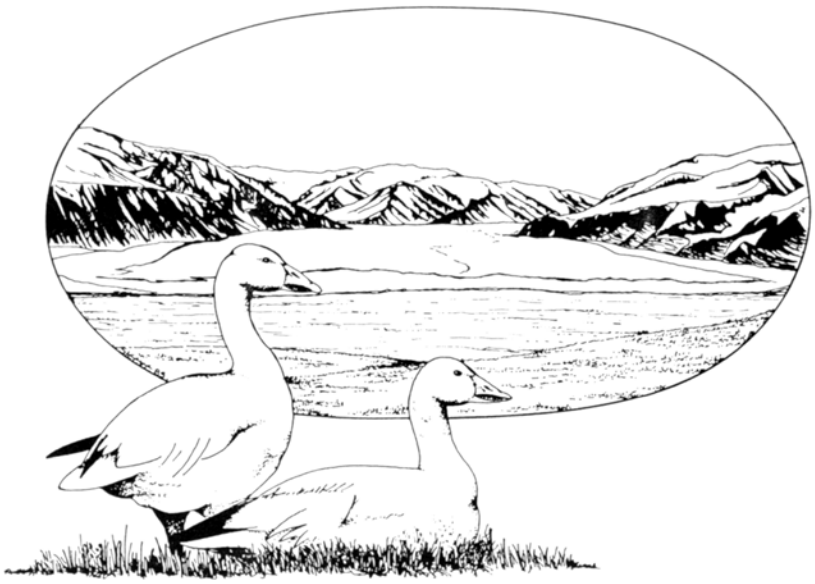
POPULATION STUDY OF GREATER SNOW GEESE AND ITS NESTING HABITAT ON BYLOT ISLAND, NUNAVUT IN 2018: A PROGRESS REPORT



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INTRODUCTION

In 2018, 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 considerable stress on its breeding habitat, while extensive use of agriculture lands provides an unlimited source of food during winter and migratory stopovers for them. Remedial management actions during autumn, 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 2018 were as follows:

1) Monitor productivity (egg laying date, clutch size and nesting success) of Greater Snow Geese on Bylot Island.
2) Mark goslings in the nest to provide a sample of known-age individuals to be used to assess the growth of goslings by their recapture in late summer.
3) Band goslings and adults, and neck-collar adult females at the end of the summer to continue the long-term study of demographic parameters such as survival and breeding propensity.
4) Monitor the abundance of lemmings and study their demography along with factors affecting their cyclic fluctuations of abundance.
5) Monitor the breeding activity of other bird species and in particular avian predators (owls, jaegers, gulls and hawks).
6) Monitor the breeding activity of foxes at dens.
7) Capture and mark adult foxes and their pups with ear-tags to study their movements and demography.
8) Sample plants in exclosures to assess annual production and the impact of goose grazing on plant abundance in wet meadows.
9) Maintain our automated environmental and weather monitoring system.

FIELD ACTIVITIES

***Field camps.* —** In 2018, 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 9 May to 21 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 26 May to 20 July (Fig. 1). Finally, 6 fly camps were also established for periods ranging from 3 to 28 days at various times throughout the island, west of Dufour Point.

***Field parties.* —** The total number of people in both camps ranged from 4 to 16 depending on the period. Members of our field party included project leaders Gilles Gauthier, Joël Bêty, Dominique Berteaux, Josée Lefebvre and several graduate students whose thesis projects addressed many of the objectives mentioned above: Frédéric LeTourneux (PhD, objectives 1, 2 and 3), Mathilde Poirier (PhD, objective 4), Yannick Seyer (PhD, objective 5), Alexis Grenier-Potvin (MSc, objective 6) and Jeanne Clermont (PhD, objective 7). Several other students assisted them in the field, including Marianne Valcourt, Madelaine Proulx, Audrey Roy, Jacob Bruel-Courville, Mathieu Manuel, Clément Chevalier and Marie-Pier Poulin. Other people in the field included Marie-Christine Cadieux, a research professional in charge of goose banding and plant sampling (objectives 3 and 8); Denis Sarrazin, research professional responsible of the maintenance of the weather stations (objective 9); Dominique Fauteux, a researcher from the Canadian Museum of Nature (objective 4); Christian Marcotte, a wildlife technician from the Canadian Wildlife Service (CWS, Quebec region) and Pierre Legagneux, a researcher from the Centre National de la Recherche Scientifique (CNRS, France). Finally, we hired 2 persons from Pond Inlet work with us. They were Sylvia Pewatoalook (marking goslings in nests and goose banding: 3-15 July and 7-14 August) and Jonas Arreak (lemming monitoring: 30 June-6 July).

Several other people also used our camps during the summer. They were Andréanne Beardsell (PhD student), Aurélie Chagnon-Lafortune (MSc student) and Éliane Duchesne (MSc student) who studied shorebirds, lapland longspurs and insects under the supervision of Joël Bêty; the field party of Daniel Fortier (Université de Montréal) and Mélissa Lafrenière (Queen's University), which included Karine Rioux (MSc student) who studied the permafrost and geomorphology; the field party of Esther Lévesque, Christophe Kinnard and Vincent Maire (Université du Québec à Trois-Rivières), which included Lucas Deschamps (PhD student), Hadi Mohammadzadeh Khani (PhD student), Matthieu Loyer (MSc student), Amélie Morneault (MSc student), Simon Charbonneau and Isabelle Gosselin who studied plant ecology and hydrology; the field party of Isabelle Laurion (Institut National de la Recherche Scientifique), which included Thomas Pacoureau (PhD student), Vincent Laderrière (PhD student) and Raoul-Marie Couture who studied the carbon cycle in ponds; and Florent Dominé (Takuvik, Université Laval/CNRS), Mathieu Barrère and Mikael Gagnon (MSc student) who studied the snow physical properties. Brian Koonoo and Terry Kalluk from Parks Canada inspected both camps during the summer. Sheatie Tagak and his team from Tagak Outfitting Services also guided the research teams of Christophe Kinnard and Florent Dominé in snowmobiles to bring them to the main field station in early May. Finally, Keita Nishizawa (PhD student) from Yokohama National University (Japan) visited our plant sampling sites in the Qarlikturvik Valley to assess them for a possible collaboration.

***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 every two to three days from our arrival on the island on 30 May until the end of snowmelt on sample plots. Nest searches were carried out within walking distance (~6 km) of both the main field station and the Camp 2 between 8 and 18 June. Nests 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 2-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.

***Goose banding.* —** From 7 to 14 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) and some adult females were fitted with coded yellow plastic neck-collars. We also collected oral and cloacal swab samples from goslings for the Centre de recherche en infectiologie, CHU de Québec-Université Laval.

***Small mammals.* —** We sampled the annual abundance of lemmings at two sites in the Qarlikturvik Valley (one in wet meadow and one in mesic habitat) and one site at the Camp 2 (mixed habitat) in July using snap-traps. At each site, we used 240 Museum Special traps set at 80 stations (3 traps per station), spaced 15-m apart along two to four parallel transect lines 100 m apart and left open for 3 days. We also sampled lemming abundance and demography using live-traps. We trapped on 2 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). We also trapped at three other sites (270 × 270 m grids with 100 traps; mixed habitat): one between the main field station and Camp 2, one at Camp 2 and one at Dufour Point. 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) on grids of the Qarlikturvik Valley and during one period in mid-July elsewhere.

All trapped 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 163 500-m transects randomly distributed in different habitats (wetlands, mesic tundra, streams in mesic tundra and willow shrubs) at the four sites where live-traping was conducted.

Breeding activity of foxes at dens and marking. **—** All known fox dens located within a 600 km^2 area were visited one to five times during the summer and inspected for signs of use and/or presence of reproductive adults with pups. Automated cameras were deployed at dens showing signs of activity. We attempted to live-trap adults with padded leghold traps at locations where foxes were seen hunting or travelling. At reproductive dens, we noted the species (Arctic Fox, *Vulpes lagopus*, or Red Fox, *Vulpes vulpes*) and minimum litter size, and, whenever possible, we live-trapped pups with Tomahawk collapsible cage traps. Cage traps were kept under continuous surveillance and leghold traps were visited at least every 6 hours. Captured foxes were measured, weighed and tagged on both ears using a unique set of coloured and numbered plastic tags. Samples of winter and summer fur, blood, saliva, claws and scats were also collected for genetic, microbiome and diet analyses.

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

Monitoring of plant growth and goose grazing. **—** The annual plant production and the impact of goose grazing was evaluated in wet meadows dominated by graminoid plants at 2 sites (Fig. 1): the Qarlikturvik Valley (brood-rearing areas), and the Camp 2 area (nesting colony). At each site, 12 exclosures (1 × 1 m) were installed in late June in two groups of 6 in the same general area every year. At Camp 2, one of the groups of 6 exclosures was moved about 200 m in 2011 due to the natural drainage of some wetlands. Plant biomass was sampled in ungrazed and grazed areas (i.e. inside and outside exclosures) at the end of the plant-growing season between 11 and 15 August. Plants were sorted into sedges (*Eriophorum scheuchzeri* and *Carex aquatilis*) and grasses (*Dupontia fisheri*). Use of the area by geese was monitored by counting faeces on 1 × 10 m transects located near each exclosure every 2 weeks in the Qarlikturvik Valley and once at the end of the season at the Camp 2 area.

PRELIMINARY RESULTS

Weather conditions. **—** Temperatures in spring were generally cool. Air temperature averaged -0.6°C (0.1°C below normal) between 20 May and 20 June, the period of goose arrival and egg-laying, and 1.6°C (0.2°C above normal) during 1-15 June, which is the critical period of egg formation and egg-laying. Snow pack at the end of the winter was very thick (snow depth was 42.9 cm on 15 May; Fig. 2). This, combined with the cool temperature, resulted in a delayed snow-melt in June. Temperatures were cool and the sky mainly overcast throughout most of the summer. Conditions were dry until July with little rainfall but wet conditions prevailed after that with

frequent rainfall (cumulative rainfall from 1 June to 18 August: 53 mm, long-term average: 78 mm).

Goose arrival and nesting activity. **—** The first geese on the hills surrounding the Qarlikturvik Valley (main field station), usually the first area used by geese upon arrival, appeared around 30 May. This number increased rapidly over the next few days to peak at 469 pairs on 8 June, a high number (Fig. 3). This suggests that goose arrival on Bylot Island was delayed compared to last year but still within dates observed in most years. The subsequent decline in goose numbers was due to the movements of geese to the nesting colony, away from the Qarlikturvik Valley.

Nest density in the center of the colony was lower than last year (3.5 vs. 8.1 nests/ha in 2017) and below the long-term average (Table 1). Egg-laying date in the colony (median: 14 June) was lower than the long-term average on Bylot Island (Table 1). Delayed snowmelt in the colony clearly affected goose nesting in 2018 as 50% of the nesting area was still covered by snow on 15 June, which is unusual. Average clutch size was 3.5, which is also below the long-term average (Table 1). Only one nest was found in the Qarlikturvik Valley (predominantly a brood-rearing area).

Nesting success of geese. **—** Nesting success (50%; proportion of nests hatching at least one egg) was below to the long-term average (Table 1). This was largely due to a high activity of Arctic Foxes and avian predators around goose nests, which destroyed many nests. During the summer, 130 neck-collared birds were sighted in the colony. Peak hatch was on 11 July, which is later than the long-term average (Table 1). We tagged 1623 goslings in nests at hatch, all the main colony of the Camp 2 area. Overall, nesting conditions of geese in 2018 were therefore lower than normal.

Density of broods. **—** The density of goose faeces at the end of the summer in wet meadows of the Qarlikturvik Valley was moderate (7.9 faeces/m^2; long-term average: 6.4; Fig. 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. Faeces density at the end of the summer was below average in the wet meadows of the nesting colony at Camp 2 (2.4 faeces/m^2; long-term average: 4.1).

Goose banding. **—** The banding operation was difficult this year due to bad weather in August. We conducted 7 drives in our core banding area, i.e. in the lowlands and hills bordering the main field station to the south and north (< 8 km), and 4 additional drives further away, between the Camp 2 and the Qarlikturvik Valley. We banded a total of 2951 geese, including 467 adult females marked with neck-collars and 52 young that had been marked with web-tags at hatch. In addition, we recaptured 202 adults that were banded in previous years. The young:adult ratio among geese captured at banding was slightly higher than last year (0.94:1) and below the long-term average (Table 1). Mean brood size toward the end of brood-rearing (2.34 young, n = 175; counts conducted on 2 August) was also below the long-term average. By combining information on brood size and young:adult ratio at banding, we estimated that 81% of the adults captured were accompanied by young, a value near the long-term average (Table 1). Overall, these results are indicative of a low production of young on Bylot Island by the end of the summer.

***Small mammals.* —** During our survey using snap traps, we cumulated 1427 trap-nights at our 2 trapping sites of the Qarlikturvik Valley from 24 to 30 July, and 688 trap-nights at the Camp 2 from 15 to 17 July. In the Qarlikturvik sites, we did not catch any lemming and thus the index of abundance was 0 lemming/100 trap-nights (Fig. 5). The index of abundance was also very low in the Camp 2 area, as only 1 Collared Lemming (*Dicrostonyx groenlandicus*) was caught, for an index of 0.22 lemming/100 trap-nights. The live-trapping survey conducted throughout the summer in the Qarlikturvik Valley area revealed the same picture. Overall, we captured 2 Brown Lemmings (*Lemmus trimucronatus*) and no Collared Lemming, for an index of 0.06 lemmings/100 trap-nights, a low number compared to last year (0.81 lemmings/100 trap-nights). A formal estimation of density using capture-recapture methods confirmed that both lemming species had declined compared to 2017 (Fig. 6). The live-trapping survey conducted at the three sites outside the Qarlikturvik Valley indicated a very low abundance of lemmings across Bylot Island. We captured a total of 1 Collared Lemming at these three sites in mid-July, for an overall index of 0.11 lemmings/100 trap-nights (compared to 0.23 in 2017). Finally, the number of lemming winter nests found along our transects also revealed a reduction in lemmings during winter as we counted 76 nests in 2018 compared to 119 in 2017.

Breeding activity of foxes at dens and marking. — A total of 114 known fox denning sites were monitored in 2018. Among these dens, we found signs of activity (fresh digging and/or footprints) at 65 of them, a high number. However, the breeding activity was very low as we found only 7 different litters (6% of denning sites) of Arctic Foxes compared to 5 litters in 2017). No Red Fox litters were found in 2018. The low breeding activity of foxes is typical of what we normally observed in years of low lemming abundance (average: 5%). Minimum litter size of Arctic Fox varied between 1 and 8 pups (4 pups on average). A total of 22 Arctic Foxes (6 adults and 7 juveniles) were captured during the summer, including 9 marked in previous years. All new individuals were marked with ear-tags.

***Monitoring of other bird species.* —** We found 42 active nests of Glaucous Gulls (vs. 30 in 2017), 4 nests of Parasitic Jaegers (vs. 6 in 2017), no nest of Long-tailed Jaegers (similar to 2017), 3 nests of Rough-legged Hawks (vs. 7 in 2017) and no nests of Snowy Owls (similar to 2017). The low nesting activities of avian predators is typical of what we encountered in a year of low lemming abundance. We found 56 nests of Lapland Longspurs compared to 94 in 2017. Average clutch size of gulls was similar to last year (2.3 eggs vs 2.1 in 2017) as well as for longspurs (5.3 eggs vs. 5.4 in 2017). Nesting success was moderate for gulls (42%) and unknown for hawks and jaegers. Fledging success (proportion of nests successful in fledging at least one young) was low for longspurs (29%). We captured 5 Parasitic Jaegers (2 recaptures and 3 newly-marked birds) and 9 Long-taild Jaegers (5 recaptures and 4 newly-marked birds).

***Plant growth and grazing impact.* —** Plant production in wet meadows of the brood-rearing area was lower than last year and below the long-term average (Fig. 7). Above-ground biomass of graminoid plants in the Qarlikturvik Valley reached 42.0 g/m^2 in ungrazed areas in mid-August compared to 52.6 in 2017 (long-term average since 1990: 51.0 g/m^2). Biomass of both *Eriophorum* and *Dupontia* decreased compared to last year (Fig. 7). At the nesting colony (Camp 2 area), graminoid biomass was also lower compared to last year (64.1 vs 79.5 g/m^2 in 2017, Fig. 8). Biomass of *Eriophorum* was lower than last year but production of *Dupontia* slightly increased compared to last year in the exclosures.

Grazing pressure was high in the wet meadows of the Qarlikturvik Valley in 2018 as geese had removed 41% of the above-ground biomass (difference between paired grazed and ungrazed plots) by mid-August (long-term average: 31%; Fig. 7). Contrary to most years, grazing pressure was lower on *Eriophorum* (32% of biomass removed), the preferred plant of geese, than *Dupontia* (43% of biomass removed). Grazing pressure at the Camp 2 area (nesting colony) was much lower than at the Qarlikturvik Valley (16% of the graminoid biomass removed by geese) and lower than the long-term average at this site (27%; Fig. 8). Geese also removed 28% of the *Dupontia* biomass but we detected no impact on the *Eriophorum* biomass at this site.

CONCLUSIONS

Most indicators of goose reproduction on Bylot Island were poor in 2018. Indeed, the nesting effort (indexed by nest density in the colony) was low, egg-laying was late and clutch size was low. This was undoubtedly the consequence of the thick snow-pack and cool temperature that prevailed in spring and early summer, which delayed snowmelt. Even though geese arrived near normal dates in spring, reports from northern Québec indicated that spring was cold and delayed there in 2018. Thus, geese likely encountered harsh environmental conditions during their spring migration, which may have reduced their body condition upon arrival. Reduced food availability during the pre-laying period due to high snow cover at arrival may have further limited the amount of nutrient that geese could invest in egg formation. Nesting success was also low, a consequence of a high activity of predators and of the low density of geese in the colony, which reduces the predator-swamping effect. The high activity of predators (foxes, gulls, jaegers, ravens) in the colony was likely a consequence of the low lemming abundance on the island this year, as their populations were in the low phase of the cycle for a second year in a row. When lemmings are scarce, goose eggs become a major source of food for local predators. Even though few fox dens had pups, adult foxes are known to remain on their territory during the summer and forage around when lemmings are low.

The proportion of young recorded in our catches at banding suggested that production on Bylot Island was moderate in 2018. This value was somewhat surprising because most indicators of goose nesting were poor, as explained above. Based on the young:adult ratio recorded at banding, we predicted a percentage of young in the fall flock of 17%, comparable to last year prediction (15%) but below the long-term average (23%). However, the percentage of young measured during juvenile counts conducted in southern Quebec this fall was a meagre 5% (n = 27,955). This value was in sharp contrast with our prediction but in line with our observations during nesting, when all indicators of breeding were poor (nest density, laying date, clutch size and nesting success). A possible explanation for these discrepancies may be that a high proportion of individuals skipped breeding this year or lost their clutch to predators early during nesting in 2018. These individuals are known to leave the island to molt (Reed et al. 2003 *Arctic* 56:76-81) and thus cannot be captured at banding. If this contingent of individuals was especially high this year, this may have biased high the young:adult ratio recorded at banding. In addition, low survival of young during the fall migration, either due to poor growth during the summer or bad weather conditions encountered during the migration, may have contributed to the low production in fall. Nonetheless, the 5% of young recorded in fall suggests that breeding conditions encountered by geese were not better elsewhere than on Bylot Island last summer and were likely worse. A proportion of young lower than 10% in the fall flock in considered indicative of widespread breeding failure. Other teams working elsewhere in the Arctic (e.g. J. Leafloor studying lesser snow geese in southern Baffin Island) also reported a low production of young due to cold

temperature last summer. Therefore, it appears that poor breeding conditions for geese prevailed over much of the eastern Arctic in 2018.

Above-ground graminoid production in wet meadows of the Qarlikturvik Valley (a prime brood-rearing area) and of the colony was generally poor this year. At the former site, use of the wet habitat by broods was moderate, as shown by the density of faeces recorded on our transects, and resulted in a relatively high impact of goose grazing there. The low density of broods this year may have encouraged families to concentrate their feeding activity in wet meadows and to avoid dispersing to mesic habitat to reduce predator pressure. The low plant production may also have exacerbated the impact of goose grazing. Grazing impact was lower at the colony itself than in the brood-rearing areas of the Qarlikturvik Valley. This suggests that more goose families moved from the colony to this site after hatch than usual. High predator activity in the colony combined with the low plant production there may have promoted these movements.

PLANS FOR 2019

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*) determining the long-term effects of geese on the arctic landscape; *iii*) assessing how climate change may be affecting the carrying capacity of the habitat for geese, *iv*) studying indirect interactions between snow geese and lemmings via shared predators; *v*) studying the ecology of the main predator of geese, Arctic Foxes; and *vi*) assessing the impact of climate change on goose reproduction. In 2019, we anticipate to:

1) Monitor productivity (egg laying date, clutch size and nesting success) and nesting distribution of Greater Snow Geese on Bylot Island.
2) Mark goslings in the nest to provide a sample of known-age individuals to assess the growth and pre-fledging survival of goslings by their recapture in late summer.
3) Band goslings and adults, and neck-collar adult females at the end of the summer to continue the long-term study of demographic parameters such as survival and breeding propensity.
4) Monitor the abundance of lemmings and study their demography in relationship with snow conditions.
5) Monitor the breeding activity of other bird species, in particular avian predators (Snowy Owls, jaegers, Glaucous Gulls and Rough-legged Hawks).
6) Monitor the breeding activity of foxes at dens and mark individuals to study their movements and demography.
7) Sample plants in exclosures to assess annual production and the impact of goose and lemming grazing on plant abundance in wet meadows.
8) Maintain our automated environmental and weather monitoring system.

In 2019, at least 5 graduate students will be involved in the Bylot Island snow goose project. **Frédéric LeTourneux** (PhD) will continue his study of the impact of recent management actions on the survival and population dynamics of snow geese. **Mathilde Poirier** (PhD) will continue her study on the population dynamics of lemmings and how it is impacted by snow physical properties. **Yannick Seyer** (PhD) will complete his study on the migratory and reproductive strategies of the Long-tailed Jaegers. **Frederic Dulude-de Broin** (PhD) will start a project on carry over effects of conditions during migration on reproduction of snow geese. Finally, **Marianne Valcourt** (MSc) will start her study on habitat use by lemmings.

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

	2009	2010	2011	2012	2013	2014	2015	2016	2017	**2018**	Average[2]
Number of nest monitored	405	372	382	375	451	491	347	337	342	**277**	--
Nest density (n/ha)	4.94	2.95	4.89	5.24	8.85	7.89	9.26	5.50	8.14	**3.46**	4.90
Median date of egg-laying	12 June	13 June	13 June	12 June	13 June	11 June	12 June	13 June	11 June	**14 June**	12 June
Clutch size	3.38	3.68	3.74	3.80	3.58	3.85	3.48	3.36	3.53	**3.50**	3.70
Nesting success[1]	74%	80%	90%	54%	67%	91%	77%	73%	56%	**50%**	67%
Median date of hatching	9 July	10 July	8 July	9 July	10 July	8 July	9 July	9 July	8 July	**11 July**	9 July
Number of geese banded	5417	4267	3802	2512	4865	2001	3675	4357	3216	**2951**	3543
Ratio young:adult at banding	1.07:1	1.18:1	1.19:1	0.92:1	1.10:1	1.19:1	0.99:1	0.91:1	0.88:1	**0.94:1**	1.03:1
Brood size at banding	2.35	2.39	2.80	2.54	2.51	2.58	2.08	2.35	2.14	**2.34**	2.48
Proportion of adults with young at banding	91%	98%	85%	73%	88%	92%	95%	78%	83%	**81%**	83%

[1] Mayfield estimate
[2] Period 1989-2018

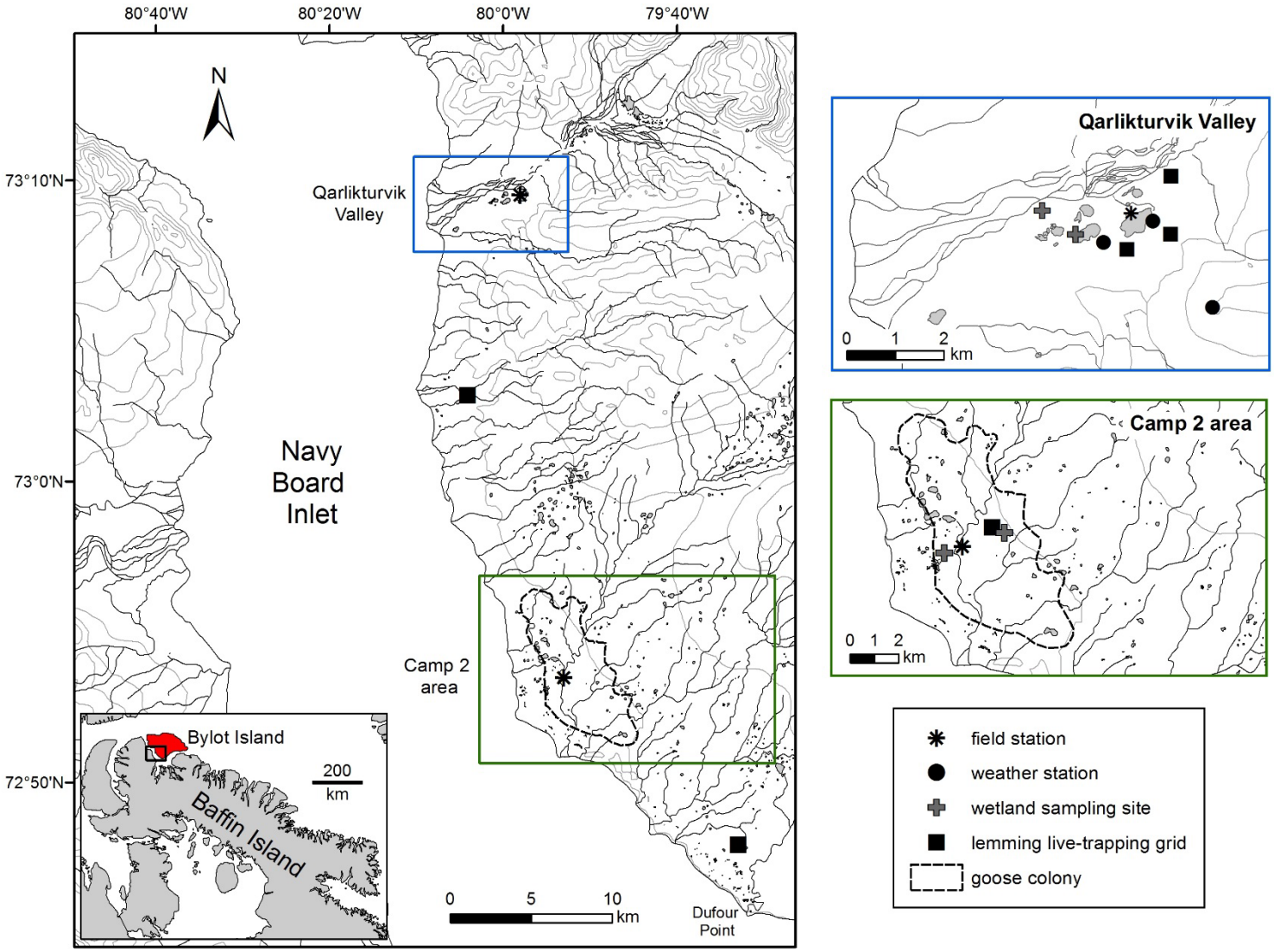

Figure 1. Location of the two main study sites (Qarlikturvik Valley and the Camp 2 area) on the South Plain of Bylot Island, Nunavut. Enlarged maps on the right present these study sites in more details, including locations of our field stations, automated weather stations, wetland sampling sites for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

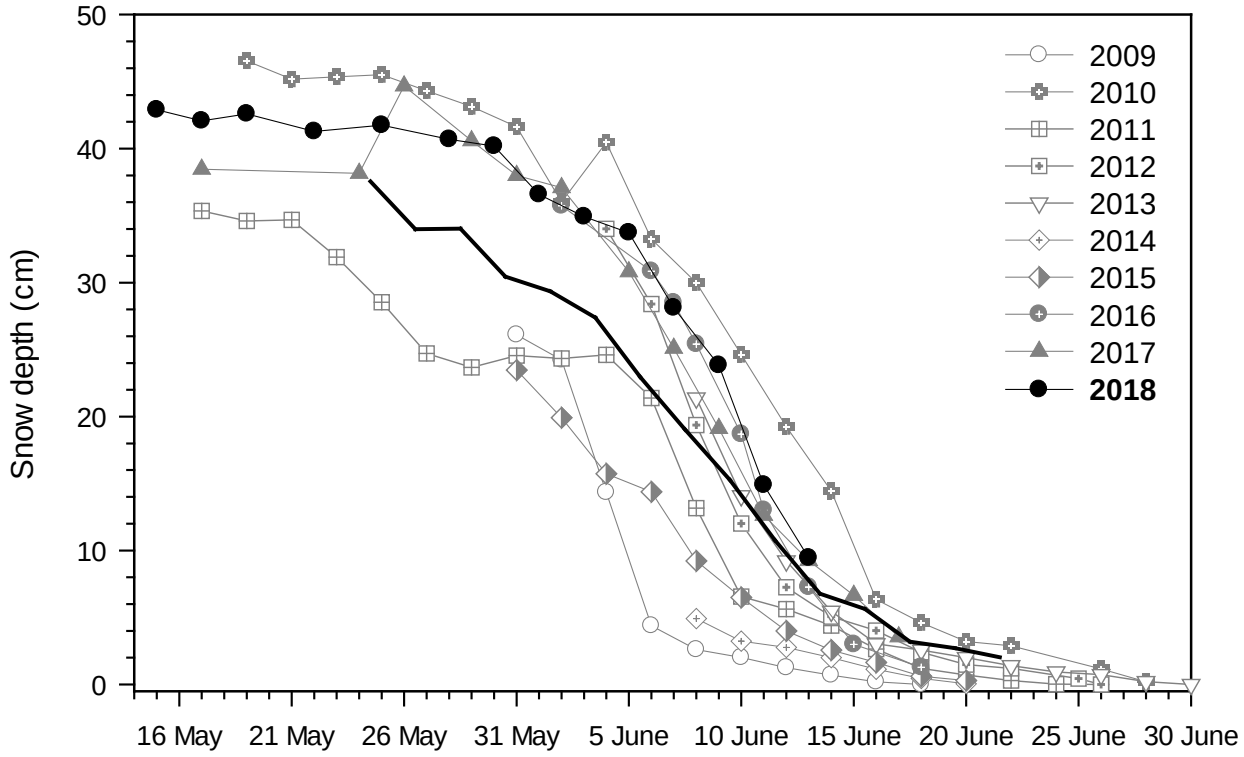

Figure 2. Average snow depth along 2 transects showing the rate of snowmelt in the lowlands of Bylot Island in spring over the past decade (n = 50 stations). The thick solid line represents the average snowmelt rate since 1995.

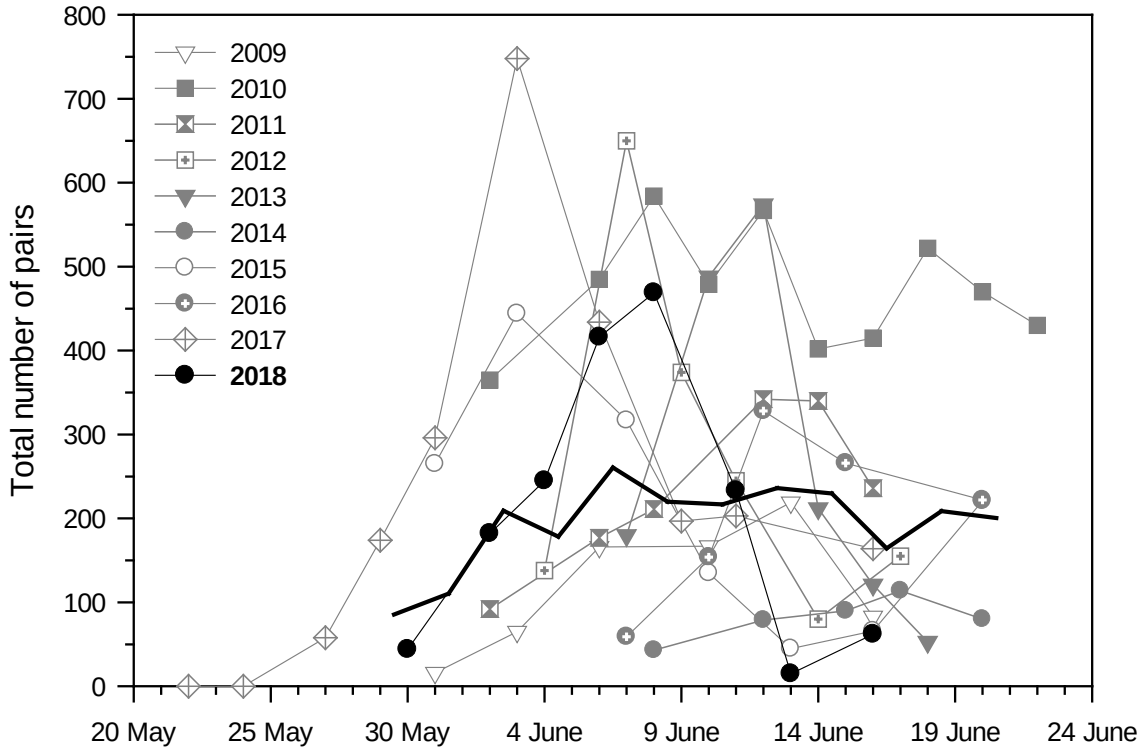

Figure 3. Total number of goose pairs counted in the Qarlikturvik Valley from arrival of our crew on Bylot Island in late May until the end of snowmelt over the past decade. The thick solid line represents the average number of goose pairs counted since 1996.

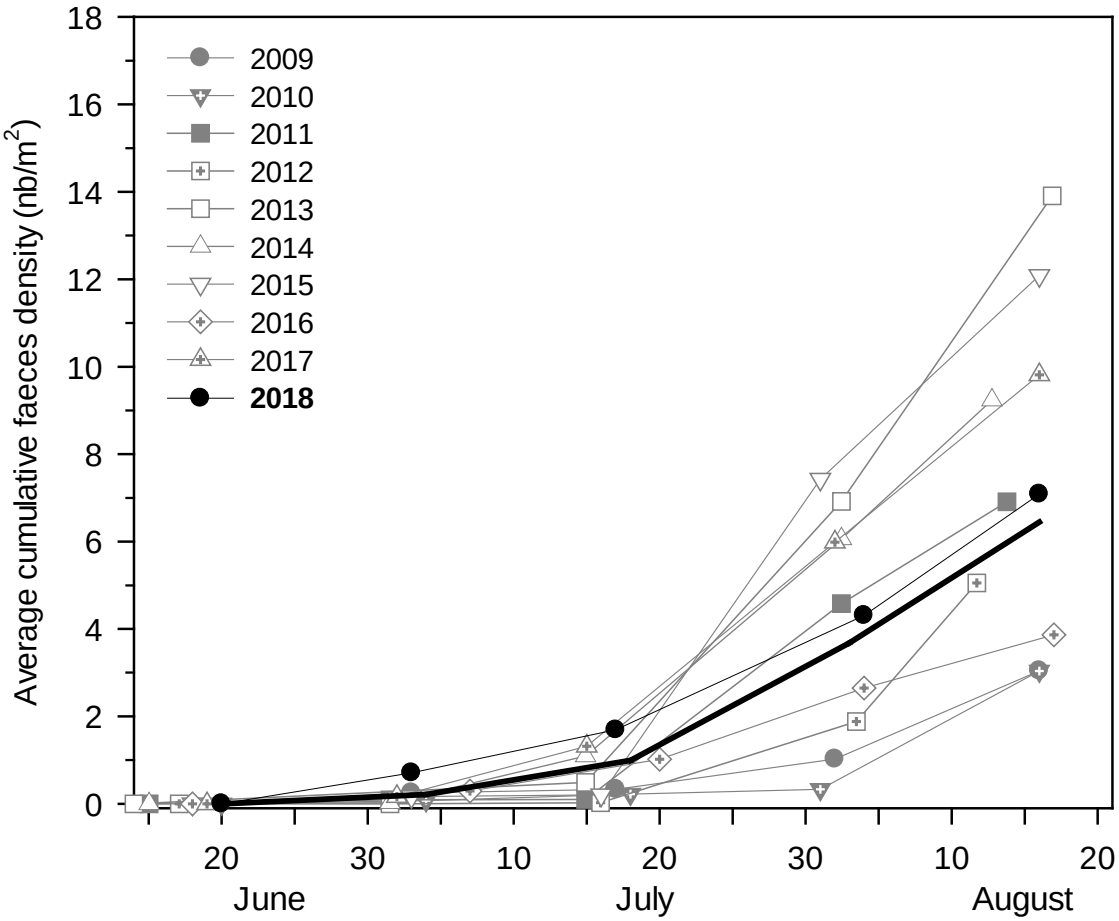

Figure 4. Average cumulative faeces density showing the use of the Qarlikturvik Valley by Greater Snow Goose families on Bylot Island throughout the summer over the past decade (n = 12 transects of 1 x 10 m; except 2013 n = 5 and 2016 n = 11). The thick solid line represents the average cumulative faeces density since 1990.

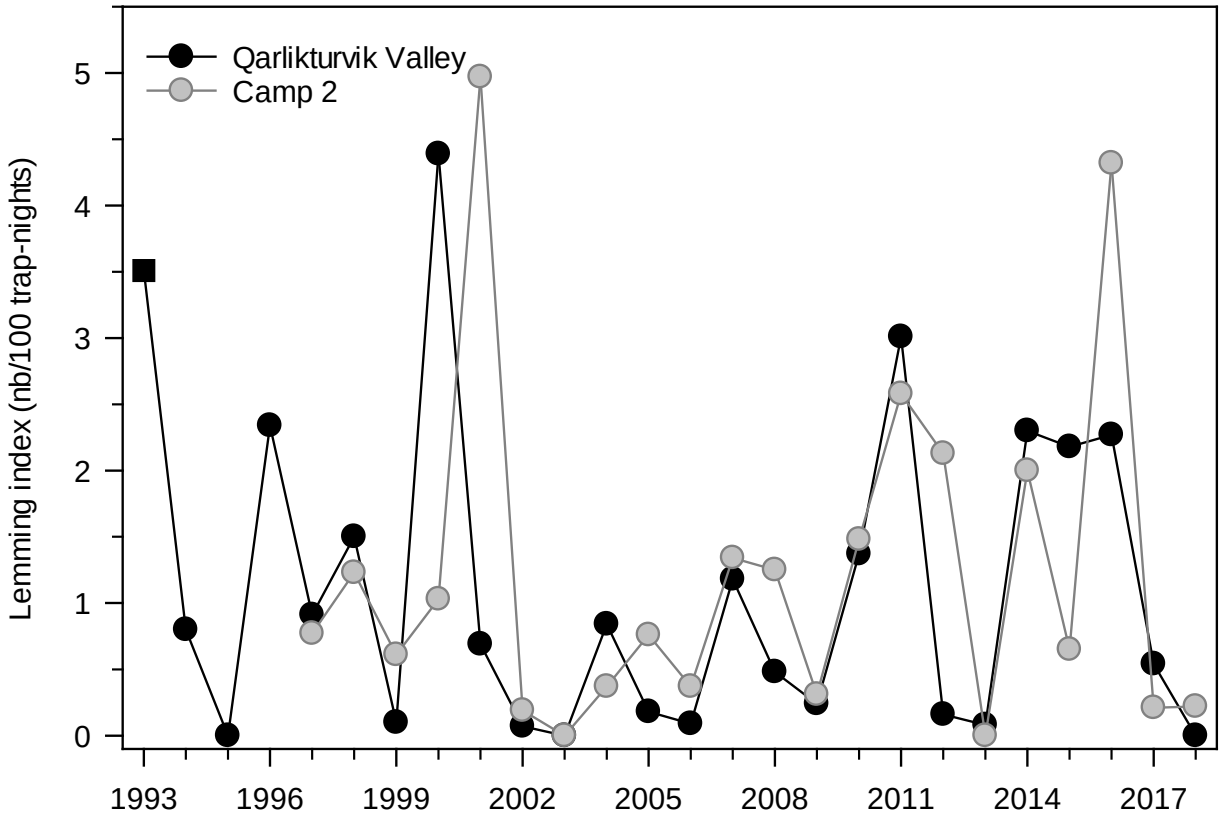

Figure 5. Annual index of lemming abundance based on snap-trapping at two study areas (Qarlikturvik Valley and Camp 2) located 30 km apart on Bylot Island (see Fig. 1). Because the sampling protocol changed after 2006, the trapping effort was adjusted in the calculation (i.e. reduced from 3 to 2 traps per station) to make the data collected after 2006 comparable to the previous period.

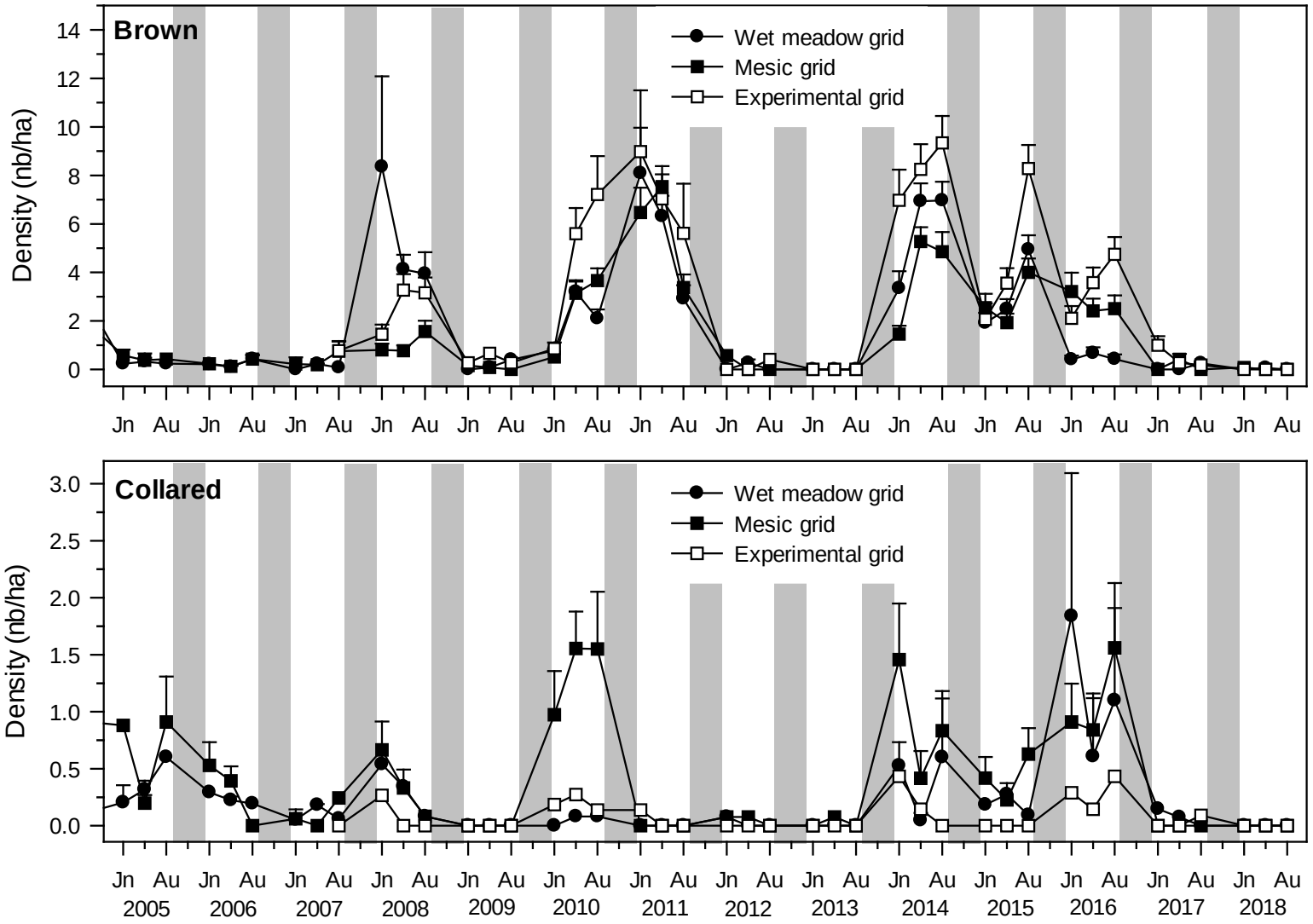

Figure 6. Annual summer density (+ SE) of Brown and Collared Lemmings on 3 trapping grids located in the Qarlikturvik Valley of Bylot Island over the part 14 years (snow cover was increased from 2008 to 2011 and predators were excluded from 2012 to 2018 on the experimental grid). The gray area indicates winter. Jn = mid-June, Au = mid-August.

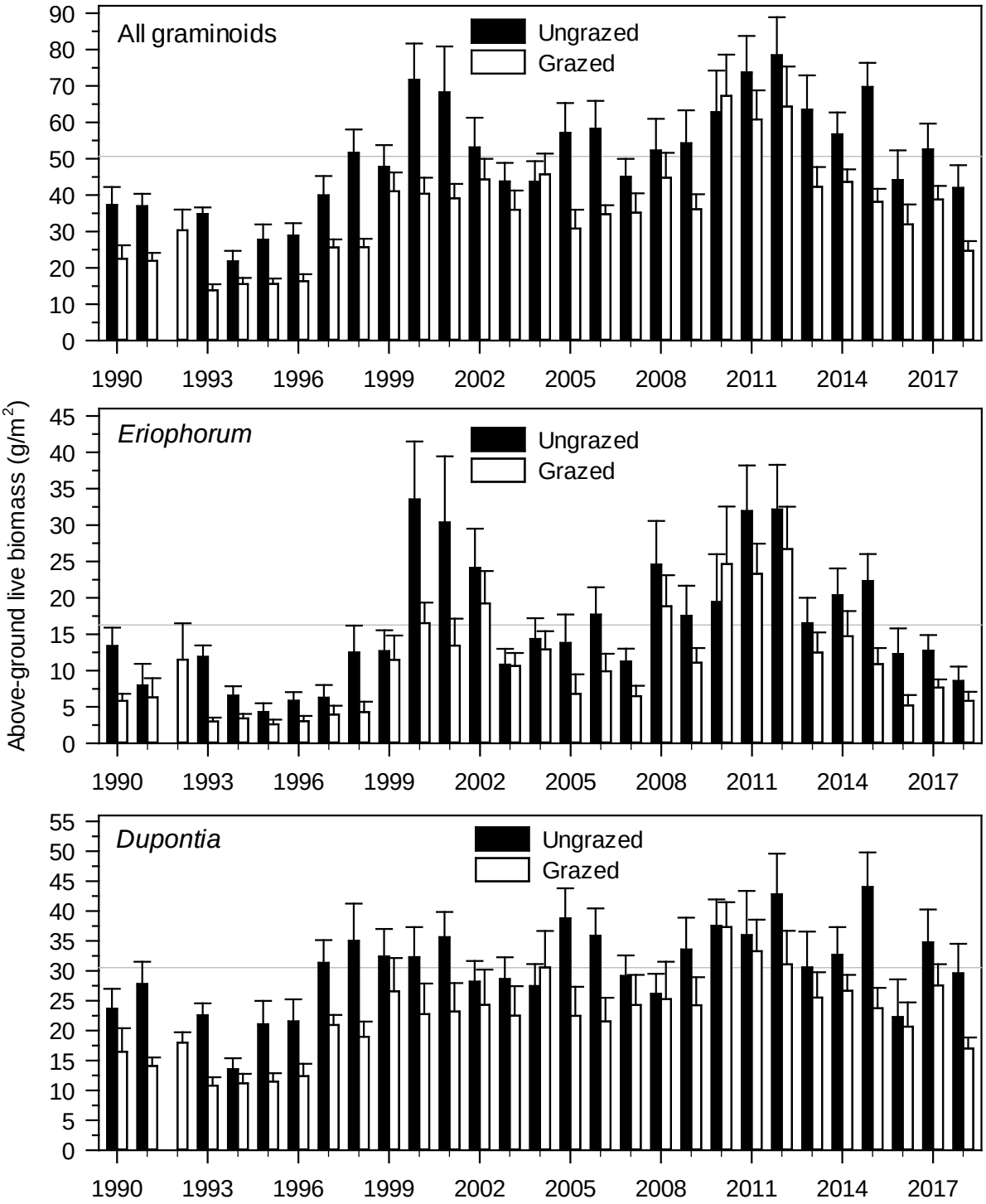

Figure 7. Live above-ground biomass (mean + SE, dry mass) of graminoids around 14 August in grazed and ungrazed wet meadows of the Qarlikturvik Valley, Bylot Island (n = 12, except in 2013, 2014 and 2016, n = 11). Total graminoids include *Eriophorum scheuchzeri*, *Dupontia fisheri* and *Carex aquatilis*. There is no data from ungrazed area in 1992. The solid gray line is the long-term average for ungrazed area.

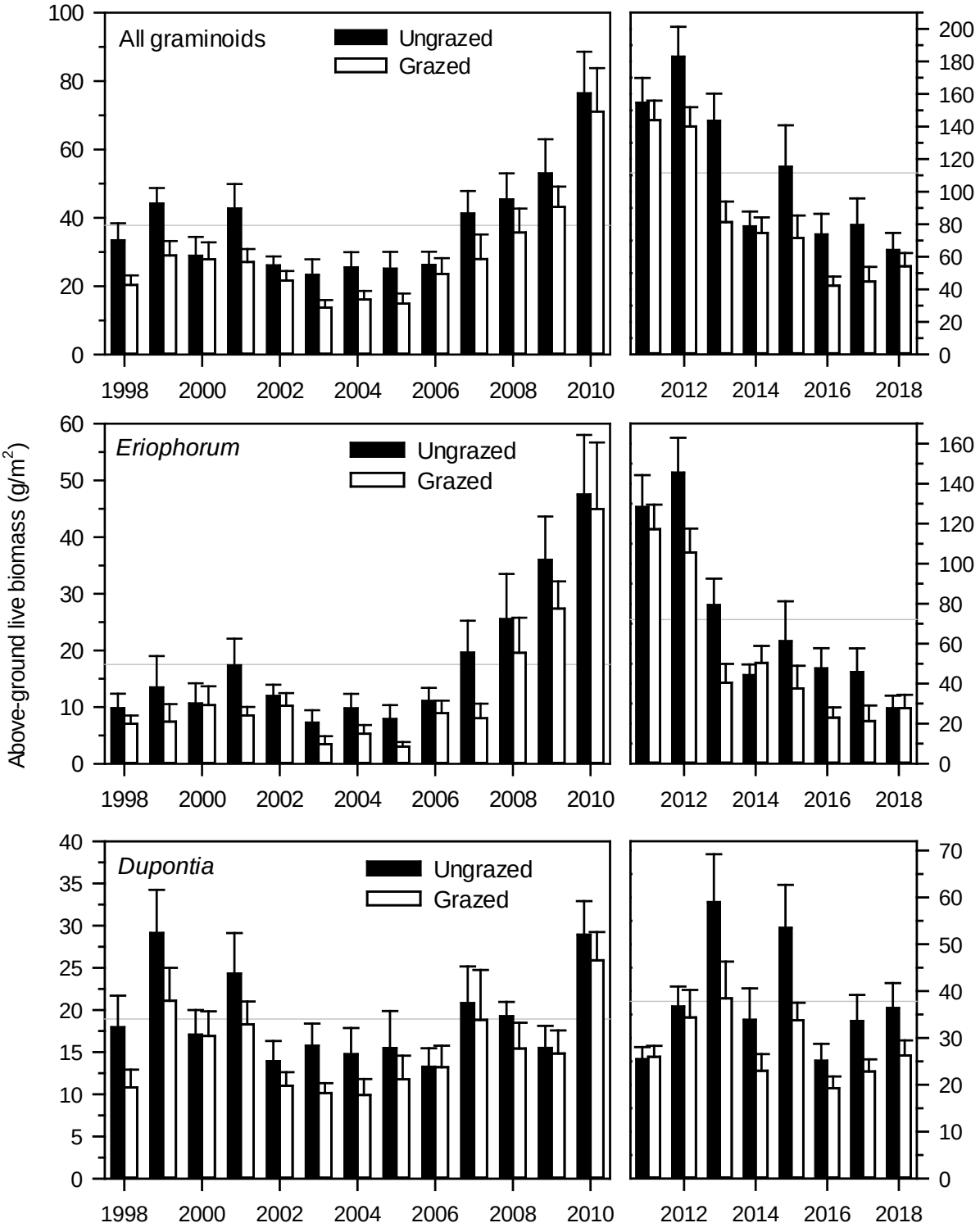

Figure 8. Live above-ground biomass (mean + SE, dry mass) of graminoids around 14 August in grazed and ungrazed wet meadows of the Camp 2 (goose colony), Bylot Island (n = 12, except in 2008 and 2014 n = 8, and 2012, 2013 and 2015 n = 10). Total graminoids include *Eriophorum scheuchzeri*, *Dupontia 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.

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Papers in refereed journals

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J.181. Weiser E.L., S.C. Brown, R.B. Lanctot, H.R. Gates, K. Abraham, R.L. Bentzen, J. Bêty et al. 2018. Effects of environmental conditions on reproductive effort and nest success of Arctic-breeding shorebirds. **Ibis** 160:608-623.

J.180. Weiser E.L., S.C. Brown, R.B. Lanctot, H.R. Gates, K. Abraham, R.L. Bentzen, J. Bêty et al. 2018. Life-history tradeoffs revealed by seasonal declines in reproductive traits of Arctic-breeding shorebirds. **Journal Avian Biology** 49:e01531.

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C.207. Fauteux, D., E. Schmidt, J.-F. Therrien, G. Gauthier & Y. Seyer. 2018. Enhancing terrestrial predators' diet assessments with rodent mandibles. *ArcticNet Scientific Meeting*, Ottawa, ON.

C.206. Gérin-Lajoie J, G. Gauthier, J. Bêty & G. MacMillan. 2018. A visual tool in Participative Action Research for consulting Inuit communities about their environmental concerns and research interests. *ArcticNet Scientific Meeting*, Ottawa, ON.

C.205. Berner, L. P. Jantz, R. Massey, P. Burns, G. Gauthier, B. Forbes, M. Macias-Fauria, B. Gagliote, L. Andreu-Hayles, R. D'Arrigo & S. Goetz. 2018. Rapid warming leads to greening of the tundra biome. *American Geophysical Union annual meeting*, Washington DC, USA.

C.204. Gauthier G. & J. Lefebvre. 2018. Projecting the population dynamic of greater snow geese into an uncertain future: the interplay between management actions and climate change. *Fourteenth North American Arctic Goose Conference and Workshop*, Lincoln, Nebraska, USA.

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C.201. Berteaux, D. 2017. Satellite tracking of arctic foxes on the Canadian Arctic sea ice: fine-scale genetic structure of the arctic fox population of Bylot Island (Nunavut, Canada). *Arctic Change 2017 conference*, Quebec, QC.

C.200. Legagneux, P., M-A. Giroux, P. Archambault, F. Barraquand, D. Berteaux, J. Bêty, G. Gauthier, D. Ehrich, T. Hoye, R. Ims, N. Lecomte, M-J. Naud, T. Roslin, N.M. Schmidt, P. Smith, S. Sokolov, N.G. Yoccoz & D. Gravel. 2017. ArcticWEB, a pan-Arctic network to monitor and model Arctic trophic interactions. *Arctic Change 2017 conference*, Quebec, QC.

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C.196. Lamarre, J.-F., J. Bêty. E. Reed, R. Lanctot, O. Love, G. Gauthier, O.W. Johnson, J. Liebezeit, R. Bentzen, M. Russell, L. McKinnon, L. Kolosky, P. Smith, S. Flemming, N. Lecomte, M.-A. Giroux, S. Bauer & T. Emmeneger. 2017. Year-round variation in migratory connectivity in American Golden-Plover (*Pluvialis dominica)*. *Arctic Change 2017 conference*, Quebec, QC.

C.195. Poirier, M., G. Gauthier, F. Dominé & M. Barrère. 2017. Physical properties of snow guide the movements of lemmings under the snowpack. *Arctic Change Conference*, Quebec, QC.

C.194. Seyer, Yannick, G. Gauthier, J. Bêty & N. Lecomte. 2017. Connectivity between the Canadian Arctic and the west coast of Africa: the journey of the Long-tailed jaeger. *Arctic Change Conference*, Quebec, QC.

C.193. Slevan-Tremblay, G., G. Gauthier & E. Lévesque. 2017. Impact of lemming grazing on Arctic willows under experimentally reduced predation. *Arctic Change Conference*, Quebec, QC.

C.192. Juhasz, C.-C., A. Lycke, V. Carreau, G. Gauthier, J.-F. Giroux & N. Lecomte. 2017. Picking the right cache: hoarding-site selection for egg predators in the Arctic. *5th International Conference in Arctic Fox Biology*. Rimouski, QC.

C.191. Therrien J.F., A. Beardsell, G. Gauthier, N. Lecomte & J Bêty. 2017. Reproductive and movement ecology of rough-legged hawks breeding in the high arctic. *Raptor Research Foundation Annual Conference*. Salt Lake City, Utah, USA.

C.190. Couchoux, C., J. Clermont, S. Lai, F. Lapierre-Poulin, C. Chevallier & D. Berteaux. 2017. Implementing measures of individual behavioural variation in the Arctic ecosystem: can we assess personality in arctic foxes? *5th International Conference in Arctic Fox Biology*. Rimouski, QC.

C.189. Darbon, C., S. Lai & D. Berteaux. 2017. Influence of the distribution of medium-sized prey species on the presence of red foxes in the south plain of Bylot Island, Nunavut, Canada. *5th International Conference in Arctic Fox Biology*. Rimouski, QC.

C.188. Thierry, A.-M., J. Bêty & D. Berteaux. 2017. Competition between Arctic and red foxes at the expanding front of the red fox in the Canadian Arctic. *5th International Conference in Arctic Fox Biology*. Rimouski, QC.

C.187. Lapierre-Poulin, F., D. Fortier & D. Berteaux. 2017. Developing a vulnerability index to climate change for arctic fox dens. *5th International Conference in Arctic Fox Biology*. Rimouski, QC.

C.186. Chevallier, C., G. Gauthier & D. Berteaux. 2017. Weather variability has no direct impact on adult survival in Arctic foxes. *5th International Conference in Arctic Fox Biology*. Rimouski, QC.

C.185. Devost, E, N. Casajus, S. Lai & D. Berteaux. 2017. FoxMask image analysis software, assisting ecologists in facing big data challenges. *5th International Conference in Arctic Fox Biology*. Rimouski, QC.

C.184. Berteaux. D. 2017. Satellite tracking of Arctic foxes on the Canadian Arctic sea ice. *5th International Conference in Arctic Fox Biology*. Rimouski, QC.

C.183. Lapierre-Poulin, F., D. Fortier & D. Berteaux. 2017. Are arctic fox reproductive dens vulnerable to climate change in the Canadian High Arctic? *5th International Conference in Arctic Fox Biology*. Rimouski, QC.

C.182. Lai, S., A. Quiles, J. Lambourdière, D. Berteaux & A. Lalis. 2017. Fine-scale genetic structure of the arctic fox population of Bylot Island (Nunavut, Canada). *5th International Conference in Arctic Fox Biology*. Rimouski, QC.

C.181. Chevallier, C., D. Berteaux & G. Gauthier. 2017. Are demographic parameters of adult Arctic foxes resource-dependent? *5th International Conference in Arctic Fox Biology*. Rimouski, QC.

C.180. Fauteux, D., G. Gauthier, R. Boonstra, R. Palme & D. Berteaux. 2017. Top-down regulation of lemmings by Arctic foxes and other predators: observations and experiments on Bylot Island. *5th International Conference in Arctic Fox Biology*. Rimouski, QC.

C.179. Gauthier G., D. Fauteux, J. Bêty, D. Berteaux, M. Mazerolle & M.-C. Cadieux. 2017. Evaluation of invasive and non-invasive methods to monitor lemming abundance in the Canadian Arctic. *5th International Conference in Arctic Fox Biology*. Rimouski, QC.

C.178. Therrien J.-F., G. Gauthier, A. Robillard, T. McDonald, N. Smith, S. Weidensaul, D. Brinker, J. Bêty & N. Lecomte. 2017. The irruptive nature of snowy owls: going full cycle. *World Owl Conference*. Évora, Portugal.

C.177. Lefebvre, J., G. Gauthier, J.-F. Giroux, A. Reed, A. Béchet & E. Reed. 2017. Managing an overabundant population: the Greater Snow Goose in North America. *Dutch scientific goose meeting*. Leeurwarden, Netherlands.

C.176. Gauthier, G. A. Robillard, J.-F. Therrien & J. Bêty. 2017. What can we learn from isotopic analyses of snowy owl feathers? *4th meeting of the International Snowy Owl Working Group*, Milton, Massachussetts, USA.

C.175. Robillard A., G. Gauthier, J.-F. Therrien & J. Bêty. 2017. Wintering strategies, habitat use and site fidelity of snowy owls in eastern North America. *4th meeting of the International Snowy Owl Working Group*. Milton, Massachussetts, USA.

C.174. Juhasz, C.-C., N. Lecomte & G. Gauthier. 2016. How predator-prey interactions can mediate effects of climate on prey nesting success: the case of an Arctic nesting bird. *ArcticNet Scientific Meeting*, Winnipeg, MB.

C.173. Resendiz, C. & G. Gauthier. 2016. Heterogeneous long-term effects of a changing environment on the reproductive success of greater snow geese. *ArcticNet Scientific Meeting*, Winnipeg, MB.

C.172. Fauteux, D., G. Gauthier, D. Berteaux, R. Palme, C. Bosson & R. Boonstra. 2016. Lethal and non-lethal effects of predation on arctic lemmings. *Fifeteenth International Conference on Rodent Biology*, Olomouc, Czech Republic.

C.171. Giroux, M.-A., N. Lecomte, D. Gravel, D. Berteaux, G. Gauthier, P. Legagneux & J. Bêty. 2015. Bridging the gap between monitoring and modeling approaches to better understand arctic food webs under global pressures. *ArcticNet Scientific Meeting*, Vancouver, BC.

C.170. Seyer, Y., G. Gauthier & J. Bêty. 2015. From the Canadian Arctic to the western coast of Africa: The trans-equatorial migration of the Long-tailed jaeger. *ArcticNet Scientific Meeting*, Vancouver, BC.

C.169. Slevan-Tremblay, G., G. Gauthier & E. Lévesque 2015. Validation of a non-destructive method to estimate grazing impact of lemmings in the Arctic tundra. *ArcticNet Scientific Meeting*, Vancouver, BC.

C.168. Resendiz, C. & G. Gauthier. 2015. To change or not to change? Variations in components of the Greater Snow Goose reproductive success over a 26-year period. *ArcticNet Scientific Meeting*, Vancouver, BC.

C.167. Giroux, M.-A., N. Lecomte, D. Gravel, J. Bêty, G. Gauthier & D. Berteaux. 2015. Can animal migration explain the dominance of top-down forces in many Arctic food webs? Insights from empirical and theoretical approaches. *100th Ecological Society of America Annual Meeting*, Baltimore, MD.

C.166. Fauteux, D., G. Gauthier & D. Berteaux. 2015. Socio-economic relationships between Inuit and lemmings and the scientific methods employed to monitor lemmings. *International workshop on small mammal population outbreaks and their consequences*, Frasne, France.

C.165. Gauthier, G. 2015. Goose, plant and predator interactions in arctic systems: how will climate change things? *Thirteenth North American Arctic Goose Conference and Workshop*, Winnipeg, MB.

C.164. Lamarre, J.-F., G. Gauthier, P. Legagneux, E.T. Reed & J. Bêty. 2015. Snow goose colony: a risky nesting area for shorebirds. *Thirteenth North American Arctic Goose Conference and Workshop*, Winnipeg, MB.

C.163. Marmillot, V., G. Gauthier, M.-C. Cadieux & P. Legagneux. 2015. Plasticity in speed and timing of flight feather molt in the greater snow goose, a high-arctic-nesting species. *Thirteenth North American Arctic Goose Conference and Workshop*, Winnipeg, MB.

C.162. Resendiz, C. & G. Gauthier. 2015. Temporal trends and spatial variation in components of reproductive success of Greater Snow Geese on Bylot Island. *Thirteenth North American Arctic Goose Conference and Workshop*, Winnipeg, MB.

C.161. Gauthier, G. & D. Berteaux. 2014. Monitoring of terrestrial wildlife on Bylot Island in a global warming context: what did we learn after 20 years? *Arctic Change 2014 conference*, Ottawa, ON.

C.160. Robillard, A., J.-F. Therrien, G. Gauthier & J. Bêty. 2014. Fall migration and winter habitat use of an Arctic top predator: the Snowy Owl. *Arctic Change 2014 Conference*, Ottawa, ON.

C.159. Fauteux, D., G. Gauthier & D. Berteaux. 2014. Seasonal demography of a cyclic lemming population in the Canadian Arctic. *Arctic Change 2014 Conference*, Ottawa, ON.

C.158. Royer-Boutin, P., D. Berteaux, G. Gauthier & J. Bêty. 2014. Effects of lemming cycles on reproductive success of arctic-nesting birds using different antipredator strategies. *Arctic Change 2014 conference*, Ottawa, ON.

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.

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C.6. Gauthier, G. 1992. Diet, food quality and food intake of pre-laying and laying greater snow geese. *Seventh North American Arctic Goose Conference*, Vallejo, CA.
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Graduate student theses

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T.61. Lai, S. 2017. Écologie spatiale du renard arctique sur l'Île Bylot, Nunavut, Canada. PhD thesis, Département de biologie, Université du Québec à Rimouski.
T.60. Robillard, A. 2017. Mouvements et utilisation de l'habitat en hiver chez un prédateur nomade: le harfang des neiges. PhD thesis, Département de biologie, Université Laval, Québec.
T.59. Fauteux, D. 2016. Effets directs et indirects de la prédation sur les lemmings dans l'Arctique canadien. PhD thesis, Département de biologie, Université Laval, Québec.
T.58. Beardsell, A. 2016. Écologie de la nidification de la buse pattue dans le Haut-Arctique et vulnérabilité des nids aux risques géomorphologiques. MSc thesis, Département de biologie, Université Laval, Québec.
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T.52. Rioux, M.-J. 2014. La dynamique socio-spatiale hivernale chez les couples de renard arctique (*Vulpes lagopus*) dans le haut-arctique canadien. MSc thesis, Département de biologie, Université du Québec à Rimouski.

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T.50. Souchay, G. 2013. Aspects non-canalisés de la dynamique de population de la grande oie des neiges. Probabilités de reproduction et de survie juvénile. PhD thesis, Département de biologie, Université Laval, Québec & Université de Montpellier 2, Montpellier, France.

T.49. Bolduc, E. 2013. Abondance et phénologie des arthropodes terrestres de l'Arctique canadien: modélisation de la disponibilité des ressources alimentaires pour les oiseaux insectivores. MSc thesis, Département de biologie, Université du Québec à Rimouski.

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