebec, we banded 577 snow geese captured with cannon-nets and we equipped 51 adult females with GPS/GSM transmitters mounted on neck collars. We were also able to monitor 31 additional females equipped with similar transmitters in previous years. On Bylot Island, we conducted intensive ground surveys (mostly from 11 to 18 June) of the breeding colony to find the nests of radio-marked geese and monitor their nests until hatching.

Goose banding. **—** From 7 to 13 August, we banded geese with the assistance of 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 (body mass and length of culmen, head, tarsus and 9th primary). We also collected cloacal and blood samples on geese to study their aging process.

Small mammals. **—** We sampled lemming abundance and demography using live-traps. We trapped on two 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 (200 × 340 m; 96 traps) in mesic habitat where a predator exclosure experiment was set up in 2012-2013 (the grid is surrounded by a chicken wire fence and covered by criss-crossing fishing line on top). The fishing line covering the grid to prevent avian predators to enter inside the enclosure was removed in summer 2022 but the fence remained in place. We used Longworth traps set at each grid intersection every 30-m. We trapped for 3 consecutive days during 3 periods (mid-June, mid-July and mid-August). Traps were checked at 12-hour intervals and all captured animals were identified, sexed, weighed and marked with electronic PIT tags or ear-tags (or checked for the presence of such tags). Finally, we sampled the abundance of lemming winter nests along 145 500-m transects randomly distributed in different habitats (mesic tundra, streams in mesic tundra and willow shrubs) between the main field station and Dufour Point.

Breeding activity of foxes at dens and marking. **—** All known fox dens located within a 600 km^2 area ranging from the Qarlikturvik Valley in the north to Dufour Point in the south and from the coast to approximately 10 km inland. Dens were visited one to five times during the summer and inspected for signs of use and/or presence of reproductive adults with pups. Automated cameras were deployed at dens showing signs of activity. We attempted to live-trap adults with cages and padded leghold traps at locations where foxes were seen hunting or travelling. At each den, we noted the species (Arctic Fox, *Vulpes lagopus*, or Red Fox, *Vulpes vulpes*), the presence of previously marked adults, and monitored for the presence of pups to determine minimum litter size. Cages 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. Samples of winter and summer fur and claws 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*), Peregrine Falcons (*Falco peregrinus*), Rough-legged Hawks (*Buteo lagopus*) and Lapland Longspurs (*Calcarius lapponicus*). Gull and Long-tailed jaeger nests were only monitored in the Qarlikturvik Valley and the Camp-2 area, but nests of other avian predators were monitored throughout the same 600 km^2 area than for foxes. Nests were found through systematic searches of suitable habitats or opportunistically and revisited to determine their fate (successful or not) until fledging.

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 one site in the Qarlikturvik Valley, a brood-rearing areas. Twelve exclosures (1 × 1 m) were installed in late June in two groups of 6 in the same general area every year. Plant biomass was sampled in ungrazed and grazed areas (i.e. inside and outside exclosures) at the end of the plant-growing season in 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. No monitoring took place at the Camp 2 area in 2023.

PRELIMINARY RESULTS

***Weather conditions.* —** Temperatures in spring were cool. Air temperature averaged -4.9°C (2.4°C below normal) between 20 May and 5 June, the period of goose arrival, and 1.5°C (1.0°C below normal) during 5-20 June, which is the most critical period for egg formation and egg-laying. Snowpack at the end of the winter was higher than normal (snow depth was 47.6 cm on 20 May; Fig. 2). However, cool temperature in spring and snow fall in late May delayed snowmelt to the end of June, which was later than normal. Temperature throughout most of the summer were warm and the sky mainly clear and sunny. Rainfall was well below average and concentrated mostly in August (cumulative rainfall from 1 June to 17 August: 12 mm, long-term average: 76 mm).

***Goose arrival and nesting activity.* —** The first geese were detected on the hills surrounding the Qarlikturvik Valley, usually the first area used by geese after arrival, around 4 June. This number increased over the next few weeks to peak at 692 pairs on 22 June, a high number (Fig. 3). When compared to other years, goose arrival on Bylot Island tended to be later in 2023. Usually, we see a decline in goose numbers due to the movements of geese to the nesting colony and potentially to moulting sites, away from the Qarlikturvik Valley. However, in 2023, this decline did not occur and this could result from the fact that many geese decided to nest in the area which is very unusual in a low lemming year (see below).

The distribution of goose nests was highly unusual this year as several geese nested in the Qarlikturvik Valley (mostly a brood-rearing area). This usually happens in years when geese nest in associating with Snowy Owls but no owls were found in our study area in 2023.

Nest density in the center of the colony (10.6 nests/ha) was much higher than the long-term average while density outside the colony (2.5 nests/ha) was similar to the long-term average (Table 1). Egg-laying date in the colony (median: 15 June) was 3 days later than the long-term average, while geese initiated their nest even later at the Qarlikturvik Valley (median: 18 June). Average clutch size was 3.7 in the colony and 3.5 in the Qarlikturvik Valley (long-term average: 3.7; Table 1). Across the island, we found 100 nests of Cackling Geese compared to 61 in 2022 (Table 1).

***Nesting success of geese.* —** Overall, nesting success was high (70%; proportion of nests hatching at least one egg) and slightly above to the long-term average (Table 1). This was largely due to a very low activity of Arctic Foxes and avian predators around goose nests, which destroyed less nests than in normal years and far less than in years with low-lemming abundance. Nesting success was higher in the Qarlikturvik Valley (74%, n = 155) than in the Camp 2 area (colony, 70%, n = 355). During the summer, 42 neck-collared birds were sighted in the colony. Peak hatch was on 13 July for both nesting area, which is 3 days later than the long-term average (Table 1). We tagged 1710 goslings in nests at hatch in the Camp 2 area and 218 in the Qarlikturvik Valley. Overall, nesting parameters of geese in 2023 were good.

***Density of broods.* —** The density of goose faeces at the end of the summer in wet meadows of the Qarlikturvik Valley was low (4.5 ± 1.0 [SE] faeces/m^2; long-term average: 6.4). Accumulation of faeces began in mid-July, when newly-hatched broods started to move in the valley and increased steadily thereafter until mid-August.

***Tracking of geese radio-marked in the south.* —** We were able to monitor departure date of 60 adult females from southern Quebec and the migration pattern and breeding decisions in the Arctic for all of them. Birds left Quebec around 19 May and arrived in Nunavut between 27 May and 2 June. Among those, 14 females arrived on Bylot Island around 15 June. Based on their tracking, we estimated that six of them attempted nesting (median: 19 June) but none of them were successful. Through our intensive ground surveys, we were able to found the nest of two of those birds. Among the 46 females that migrated to the Arctic, 16 attempted to nest and 7 were successful. These females were also tracked during the fall migration and arrived in Quebec between 17 September and 12 October. Four of them were shot during the fall hunting season. Most geese were in Delaware, Maryland, and New Jersey on 26 January 2024.

***Goose banding.* —** The banding operation was very successful this year due to good weather prevailing throughout the banding period. We conducted 12 drives between the main field station and the Camp 2 area. We banded a total of 3497 geese, including 56 young that had been marked with web-tags at hatch. In addition, we recaptured 132 adults that were banded in previous years. We collected cloaca and blood samples from 50 goslings and 80 adults. The young:adult ratio among geese captured at banding was higher than last year (1.15:1 vs. 0.53:1 in 2022; long-term average:1.02:1). Mean brood size toward the end of brood-rearing (2.42 young, n = 189; counts conducted between 31 July and 3 August) was slightly higher than last year (2.28) but close to the long-term average (2.48). By combining information on brood size and young:adult ratio at banding, we estimated that 95% of the adults captured were accompanied by young, a moderate value. Overall, these results are indicative of a good production of young on Bylot Island by the end of the summer.

***Small mammals.* —** During our live-trapping survey, which cumulated 6,816 12-hr trapping sessions throughout the summer, we only captured 4 Collared Lemmings and no Brown Lemmings, a very low number. A formal estimation of density using capture-recapture methods confirmed that Brown Lemmings, which had reached a record high abundance in summer 2021 (>15 lemmings/ha), had continued to crash to extremely low values throughout the summer 2025 (Fig. 5). Finally, the number of lemming winter nests found along our transects confirmed a decrease in lemmings during winter as we counted 41 nests in 2023 compared to 105 in 2022.

Breeding activity of foxes at dens and marking. — A total of 127 known fox denning sites were monitored in 2023. Among these dens, we found signs of activity (fresh digging and/or footprints) at 50 of them, a high number. However, only 4 litters of Arctic Foxes were seen this year, which is typical of what can be observed in years of very low lemming abundance. A total of 14 adult Arctic Foxes were captured during the summer, including 1 individual marked in previous years. Four Arctic Foxes marked in previous years were also sighted but not recaptured. All new individuals were marked with ear-tags and a GPS collar.

***Monitoring of other bird species.* —** We found 26 active nests of Glaucous Gulls (vs. 32 in 2022), 4 nests of Parasitic Jaegers (vs. 2 in 2022), 1 nest of Long-tailed Jaegers (vs. none in 2022), no nest of Rough-legged Hawks (vs. 3 in 2022), 2 nests of Peregrine Falcons (vs. 5 in 2022) and no nest of Snowy Owls (vs. none in 2022). The low nesting activity of avian predators is typical of what we encountered in a year of low lemming abundance. We found 111 nests of Lapland Longspurs compared to 122 in 2022. Average clutch size of gulls was similar to 2022 (2.6 eggs vs 2.6 in 2022) as well as for longspurs (5.3 eggs vs. 5.5 in 2022). Nesting success was unknown for gulls, hawks,

falcons and jaegers. Fledging success (proportion of nests successful in fledging at least one young) was high for longspurs (78%).

Plant growth and grazing impact. **—** Plant production in wet meadows of the brood-rearing area was above the long-term average and higher than the last several years. Above-ground biomass of graminoid plants in the Qarlikturvik Valley reached 59.5 ± 9.7 [SE] g/m^2 in ungrazed areas in mid-August compared to 50.6 ± 6.2 in 2022 (long-term average since 1990: 51.1 g/m^2). Biomass of both *Eriophorum* and *Dupontia* was higher compared to last year.

Grazing pressure was moderate in the wet meadows of the Qarlikturvik Valley in 2023 as geese had removed 31% of the above-ground biomass (difference between paired grazed and ungrazed plots by mid-August (long-term average: 31%). Grazing pressure was similar on both *Eriophorum* (36% of biomass removed) and *Dupontia* (29% of biomass removed).

CONCLUSIONS

Despite late spring conditions similar to 2022, reproduction of greater snow geese on Bylot Island was above average in 2023. Geese arrived relatively early and in large numbers on the island with numbers increasing until 22 June. Nesting effort (indexed by nest density in the colony) was very high despite delayed egg-laying. The delay was undoubtedly the consequence of the late spring which resulted in one of the latest snow melt in our records. This breeding delay could also be explained by an adverse wind conditions during the spring migration (Grandmont et al., unpub. data). However, we did not observe strong breeding suppression as seen in 2022. The breeding propensity (42%) was comparable to other years: breeding propensity obtained in 2019-2021 was 52% in average (range 46 to 67%) and only 5% in 2022. The high nesting density in the core of the colony in 2023 is thus quite surprising and could be explained by the very low reproduction in 2022 (very small proportion of breeders, low density, and high nest predation). Skipping a breeding event allow long-lived species to increase their body condition over the next year and increase their nesting success. Accordingly, body condition of females measured at their spring staging area was high in 2023 (Legagneux et al., unpub. data).

The very low abundance of lemmings observed in 2023 should have led to a strong reduction in nesting success as observed in our long-term monitoring. Unexpectedly, the nesting success was relatively high in 2023. The low rate of predation was likely due to a redistribution of Arctic foxes around the goose colony (almost all captured and sighted individuals were new in the population) probably due to the drastic decrease in goose abundance in 2022. Since Arctic fox depend on their food caches to survive the whole winter, most foxes with established territories in 2022 likely died or emigrate during the winter leaving room for more naive foxes to occupy the area. Fox home range sizes were indeed much higher in 2023 compared to 2022 and equivalent to home range usually found outside the goose colony (Ouelette and Berteaux, unpub. data) which is an indication of low predation. Indeed, the probability of prey encounter directly depends on the size of predator’s home range size (Dulude-de Broin et al., 2023). This lower predation might also have occurred in the Qarlikturvik valley as many geese were nesting there, which is unsual for a low lemming year.

The proportion of young geese observed in our catches during banding indicates that the production on Bylot Island was relatively high in 2023. Based on the young-to-adult ratio observed during banding, we anticipated a fall flock with 27% young, a figure exceeding the long-term average (21%) and notably surpassing the previous year's figure (2%). However, the percentage of young geese observed during juvenile counts in southern Quebec this fall stood at 15% (n = 18,008). Therefore, it suggests that either the survival of young during migration from the Arctic to southern latitudes was low, or the breeding conditions on Bylot Island were not representative of the broader breeding range of the population. In 2023, spring was delayed in many areas of the High Arctic in eastern Canada. These conditions, coupled with the low abundance of lemmings—usually synchronized with Bylot's abundance—likely account for the relatively low production of geese at the population level. Hence, it appears that the favorable reproductive success experienced by snow geese on Bylot Island in 2023 does not reflect the entire breeding range of the population.

An emerging phenomenon on Bylot Island is the growing number of nesting Cackling geese. In our study area, the first nest was found in 1996. Until 2010, their presence was relatively rare. However, as we noticed a rapid increase in their number, we started to search more systematically the study area in 2014. In 2023, we found 100 cackling nests, which constitute the highest number recorded since 1996. Moreover, the nesting success of cackling was relatively high in 2023 (77% vs 31% in 2022; long-term average: 68%).

Above-ground graminoid production in wet meadows of the Qarlikturvik Valley, a prime brood-rearing area, was above average this year. Faeces counts revealed that use by broods was near average in that area which is in accordance with the moderate grazing impact on vegetation. This is partly due to the high vegetation production in 2023.

PLANS FOR 2024

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 Canada and since 2009 in the United States. 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*) studying indirect interactions between snow geese and lemmings via shared predators; *iii*) studying the ecology of the main predator of geese, the Arctic Fox; and *iv*) assessing the impact of climate change on goose reproduction and the carrying capacity of the habitat for geese. In 2024, 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 at the end of the summer to continue the long-term study of demographic parameters such as survival and breeding propensity.
4) Monitor the abundance of lemmings and study their demography and the impact of predation on their cyclic fluctuations of abundance.
5) Monitor wintering ecology of lemmings and ermines with passive sensors and cameras.
6) Monitor the breeding activity of other bird species, in particular avian predators (Snowy Owls, jaegers, Glaucous Gulls, Peregrine Falcons and Rough-legged Hawks).
7) Monitor the breeding activity of foxes at dens.
8) Capture and mark adult foxes and their pups to study their movements, demography and foraging activity.
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.

In 2024, at least 5 graduate students will be involved in the Bylot Island snow goose project. **Ilona Grentzmann** (PhD) will finish her study on the effect of senescence on the population dynamics and physiology of snow geese. **Gabriel Bergeron** (PhD) will continue his study on seasonal Arctic food-web modeling. **Camille Gaudreau-Rousseau** (PhD) will continue her study on the vulnerability of lemmings to predation by ermine in different phases of the cycle. **Matthieu Weiss-Blais** (MSc) will finish his study on nest attendance of snow geese during incubation and its impact on the risk of predation by arctic foxes. **Anne-Marie Blanchette** (MSc) will start her study on the combined effect of predation on lemming populations and their grazing impact on vegetation productivity and diversity.

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

	2014	2015	2016	2017	2018	2019	2020	2021	2022	**2023**	Average[2]
Number of nests monitored	491	347	337	342	277	422	580[3]	487[3]	332	**558**	--
Nest density in the core of the colony (n/ha)	7.89	9.26	5.50	8.14	3.46	5.70	8.35[3]	9.09[3]	4.09	**10.56**	5.10
Nest density in random plots (n/ha)	3.39	2.73	3.70	3.41	3.35	4.38	4.41[3]	4.15[3]	1.28	**2.45**	2.62
Median date of egg-laying	11 June	12 June	13 June	11 June	14 June	7 June	12 June[4]	13 June[4]	15 June	**15 June**	12 June
Clutch size	3.85	3.48	3.36	3.53	3.50	4.04	3.67[4]	2.75[4]	3.74	**3.66**	3.71
Nesting success[1]	91%	77%	73%	56%	50%	82%	64%[3]	--	37%	**70%**	67%
Median date of hatching	8 July	9 July	9 July	8 July	11 July	4 July	11 July[4]	10 July[4]	12 July	**13 July**	9 July
Ratio young:adult at banding	1.19:1	0.99:1	0.91:1	0.88:1	0.94:1	1.20:1	--	1.02:1	0.53:1	**1.15:1**	1.02:1
Brood size at banding	2.58	2.08	2.35	2.14	2.34	2.65	--	2.51	2.28	**2.42**	2.48
Proportion of adults with young at banding	92%	95%	78%	83%	81%	91%	--	81%	47%	**95%**	82%
Number of Cackling goose nests found	22	11	28	40	61	76	--	--	61	**100**	35[6]

[1] Mayfield estimate.
[2] Period 1989-2019 and 2022-2023. Data from 2020 and 2021 are not included in the long-term average (except banding data) because different protocols were used during the covid19 pandemic.
[3] These values were estimated from analyses of satellite images.
[4] These values are only based on the GPS-tracking of 4 females that nested on Bylot Island.
[6] Period 2010-2019 and 2022-2023.

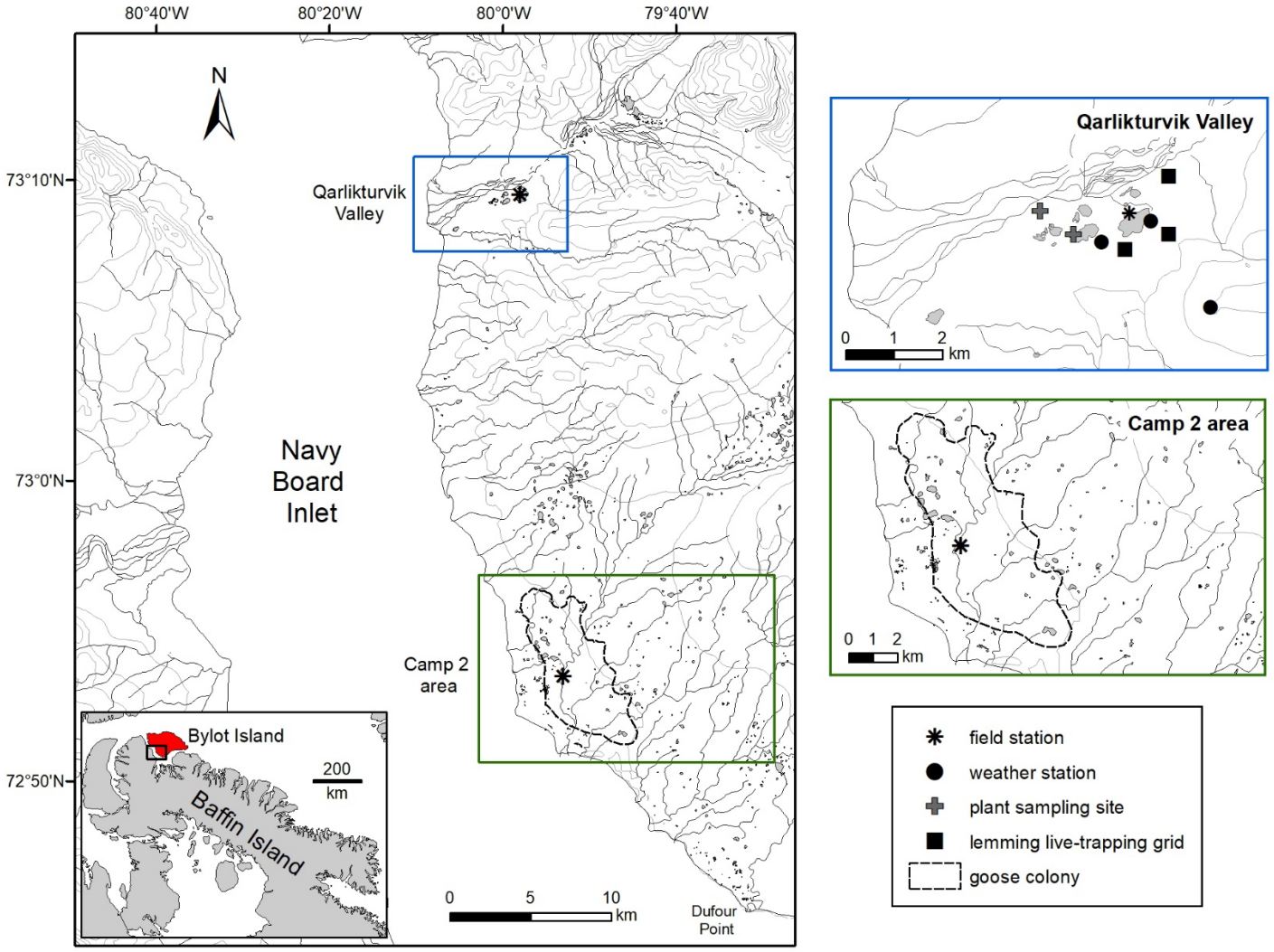

Figure 1. Location of the two main study sites (Qarlikturvik Valley and the Camp 2 area) on the South Plain of Bylot Island, Nunavut. Enlarged maps on the right present these study sites in more details, including locations of our field stations, automated weather stations, wetland sampling sites for plants, lemming live-trapping grids and the extent of the main snow goose colony. The Qarlikturvik Valley is predominantly a brood-rearing area for geese.

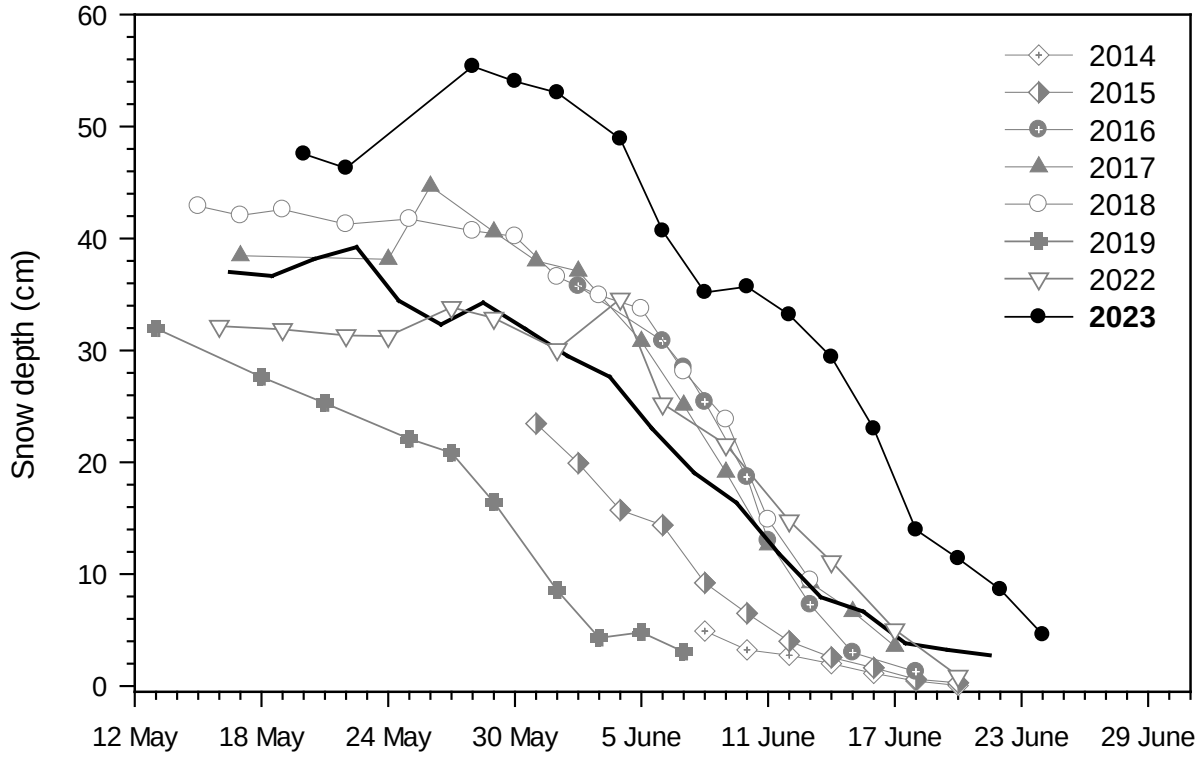

Figure 2. Average snow depth along two transects showing the rate of snowmelt in the lowlands of Bylot Island in spring over the past decade (n = 50 stations). The thick solid line represents the average snowmelt rate since 1995. No field data available in 2020 and 2021 due the covid19 pandemic.

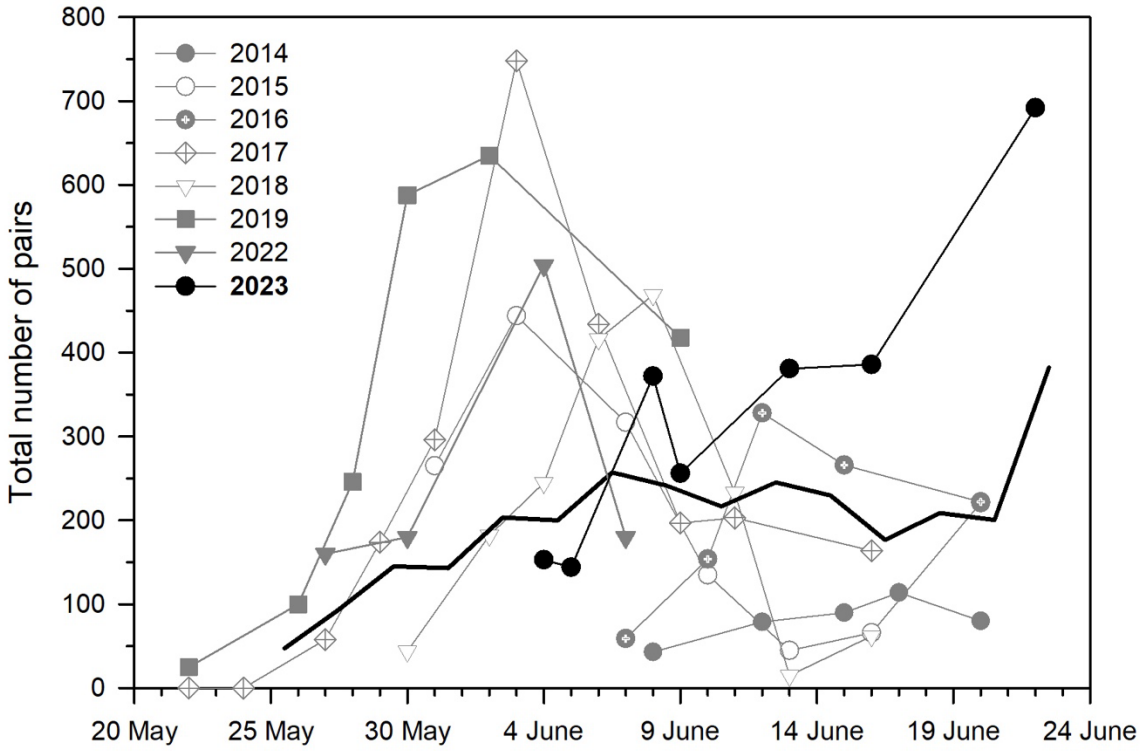

Figure 3. Total number of goose pairs counted in the Qarlikturvik Valley from arrival of our crew on Bylot Island in late May until the end of snowmelt over the past decade. The thick solid line represents the average number of goose pairs counted since 1996. No field data available in 2020 and 2021 due the covid19 pandemic.

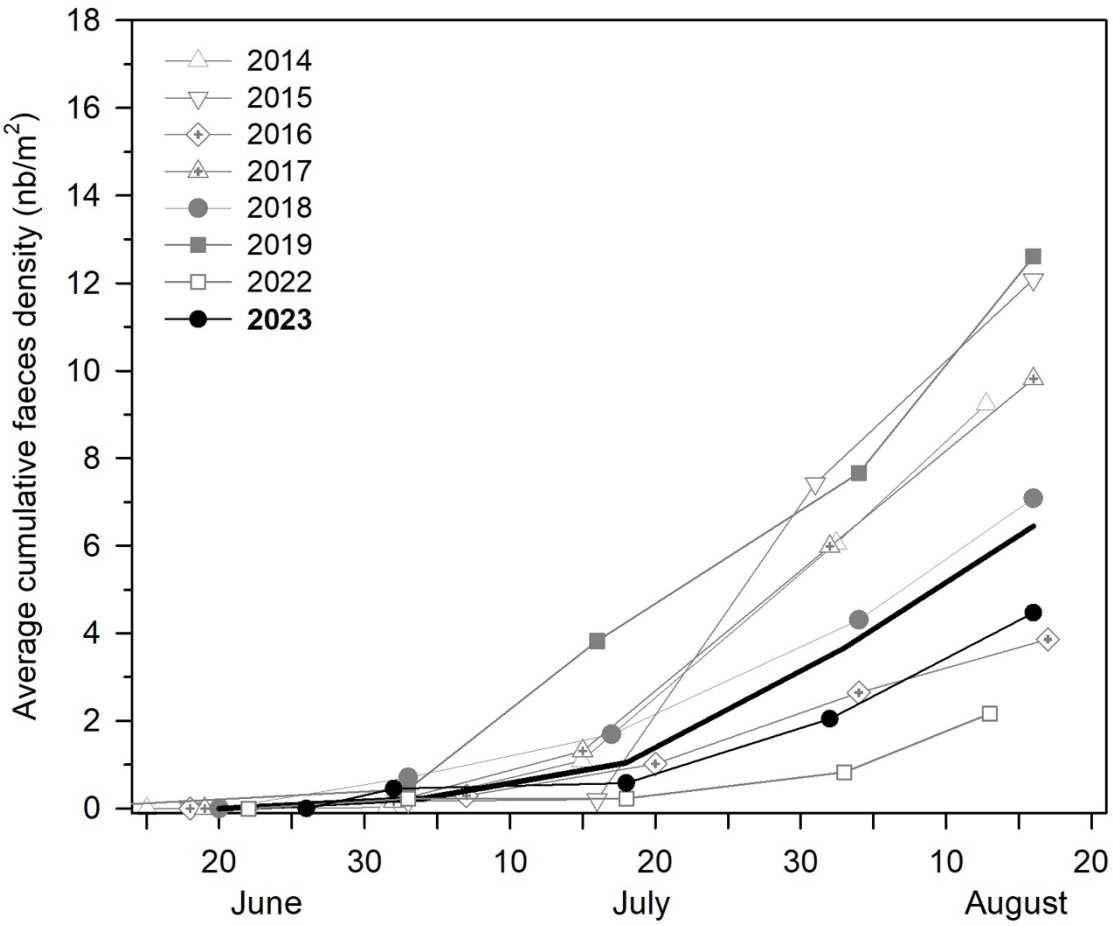

Figure 4. Average cumulative faeces density showing the use of the Qarlikturvik Valley by Greater Snow Goose families on Bylot Island throughout the summer over the past decade (n = 12 transects of 1 x 10 m; except 2013 n = 5 and 2016 n = 11). The thick solid line represents the average cumulative faeces density since 1990. No field data available in 2020 and 2021 due the covid19 pandemic.

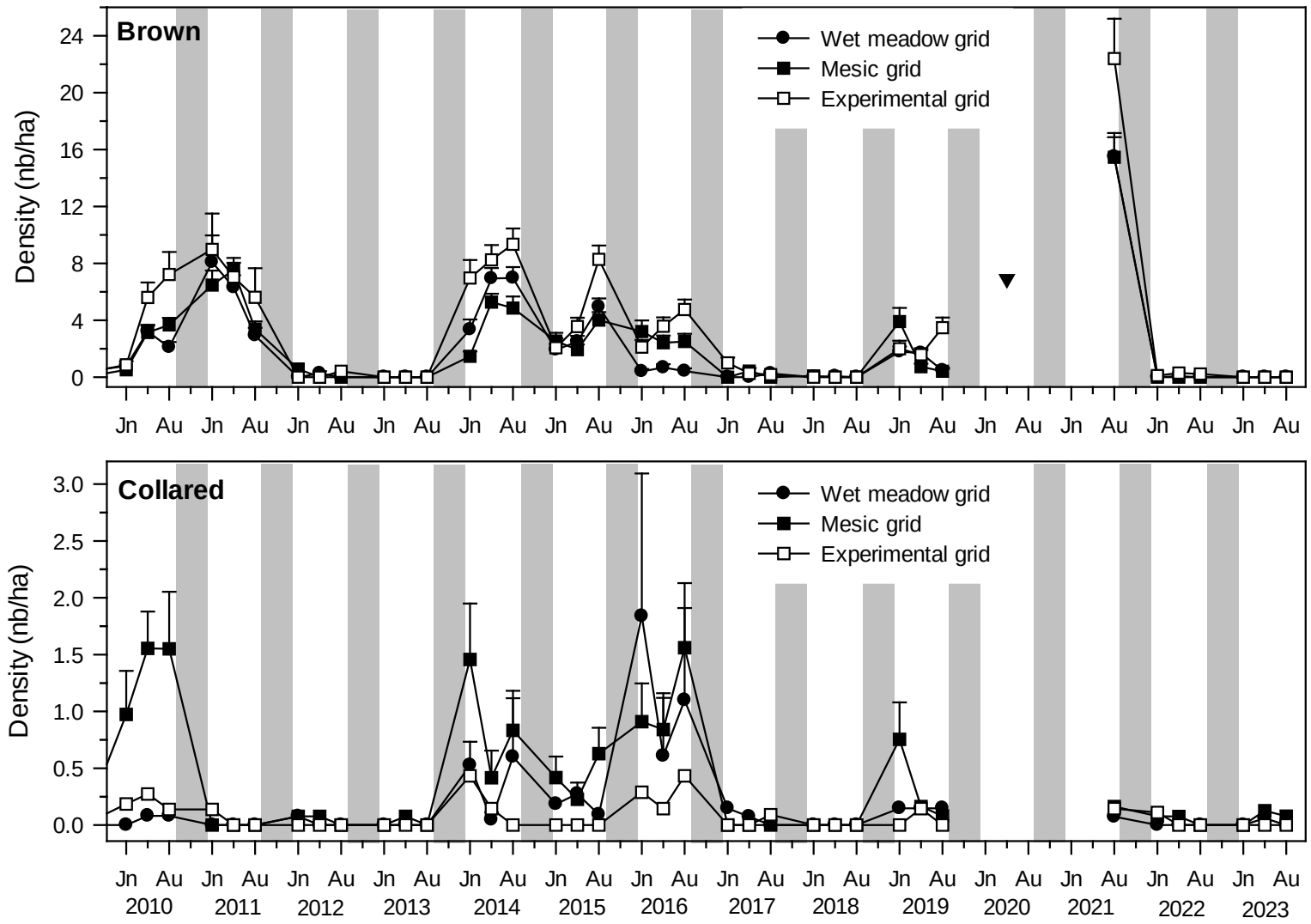

Figure 5. Annual summer density (+ SE) of Brown and Collared Lemmings on three trapping grids located in the Qarlikturvik Valley of Bylot Island over the past 14 years (snow cover was increased from 2008 to 2011 and predators were excluded from 2012 to 2022 on the experimental grid). The gray area indicates winter. Jn = mid-June, Au = mid-August. Lemming density in 2020 (both specied combined; black triangle) was inferred based on the density of snowy owls estimated through satellite images.

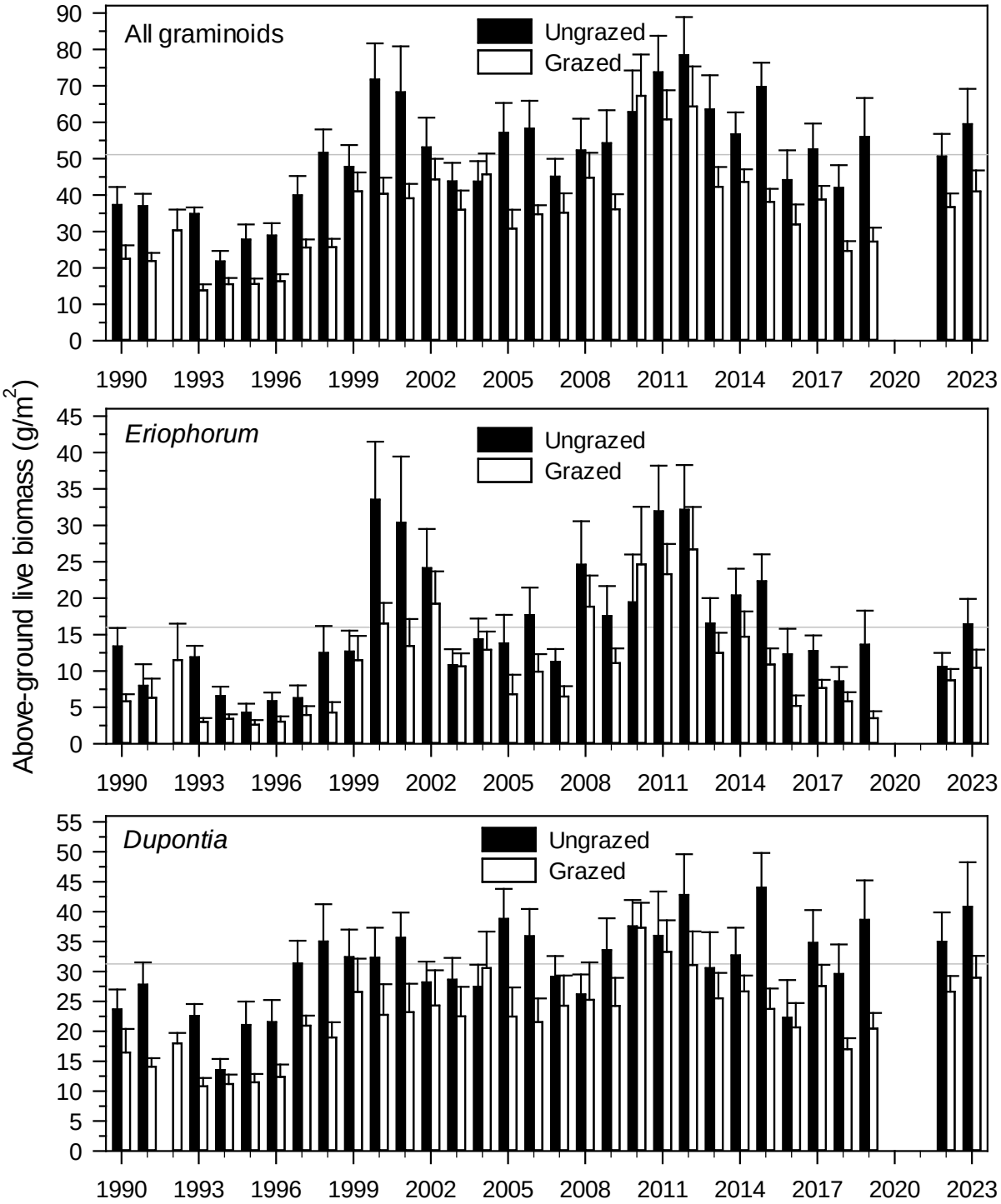

Figure 6. Live above-ground biomass (mean + SE, dry mass) of graminoids around 14 August in grazed and ungrazed wet meadows of the Qarlikturvik Valley, Bylot Island (n = 12, except in 2013, 2014 and 2016, n = 11). Total graminoids include *Eriophorum scheuchzeri*, *Dupontia fisheri* and *Carex aquatilis*. There is no data from ungrazed area in 1992. The solid gray line is the long-term average for ungrazed area. No field data available in 2020 and 2021 due the covid19 pandemic and 2023.

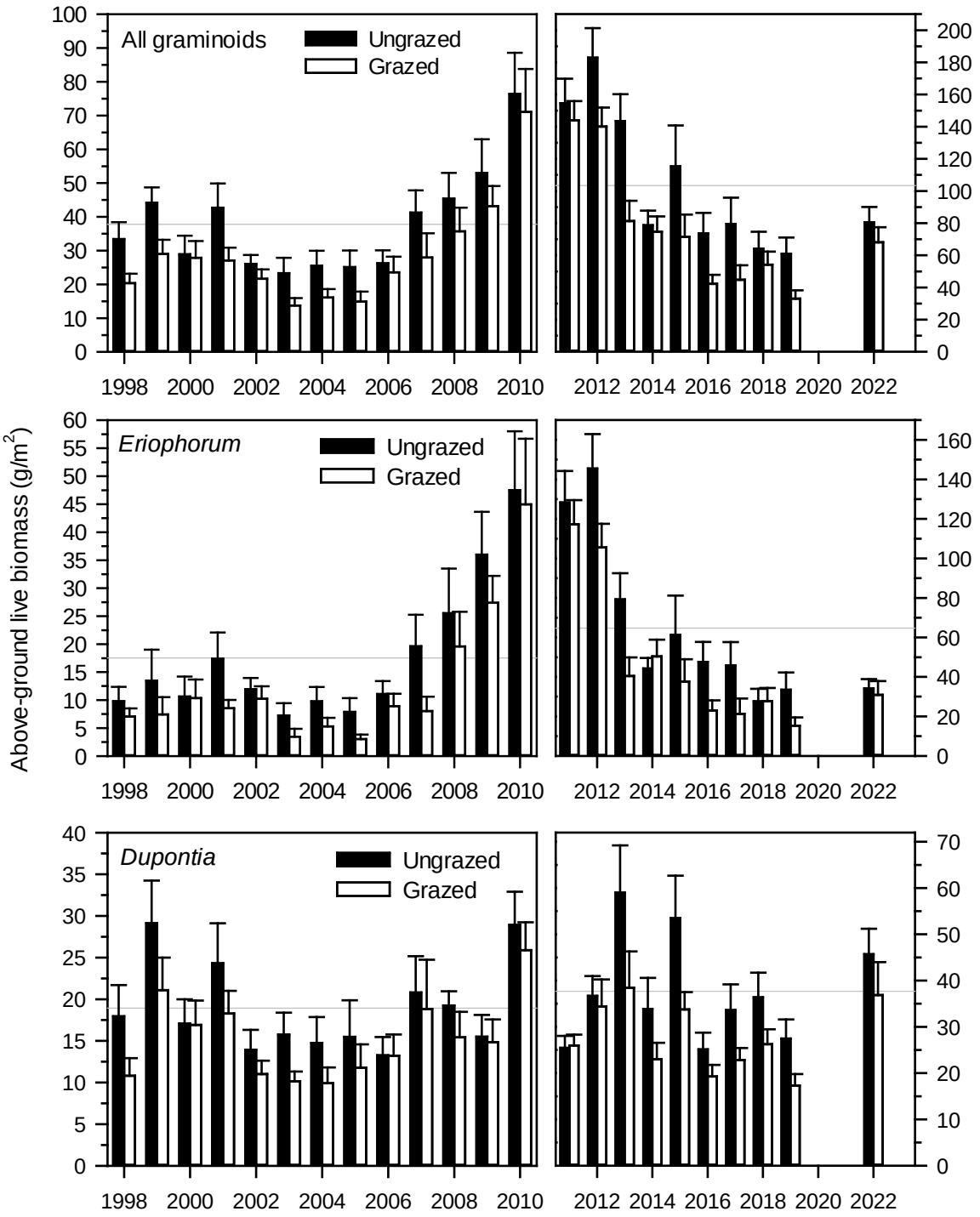

Figure 7. Live above-ground biomass (mean + SE, dry mass) of graminoids in mid-August in grazed and ungrazed wet meadows of the Camp 2 (goose colony), Bylot Island (n = 12, except in 2008 and 2014 n = 8, and 2012, 2013 and 2015 n = 10). Total graminoids include *Eriophorum scheuchzeri*, *Dupontia fisheri* and *Carex aquatilis*. Half of the exclosures had to be moved to a new site in 2011, which explains why the figure was split and the long-term average for ungrazed area (solid gray line) calculated separately before/after 2011. No field data available in 2020 and 2021 due the covid19 pandemic and 2023.

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C.157. Beardsell, A., G. Gauthier, D. Fortier, J.-F. Therrien & J. Bêty. 2014. Factors affecting nest occupancy and reproductive success of rough-legged hawks: a trade-off between predation risk, microclimatic conditions and nest stability? *Arctic Change 2014 conference,* Ottawa, ON.

C.156. Seyer, Y., G. Gauthier, J. Bêty & J.-F Therrien 2014. Migratory strategies and reproduction of the Long-tailed Jaeger in the Canadian Arctic. *Arctic Change 2014 conference*, Ottawa, ON.

C.155. Lapierre-Poulin, F., D. Fortier & D. Berteaux. 2014. Are arctic fox reproductive dens vulnerable to permafrost degradation? *Arctic Change 2014 conference*, Ottawa, ON.

C.154. Morin, C. & D. Berteaux. 2014. Seasonal migratory prey and cyclic variation in small mammal abundance affect Arctic fox litter size. *Arctic Change 2014 conference*, Ottawa, ON.

C.153. Chevallier, C., D. Berteaux & G. Gauthier. 2014. Estimating the age structure of an arctic carnivore population by comparing tooth wear and cementum line. *Arctic Change 2014 conference*, Ottawa, ON.

C.152. Berteaux, D. & G. Gauthier. 2014. Long-term monitoring of the Bylot Island tundra ecosystem: what did we learn? *Arctic Biodiversity Congress*, Trondheim, Norway.

C.151. Gauthier, G. 2014. Population dynamic and management of the greater snow goose population in North America. Symposium *The Changing World of the Goose*. Wageningen, Netherlands.

C.150. Gauthier, G., J.-F. Therrien & J. Bêty. 2014. Movements and breeding dispersal of Snowy Owls in eastern North America: a specialized predator exploiting a pulsed resource. *Third meeting of the International Snowy Owl Working Group*, Salekhard, Russia.

C.149. Robillard, A., J.-F. Therrien, G. Gauthier & J. Bêty. 2014. Winter ecology of Snowy Owls: post-reproductive movements and determinants of winter irruptions in North America. *Third meeting of the International Snowy Owl Working Group*, Salekhard, Russia.

C.148. Gauthier, G. 2013. Lemming population ecology on Bylot Island: Interaction between snow and predation. *Lemming and Snow Workshop*, University of Tromsø, Tromsø, Norway.

C.147. Beardsell A., G. Gauthier G., D. Fortier D. & J. Bêty. 2013. Breeding ecology of rough-legged hawks (*Buteo lagopus*) in the High Arctic: are nesting structures vulnerable to climate change? *Ninth ArcticNet Scientific Meeting*, Halifax, NS.

C.146. Robillard, A., J.-F. Therrien, G. Gauthier & J. Bêty. 2013. Multi-scale influence of small mammal summer densities on snowy owl winter irruptions in North America. *Ninth ArcticNet Scientific Meeting*, Halifax, NS.

C.145. Fauteux, D., G. Gauthier & D. Berteaux. 2013. Ten years of monitoring lemming demography in the Canadian High Arctic. *Ninth ArcticNet Scientific Meeting*, Halifax, NS.

C.144. Lamarre, J.-F., J. Bêty & G. Gauthier. 2013. Predator-mediated interactions between shorebirds and colony-nesting snow geese on Bylot Island, Nunavut. *5th Western Hemisphere Shorebird Group conference*, Santa Marta, Colombia.

C.143. Perkins, M., L. Ferguson, R.B. Lanctot, I.J. Stenhouse, D.C. Evers, N. Basu, J. Bêty, S. Brown, R. Gates, S. Kendall, J.-F. Lamarre, J. Liebezeit & B. Sandercock. 2013. Quantifying mercury exposure

for multiple shorebird species across the North American Arctic using blood and feather samples. *34th Annual Meeting of the Society of Environmental Toxicology and Chemistry*, Nashville, TN.

C.142. Lai, S., J. Bêty & D. Berteaux. 2013. Where do arctic foxes go in winter? A 6-year study using satellite telemetry on Bylot Island, Canada. *Fourth International Conference in Arctic Fox Biology*. Westfjords, Iceland.

C.141. Rioux, M.-J., S. Lai, J. Bêty & D. Berteaux. 2013. Spatial winter dynamics in arctic fox pairs at Bylot Island. *Fourth International Conference in Arctic Fox Biology*, Westfjords, Iceland.

C.140. Berteaux, D. 2013. Range margins of Arctic and Red fox in a rapidly changing Arctic, *8th Annual Meeting of the Canadian Society of Ecology and Evolution*, Kelowna, BC.

C.139. Berteaux, D. 2013. État et tendances de la biodiversité arctique. *Chantier arctique français*, Paris, France.

C.138. Legagneux, P., G. Gauthier, P.L.F. Fast, N. J. Harms, H. G. Gilchrist, C. Soos & J. Bêty. 2013. Empirical and experimental evidence of carry-over effects on waterfowl reproduction. *Canadian Society of Zoologists Annual Meeting*, Guelph, ON.

C.137. Souchay, G., G. Gauthier & R. Pradel. 2013. A new approach to account for temporary emigration using a multi-event framework. *EURING analytical conference*, Athens, GA.

C.136. Van Oudenhove, L., G. Gauthier, & J.D. Lebreton. 2013 Modelling climatic effects on the population dynamic of a long-distance, arctic-nesting migrant. *EURING analytical conference*, Athens, GA.

C.135. Legagneux, P., C. Juillet, P.L.F. Fast, G. Gauthier & J. Bêty. 2013. Experimental evidence of carry-over effects on greater snow goose reproduction and its management implications. *6th North American Duck Symposium and Workshop*, Memphis, TN.

C.134. Bêty, J. 2013. Understanding individual variation in reproductive strategies: the challenge of integrating physiology, optimization model and environmental stressors. *6th North American Duck Symposium and Workshop*, Memphis, TN.

C.133. Lefebvre, J., M. Huang, J.-F. Giroux, M. Bélisle, J. Bêty & C. Dwyer. 2013. Satellite telemetry improves our understanding of habitat use patterns and population estimates of greater snow geese. *6th North American Duck Symposium and Workshop*, Memphis, TN.

C.132. Bilodeau, F., S. Lai, G. Gauthier & D. Berteaux. 2012. Are tundra lemming populations controlled from the bottom-up or the top-down? *Eighth ArcticNet Scientific Meeting*, Vancouver, BC.

C.131. Fauteux, D., G. Gauthier, D. Berteaux & R. Boonstra. 2012. Direct and indirect effects of predation on lemmings in the High Arctic. *Eighth ArcticNet Scientific Meeting*, Vancouver, BC.

C.130. Doucet, C., G. Gauthier & J. Bêty. 2012. Synchrony between breeding phenology of an arctic-nesting insectivore and its food resources: investigating the effect of mismatch on juvenile growth rate. *Eighth ArcticNet Scientific Meeting*, Vancouver, BC.

C.129. Gauthier, G. 2012. Long-term changes in the Bylot Island tundra food web: a 20-year case study in the Canadian High Arctic. *Conference Tundra Change – The ecological dimension*. Aarhus, Denmark.

C.128. Fauchald, P., D. Ehrich, J. Schmidt, K. Klokov, F. S. I. Chapin, D. Berteaux & V. Hausner. 2012. The importance, management and status of harvested animals in the Arctic tundra ecosystems. *4th International Conference EcoSummit*, Columbus, OH.

C.127. Gauthier, G., D. Berteaux, P. Legagneux, D.G. Reid, C.J. Krebs & J. Bêty. 2012. The role of predators in controlling the tundra food web: New evidence from the ArcticWOLVES project. *International Polar Year Conference: From Knowledge to Action*. Montréal, QC.

C.126. Fast, P.L.F., M. Doiron, G. Gauthier, J.A. Schmutz, D.C. Douglas, J. Madsen, J.Y. Takekawa, J. Yee & J. Bêty. 2012. Linking animal migration, spring weather and timing of breeding in an arctic herbivore. *International Polar Year Conference: From Knowledge to Action*. Montréal, QC.

C.125. McKinnon, L., C.A. Corkery, E. Bolduc, C. Juillet, J. Bêty & E. Nol. 2012. Assessing the vulnerability of Arctic-nesting shorebirds to climate induced changes in food resource peaks. *International Polar Year Conference: From Knowledge to Action*. Montréal, QC.

C.124. Juillet, C., R. Choquet, G. Gauthier, R. Pradel & J. Lefebvre. 2012. Carry-over effects of spring hunt and climate on recruitment to the natal colony in a migratory species. *International Polar Year Conference: From Knowledge to Action*. Montréal, QC.

C.123. Lai, S., D. Berteaux and J. Bêty 2012. Movement tactics and habitat selection of overwintering arctic foxes in the Canadian high Arctic. *International Polar Year Conference: From Knowledge to Action*. Montréal, QC.

C.122. Lamarre, J.-F., J. Bêty & G. Gauthier. 2012. Shorebird predation risk in the high-Arctic, do geese have a role to play? *International Polar Year Conference: From Knowledge to Action*. Montréal, QC.

C.121. Berteaux, D., G. Gauthier, J. Bêty, A. Franke & G. Gilchrist. 2012. Effects of climate change on the canadian arctic wildlife. *International Polar Year Conference: From Knowledge to Action*. Montréal, QC.

C.120. Therrien, J.-F., G. Gauthier & J. Bêty. 2011. Avian predators play a key role in population regulation and energy flux of the Arctic tundra food web. *Annual Meeting of the Raptor Research Foundation*, Duluth, MN.

C.119. Bêty, J. 2011. Sensitive Arctic birds under the spotlights: global change and recent discoveries. *Society of Canadian Ornithologists Annual Meeting*, Moncton, NB.

C.118. Legagneux, P., P. Fast, G. Gauthier & J. Bêty. 2011. Manipulating individual state during migration provides evidence for carry-over effects modulated by environmental conditions. *Society of Canadian Ornithologists Annual Meeting*, Moncton, NB.

C.117. Bêty, J. 2011. Ecology and evolution of arctic migrants: fundamental questions and recent results. *Royal Swedish Academy of Sciences and Wenner-Gren Foundations*, Sweden.

C.116. Gauthier, G. 2011. Lemmings: a keystone species of the tundra food web vulnerable to climate change. *6th Annual Meeting of the Canadian Society of Ecology and Evolution*, Banff, AB.

C.115. Tarroux, A., D. Berteaux & J. Bêty. 2011. The marine side of a terrestrial mammal: trophic niche and diet specialization of arctic foxes. *Estación Biológica de Doñana – CSIC*, Sevilla, Spain.

C.114. Gauthier, G. & M.-C. Cadieux. 2011. Goose-plant interactions on Bylot Island in the context of global warming. *Twelfth North American Arctic Goose Conference*, Portland, OR.

C.113. Legagneux, P., P. Fast, G. Gauthier & J. Bêty. 2011. Migratory connectivity in Greater Snow Geese: carry-over effects of a manipulation of spring body condition. *Twelfth North American Arctic Goose Conference*, Portland, OR.

C.112. Fast, P., C. Redjadj, G. Gauthier & J. Bêty. 2011. Using isotopes to assess the importance of stopover sites to fuel migration and reproduction in Snow Geese. *Twelfth North American Arctic Goose Conference*, Portland, OR.

C.111. Doiron, M., G. Gauthier & E. Lévesque. 2011. Climate change and the ecological mismatch between Greater Snow Goose breeding and plant phenology. *Twelfth North American Arctic Goose Conference*, Portland, OR.

C.110. Desnoyers, M. & G. Gauthier. 2011. Travelling in greater snow goose flocks: do you know with whom you're travelling? *Twelfth North American Arctic Goose Conference*, Portland, OR.

C.109. Horrigan, E., R.L. Jefferies & G. Gauthier. 2011. Vegetation responses to simulated snow goose herbivory in two arctic ecosystems. *Twelfth North American Arctic Goose Conference*, Portland, OR.

C.108. Gauthier, G. & D. Berteaux. 2010. Is the tundra food web controlled by top predators? New evidence from the ArcticWOLVES project. *Seventh ArcticNet Scientific Meeting*, Ottawa, ON.

C.107. Bilodeau, F., G. Gauthier & D. Berteaux. 2010. Life under the snow: the effect of the snow cover on lemming population dynamics. *Seventh ArcticNet Scientific Meeting*, Ottawa, ON.

C.106. Chalifour, E., J. Bêty, M. Bélisle, J. Lefebvre & J.-F. Giroux. 2010. Molt migration of Greater Snow Geese. *Seventh ArcticNet Scientific Meeting*, Ottawa, ON.

C.105. Tarroux, A., D. Berteaux & J. Bêty. 2010. Surviving the arctic winter: insights into the foraging tactics of an arctic terrestrial predator. *Seventh ArcticNet Scientific Meeting*, Ottawa, ON.

C.104. Fast, P. 2010. Studies of migratory connectivity and nest choice in Arctic waterfowl. *Max Planck Institute for Ornithology*, Seewiesen, Germany.

C.103. Gauthier, G., J.-F. Therrien, J. Bêty, F. Doyle & D. Reid. 2010. Surprising migratory movements and site fidelity unraveled by satellite-tracking of snowy owls. *25th International Ornithological Conference*, Sao Paulo, Brazil.

C.102. Legagneux, P., G. Gauthier, D. Berteaux, J. Bêty, M.-C. Cadieux, G. Szor, F. Bilodeau, E. Bolduc, L. McKinnon, A. Tarroux, J.-F. Therrien, M.-A. Valiquette, L. Morissette & C.J. Krebs. 2010. Modeling temporal trophic dynamics of a terrestrial arctic ecosystem. *IPY Oslo Conference*, Oslo, Norway.

C.101. Doiron, M., G. Gauthier & E. Lévesque. 2010. Plant-herbivore interactions and climate change: the case of the Greater Snow Goose. *IPY Oslo Conference*, Oslo, Norway.

C.100. Legagneux, P., P. Fast, G. Gauthier & J. Bêty 2010. Effect of spring condition manipulation on reproductive success in the greater snow geese *Chen caerulescens*. *5th annual meeting of the Canadian Society of Ecology and Evolution*, Quebec, QC.

C.99. Therrien, J.-F., G. Gauthier & J. Bêty. 2010. The lemming buffet: is there anything left after owls and jaegers have eaten? *5th annual meeting of the Canadian Society of Ecology and Evolution*, Quebec, QC.

C.98. Desnoyers, M. & G. Gauthier. 2010. Le voyage organisé, un aspect inconnu du comportement grégaire de la grande oie des neiges *Chen caerulescens*. *5th annual meeting of the Canadian Society of Ecology and Evolution*, Quebec, QC.

C.97. Gauthier, G., D. Berteaux, J. Bêty, P. Legagneux, L. McKinnon, J.-F. Therrien, A. Tarroux, M.-C. Cadieux, C.J. Krebs, D. Reid, & D. Morris. 2010. The role of predators in structuring the Arctic terrestrial food web: preliminary results from the ArcticWOLVES project. *IPY Canada Early Results Workshop*, Ottawa, ON.

C.96. Doiron, M., G. Gauthier, & E. Lévesque. 2010. Impacts of climate change on a High Arctic herbivore: The case of the Greater Snow Goose. *IPY Canada Early Results Workshop*, Ottawa, ON.

C.95. Therrien, J.-F., G. Gauthier, J. Bêty D. Reid and F. Doyle. 2010. Long-distance movements of two avian predators, the Snowy Owl and Long-tailed Jaeger, tracked via satellite. *IPY Canada Early Results Workshop*, Ottawa, ON.

C.94. Reid, D., C.J. Krebs, G. Gauthier, A. Kenney, S. Gilbert, E. Hofer, D. Duchesne, M. Leung & F. Bilodeau. 2010. Snow depth and small mammal winter habitat choice: a tundra fencing experiment. *IPY Canada Early Results Workshop*, Ottawa, ON.

C.93. Lai, S., D. Berteaux & J. Bêty. 2009. From land to sea ice with the arctic fox, following the movements of a terrestrial mammal in the Canadian High Arctic. *Sixth ArcticNet Scientific Meeting*, Victoria, BC.

C.92. Tarroux, A., D. Berteaux & J. Bêty. 2009. Nomades de l'Arctique: Capacité de déplacement à grande échelle chez le renard polaire. *Sixth ArcticNet Scientific Meeting*, Victoria, BC.

C.91. Tarroux, A., D. Berteaux & J. Bêty. 2009. The marine side of a terrestrial mammal: trophic niche and diet specialization in arctic foxes. *Sixth ArcticNet Scientific Meeting*, Victoria, BC.

C.90. Therrien, J.-F., G. Gauthier & J. Bêty. 2009. The lemming buffet: is there anything left after owls and jaegers have eaten? *Sixth ArcticNet Scientific Meeting*, Victoria, BC.

C.89. Fast, P., C. Redjadj, G. Gauthier & J. Bêty. 2009. Fuelling up before the flight: Assessing the importance of stopover sites in an Arctic migrant using stable isotopes. *Sixth ArcticNet Scientific Meeting*, Victoria, BC.

C.88. Gauthier, G., C. Juillet, J. Bêty & M. Morrissette. 2009. Annual productivity in Greater Snow Geese: which fecundity parameter is the best predictor and why? *Meeting of the International Society of Ecological Modelling*, Quebec City, QC.

C.87. Legagneux, P., G. Gauthier & C.J. Krebs. 2009. Spatial and temporal trophic dynamics of terrestrial arctic ecosystems. *ECOPATH conference*, Vancouver, BC.

C.86. Gauthier, G. 2009. Impact of climate change on arctic terrestrial food webs: examples from the Bylot Island long term study. *Canadian Society of Ecology and Evolution Annual Meeting*, Halifax, NS.

C.85. Gauthier, G. & D. Berteaux. 2008. Arctic Wildlife Observatories Linking Vulnerable EcoSystems (ArcticWOLVES): A study of the impact of climate change on tundra food webs. *Arctic Change Conference*, Quebec City, QC.

C.84. Gauthier, G. & M.C. Cadieux. 2008. Impact of climate change on arctic terrestrial food webs: examples from the Bylot Island long term study. *Arctic Change Conference*, Quebec City, QC.

C.83. Doiron, M., G. Gauthier & E. Lévesque. 2008. Plant-herbivore interactions and climate change: The Case of the Greater Snow Goose. *Arctic Change Conference*, Quebec City, QC.

C.82. Therrien, J.-F., G. Gauthier & J. Bêty. 2008. Reproductive success and long-distance movements of Snowy Owls: is this top arctic predator vulnerable to climate change? *Arctic Change Conference*, Quebec City, QC.

C.81. Valiquette, M.A. & G. Gauthier. 2008. Numerical and functional responses of a generalist avian predator, the glaucous gull, to variations in lemming abundance in the Arctic. *Arctic Change Conference*, Quebec City, QC.

C.80. Juillet, C., M. Doiron, G. Gauthier & M.C. Cadieux. 2008. Importance of local and regional climatic effects on the reproduction of a migratory species, the Greater Snow Goose. *Arctic Change Conference*, Quebec City, QC.

C.79. Côté, G., R. Pienitz, G. Gauthier, D. Muir & B. Wolfe. 2008. Impacts of present-day and past animal populations on the nutrient and contamination status of freshwater lakes on Bylot Island, Nunavut (Canada). *Arctic Change Conference*, Quebec City, QC.

C.78. Pouliot, R., L. Rochefort, M. Marchand-Roy & G. Gauthier. 2008. Polygon fens and trophic interactions: 15 years of research on Bylot Island. 4th International Meeting on the Biology of Sphagnum, Juneau, Alaska.

C.77. Gauthier, G. & D. Berteaux. 2008. ArcticWOLVES: a study of the tundra food web. *International IPY conference on the Dynamics of Lemmings and Arctic foxes in the Circumpolar Tundra*, Salekhard, Russie.

C.76. Berteaux, D. & Gauthier, G. 2008. Dynamics of lemmings and arctic foxes on Bylot Island, Nunavut, Canada. *International IPY conference on the Dynamics of Lemmings and Arctic foxes in the Circumpolar Tundra*, Salekhard, Russie.

C.75. Duchesne, D., G. Gauthier & D. Berteaux. 2007. Characterization of the winter environment of lemmings in relation to the snow cover in the Arctic. *Fourth ArcticNet Scientific Meeting*, Collingwood, ON.

C.74. Doiron, M., G. Gauthier & E. Lévesque. 2007. Impacts of climate change on plant-herbivore interactions in the High Arctic. *Fourth ArcticNet Scientific Meeting*, Collingwood, ON.

C.73. Juillet, C., G. Gauthier, R. Pradel & Rémi Choquet. 2007. Use of mixture of information models to evaluate the effect of special conservation measures on survival in a hunted species, the Greater Snow Goose. *EURING-2007 meeting*, Otago, New Zealand.

C.72. Gauthier, G., K. Hobson & J. Bêty. 2006. Diet change inferred from stable-isotopes in spring-staging Greater Snow Geese. *XXIVth International Ornithological Congress*, Hamburg, Germany.

C.71. Gauthier, G. 2006. Application of capture-recapture methods to demographic analyses of bird populations: case studies with an emphasis on multistate models. Colloque *Capture 2006*, Université Laval, Québec, QC.

C.70. Dickey, M.-H. & G. Gauthier. 2005. Effect of climate variables on the phenology and reproductive success of Greater Snow Geese (*Chen caerulescens atlantica*). *Eleventh North American Arctic Goose Conference*, Reno, NV.

C.69. Lecomte, N., G. Gauthier, L. Bernatchez & J.-F. Giroux. 2005. Population structure of a Greater Snow Goose colony. *Eleventh North American Arctic Goose Conference*, Reno, NV.

C.68. Gauthier, G., A.M. Calvert & E.T. Reed. 2005. Impacts of special conservation measures on demographic parameters in Greater Snow Geese (*Chen caerulescens atlantica*). *Eleventh North American Arctic Goose Conference*, Reno, NV.

C.67. Mainguy, J., G. Gauthier, J.-F. Giroux & J. Bêty. 2005. Long distance brood movements in Greater Snow Geese: effects on goslings growth and survival. *Eleventh North American Arctic Goose Conference*, Reno, NV.

C.66. Ouellet, N., J. Larochelle & G. Gauthier. 2005. Effect of locomotion on growth in Greater Snow Goose goslings (*Chen caerulescens atlantica*). *Eleventh North American Arctic Goose Conference*, Reno, NV.

C.65. Lecomte, N., G. Gauthier & J.-F. Giroux. 2005. Habitat effects on nest predation risks: the case of the Greater Snow Goose. *Eleventh North American Arctic Goose Conference*, Reno, NV.

C.64. Audet, B., G. Gauthier & E. Lévesque. 2005. Feeding ecology of Greater Snow Goose (*Chen caerulescens atlantica*) goslings in upland tundra on Bylot Island, Nunavut. *Eleventh North American Arctic Goose Conference*, Reno, Nevada.

C.63. Bêty, J., J.-F. Giroux, & G. Gauthier. 2004 Individual variation in timing of migration: causes and reproductive consequences in greater snow geese. *122nd American Ornithologist Union Meeting*, Québec, Canada.

C.62. Calvert, A.M. & G. Gauthier. 2004. Exceptional conservation measures: how have they affected survival and hunting mortality in greater snow geese. *122nd American Ornithologist Union Meeting*, Québec, Canada.

C.61. Audet, B., G. Gauthier & E. Lévesque. 2004. Feeding ecology of Greater Snow Goose (*Chen caerulescens atlantica*) goslings in upland tundra on Bylot Island, Nunavut. *122nd American Ornithologist Union Meeting*, Québec, Canada.

C.60. Lecomte, N., G. Gauthier & J.F. Giroux. 2004. Habitat effects on nest predation risks: the case of the Greater Snow Goose. *122nd American Ornithologist Union Meeting*, Québec, Canada.

C.59. Gauthier, G., J.-F. Giroux, A. Reed, A. Béchet & L. Bélanger. 2004. Interactions between land use, habitat use and population increase in greater snow geese: what are the consequences for natural wetlands? Intecol 7th Interational Wetlands conference, Utrecth, Netherlands.

C.58. Giroux, J.-F., G. Gauthier, A. Béchet, M. Féret, J. Mainguy, J. Bêty & V. Lemoine. 2003. Controling overabundant bird populations: the case of the greater snow goose. Third International Wildlife Management Congress, 1-5 December 2003, Christchurch, New Zealand.

C.57. Gauthier, G. & J.D. Lebreton. 2003. Population models in Greater Snow Geese: a comparison of different approaches. *EURING-2003 meeting*, Radolfzell, Germany.

C.56. Reed, E., G. Gauthier & J.-F. Giroux. 2003. Effects of spring conditions on breeding propensity of greater snow goose females. *EURING-2003 meeting*, Radolfzell, Germany.

C.55. Calvert, A.M. & G. Gauthier. 2003. Applying band recovery models to an evaluation of the demographic impacts of exceptional conservation measures. *EURING-2003 meeting*, Radolfzell, Germany.

C.54. Gauthier, G., J. Bêty, J.-F. Giroux & L. Rochefort. 2003. Trophic interactions in a High Arctic Snow Goose colony. *Annual Meeting of the Society for Integrative and Comparative Biology*, Toronto, ON.

C.53. Fournier, F., G. Gauthier & J. Larochelle. 2003. The effect of food quality on developmental plasticity and digestive efficiency in Greater Snow Goose goslings. *Annual Meeting of the Society of integrative and comparative biology*, Toronto, ON.

C.52. Gauthier, G. 2002. Are Greater Snow Geese overabundant? A review of population Dynamics and management actions on this population in North America. *7th Annual Meeting of the Goose Specialist Group of Wetlands International*, El Rocio, Spain.

C.51. Gauthier, G., F. Fournier & J. Larochelle. 2002. The effect of environmental conditions on early growth in geese. *XXIIIrd International Ornithological Congress*, Beijing, China

C.50. Gauthier, G., J.-F. Giroux & L. Rochefort. 2002. The impact of goose grazing on Arctic and temperate wetlands. *XXIIIrd International Ornithological Congress*, Beijing, China.

C.49. Bêty, J., G. Gauthier, E. Korpimäki & J.-F. Giroux. 2001. Shared predators and indirect trophic interactions: lemming cycles and arctic-nesting geese. *119th American Ornithologist Union Meeting*, Seattle, WA.

C.48. Bourguelat, G., G. Gauthier & R. Pradel. 2001. New analytical tools to study stopover length in birds: what can we learn from the greater snow goose example? *119th American Ornithologist Union Meeting*, Seattle, WA.

C.47. Gauthier, G. 2001. The effects of management actions on populations: greater snow goose. *Tenth North American Arctic Goose Conference*, Québec, QC.

C.46. Gauthier, G. & J.D. Lebreton. 2001. Population models in greater snow geese: a comparison of different approaches. *Tenth North American Arctic Goose Conference*, Québec, QC.

C.45. Gauthier, G., K. Hobson & J. Bêty. 2001. The role of nutrient reserves in egg formation in greater snow geese: a reply to Ankney (1995). *Tenth North American Arctic Goose Conference*, Québec, QC.

C.44. Mainguy, J., J. Bêty & G. Gauthier. 2001. Is body condition of laying greater snow geese affected by the Québec spring conservation hunt? *Tenth North American Arctic Goose Conference*, Québec, QC.

C.43. Bêty, J., G. Gauthier, E. Korpimäki & J.-F. Giroux. 2001. Cyclic lemmings and greater snow geese: direct observations of an indirect trophic interaction. *Tenth North American Arctic Goose Conference*, Québec, QC.

C.42. Reed, E. & G. Gauthier. 2001. The costs of raising a family in greater snow geese *Chen caerulescens atlantica*. *Tenth North American Arctic Goose Conference*, Québec, QC.

C.41. Righi, M. & G. Gauthier. 2001. Abundance and distribution of intestinal helminths in greater snow geese on the breeding colony, and during their fall and spring migration. *Tenth North American Arctic Goose Conference*, Québec, QC.

C.40. Renaud, M., G. Gauthier & J. Larochelle. 2001. Energetic cost of thermoregulation for greater snow goose goslings growing in a natural environment. *Tenth North American Arctic Goose Conference*, Québec, QC.

C.39. Féret M., G. Gauthier, J.-F. Giroux & K. Hobson. 2001. Impact of spring conservation hunt on nutrient storage of greater snow geese staging in Québec. *Tenth North American Arctic Goose Conference*, Québec, QC.

C.38. Bourguelat, G., G. Gauthier & R. Pradel. 2001. Estimation of the fall stopover length of the greater snow goose in the St. Lawrence estuary using capture-recapture methods. *Tenth North American Arctic Goose Conference*, Québec, QC.

C.37. Béchet, A. J.-F. Giroux & G. Gauthier. 2001. Impact of a spring hunt on the regional movements of staging greater snow geese. *Tenth North American Arctic Goose Conference*, Québec, QC.

C.36. Demers, F. J.-F. Giroux, G. Gauthier & J. Bêty. 2001. Effect of collar-attached transmitters on pair bond, breeding success and behavior of greater snow geese. *Tenth North American Arctic Goose Conference*, Québec, QC.

C.35. Otis, P., J. Larochelle & G. Gauthier. 2001. Energy cost of locomotion in greater snow goose goslings. *Tenth North American Arctic Goose Conference*, Québec, QC.

C.34. Duclos, I., E. Lévesque & L. Rochefort. 2001. Mesic habitats of the Greater Snow Goose (*Chen caerulescens atlantica*) on Bylot Island (Nunavut): characterization and feeding potential. *Tenth North American Arctic Goose Conference*, Québec, QC.

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T.83. Corbeil-Robitaille, M.-Z. 2023. Refuges anti-prédation dans le paysage: processus de formation et sélection des îlots par les oiseaux nicheurs de l'île Bylot. MSc thesis, Département de biologie, Université du Québec à Rimouski.
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T.80. Clermont-Beaudoin, J. 2023. Effets des mouvements, des comportements alimentaires et de la témérité d'un prédateur territorial sur une communauté de proies. PhD thesis, Département de biologie, Université du Québec à Rimouski.
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