

¹ **Title: Long-term abundance time-series of the High Arctic terrestrial
2 vertebrate community of Bylot Island, Nunavut**

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²⁷ **Open Research statement:**

²⁸ Data are publicly available at <https://datadryad.org/>.

²⁹ Raw data and codes used to extract the presented data set are publicly available at
³⁰ https://github.com/chaireBioNorth/BYLOT_species_abundance_dataset.

31 **Introduction**

32 The composition of ecological communities, defined as the abundance of each species
33 within a given community, is fundamental for understanding patterns and processes in
34 community ecology. Variations in community composition can help to detect spatial pat-
35 terns linked to environmental variations (Kemp et al., 1990), assess temporal trends of
36 different groups of species after disturbances (Philippi et al., 1998; Magurran, 2007), and
37 understand food web structures (Cohen et al., 2003). Additionally, community compo-
38 sition is essential for modeling the dynamics of ecological communities. Dynamic com-
39 munity modelling allows addressing important issues and questions in ecology, such as:
40 determining the relative strength of top-down versus bottom-up forces in communities
41 (Krebs et al., 2003; Legagneux et al., 2014), assessing the ecological resilience of commu-
42 nities under climate change (Griffith et al., 2019) and evaluating the cascading effects of
43 invasive species in food web (David et al., 2017; Goto et al., 2020). Dynamic community
44 modelling can also be applied to address practical challenges, including fishery manage-
45 ment (Plagányi, 2007) and the planning of protected areas (Okey et al., 2004; Dahood
46 et al., 2020).

47 Modeling food webs requires adjusting trophic flows based on the functional responses
48 of species, which necessitates time series data on the abundance of all species within
49 a community. However, accurately determining the abundance of all species is rarely
50 achievable. Consequently, empirical community models often reduce taxonomic resolution
51 by grouping species into large functional or taxonomic categories. Additionally, food webs
52 consist of species with varying body sizes depending on their trophic level, with top-level
53 species often being highly mobile and having large home ranges (McCann et al., 2005).
54 Therefore, community models must use landscape-wide estimates of species abundance
55 to accurately represent trophic fluxes. Due to these constraints, empirical datasets with
56 high taxonomic resolution that cover entire communities at broad spatial and temporal
57 scales are rare and often include incomplete or rough estimates.

58 The composition of ecological communities is influenced by various factors acting at dif-
59 ferent temporal and spatial scales, leading to noisy data and emphasizing the need for
60 long-term data sets (Magurran et al., 2010; Lindenmayer et al., 2012). Species abun-
61 dances are influenced by stochastic effects (Hubbell, 2001), environmental changes (e.g.,
62 climate warming), and species interactions, contributing to data variability. For instance,
63 the composition of a community could be driven simultaneously by intra-annual seasonal
64 variations, multi-year cyclic variations (e.g., El Niño) and slow but directional long-term
65 variations in the environment (Brown and Heske, 1990; Snyder and Tartowski, 2006).
66 Therefore, long-term data series are required to untangle the relative effects of diverse
67 abiotic and biotic factors on community composition (Magurran et al., 2010; Lindenmayer

68 et al., 2012).

69 Arctic environments are highly valuable systems for studying community patterns and
70 processes due to their relatively low species richness (Payer et al., 2013; Legagneux et al.,
71 2014). However, logistical challenges in the Arctic limit the number of long-term bio-
72 diversity monitoring programs. Hence, the small number of Arctic communities with
73 long-term monitoring serve as highly valuable sites for holistic and empirical community
74 studies. Datasets on terrestrial communities are notably scarce, and this scarcity extends
75 to Arctic communities as well (Ims et al., 2013).

76 Within terrestrial Arctic sites, the south plain of Bylot Island in the Canadian High Arctic
77 (**Figure 1**) hosts one of the longest and most intensive biodiversity monitoring programs
78 (Gauthier et al., 2024b). Monitoring on Bylot Island began in 1989 with a focus on the
79 snow goose and it gradually expanded to other species over time. Currently, the program
80 encompasses all significant vertebrate species in the community with continuous monitor-
81 ing spanning more than a decade (Gauthier et al., 2024b). Monitoring is also conducted at
82 multiple spatial scales, including intensive and systematic observations conducted across
83 a landscape spanning approximately 400 km². This approach allows the scaling of local
84 density measurements to the landscape level when required and facilitates the estimation
85 of abundance for less common and rare species.

86 Previous work based on the tundra community of Bylot Island has already produced
87 several influential papers (Gauthier et al., 2011; Legagneux et al., 2012, 2014; Hutchison
88 et al., 2020; Duchesne et al., 2021; Gauthier et al., 2024a). These studies showed that
89 tundra communities may experience stronger top-down regulation than bottom-up reg-
90 ulation (Legagneux et al., 2012, 2014). They also revealed a heterogeneous response of
91 trophic levels to climate warming (Gauthier et al., 2013) and highlighted the effects of
92 indirect trophic interactions on the occurrence of species across the landscape (Duchesne
93 et al., 2021). However, those earlier papers were built on data from relatively short time
94 series, they were not always scaled at the landscape level, and some species or functional
95 groups were lacking abundance estimates. With over a decade of additional community-
96 wide monitoring compared to earlier studies, our goal is to synthesize and upscale the
97 data collected on the Bylot Island community since the 1990s to the landscape level. This
98 synthesis aims to provide readily accessible annual time series (or mean values in some
99 cases) of abundance and biomass for all vertebrate species in a tundra landscape, covering
100 approximately 400 km².

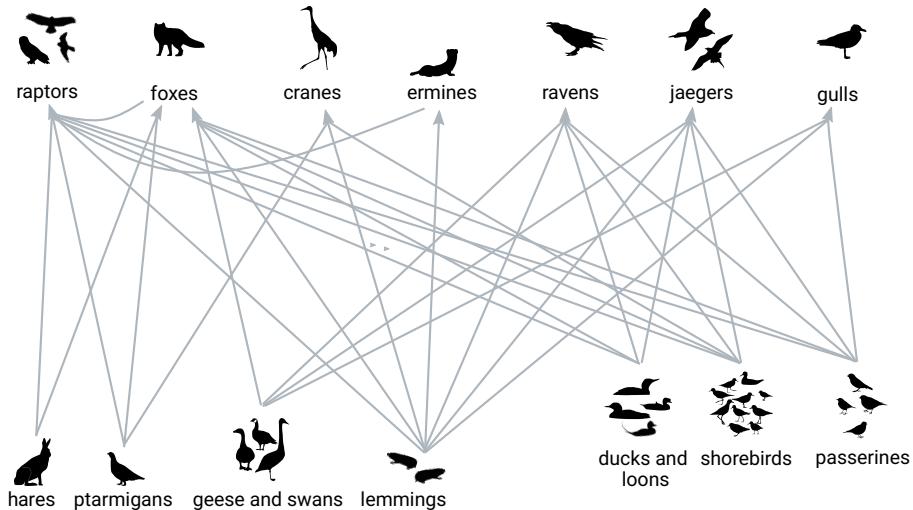


Figure 1: Synthetic vertebrate food web of the south plain of Bylot Island (figure adapted from Gauthier et al. (2011)).

101 Objective

102 Our main objective is to provide readily accessible, long-term time series of annual abun-
 103 dances of all vertebrate species within the Arctic terrestrial community of Bylot Island
 104 during the breeding season (May to August). This includes both breeding and non-
 105 breeding individuals that stay in the study area for a significant period of time, and ex-
 106 cludes non-breeding individuals that stop for only a few days during their migration. Our
 107 focus extends to estimating abundances at the landscape scale, enabling the study of com-
 108 munity and ecosystem dynamics, trophic interactions and the impacts of global changes
 109 on high-latitude environments. Additionally, we aim to provide the average body mass
 110 for each species in the community, enabling the conversion of abundances into biomasses.

₁₁₁ **Class I. Data Set Descriptors**

₁₁₂ **A. Data set identity**

₁₁₃ Long-term abundance time-series of the High Arctic terrestrial vertebrate community of
₁₁₄ Bylot Island, Nunavut

₁₁₅ **B. Data set identification codes**

₁₁₆ BYLOT-species_taxonomy.csv
₁₁₇ BYLOT-species_abundance.csv
₁₁₈ BYLOT-mean_species_abundance.csv
₁₁₉ BYLOT-mean_species_body_mass.csv
₁₂₀ BYLOT-interannual_variation_nest_density.csv

₁₂₁

₁₂₂ **C. Data set description**

₁₂₃ **1. Originators**

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₁₃₁ ence de la biodiversité du Québec, Centre d'Études Biologiques de Chizé (CEBC-CNRS)
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₁₃₃ **2. Abstract**

₁₃₄ Arctic ecosystems present unique opportunities for community-wide monitoring, in part
₁₃₅ due to their relatively low species richness. However, conducting research in these remote
₁₃₆ environments poses significant logistical challenges, resulting in long-term monitoring be-
₁₃₇ ing exceedingly rare. Here, we focus on the long-term, intensive ecological monitoring
₁₃₈ efforts conducted on the south plain of Bylot Island (almost 400 km², Nunavut, Canada),
₁₃₉ which has generated a remarkable dataset spanning up to 30 years, a rarity in tundra
₁₄₀ ecosystems. Our goal is to synthesize this dataset and upscale vertebrate abundance data

¹⁴¹ at the landscape level, a prerequisite to conduct community-level analyses. We have stan-
¹⁴² dardized data obtained with different field methods to provide readily usable long-term
¹⁴³ time series of abundance for 35 vertebrate species (30 birds and 5 mammals) present
¹⁴⁴ in the study system. Monitoring data includes intensive capture-mark-recapture density
¹⁴⁵ estimates of lemmings on trapping grids, systematic or opportunistic nest monitoring con-
¹⁴⁶ ducted across the entire study area or within specific plots for all bird species, transects of
¹⁴⁷ vertebrate counts distributed throughout the study area, daily incidental observations of
¹⁴⁸ vertebrates and satellite tracking of fox movements. Annual abundance of species was es-
¹⁴⁹ timated at the landscape level, accounting for spatial variations. Furthermore, we provide
¹⁵⁰ body masses for each species, derived from empirical onsite measurements for 18 species
¹⁵¹ and from the literature for the remaining species. Body mass is essential to convert species
¹⁵² abundance into biomass for studies of trophic fluxes and ecosystem processes. Our dataset
¹⁵³ provides a unique opportunity for holistic empirical studies of ecological communities, al-
¹⁵⁴ lowing a deeper understanding of community structure and dynamics. Considering that
¹⁵⁵ the study site is a pristine and protected area that has experienced minimal anthropogenic
¹⁵⁶ impact, it can also provide an ideal baseline for investigating the impacts of global changes
¹⁵⁷ on high-latitude terrestrial ecosystems.

¹⁵⁸ D. Key words/phrases

¹⁵⁹ Bylot Island, Canadian Arctic, Arctic tundra, 1993-2023, long-term monitoring, biodi-
¹⁶⁰ versity monitoring, community composition, species abundance, species density, species
¹⁶¹ biomass, species body mass, food web

¹⁶² **Class II. Research origin descriptors**

¹⁶³ **A. Overall project description**

¹⁶⁴ **1. Identity**

¹⁶⁵ Understanding the structure and dynamics of Arctic terrestrial vertebrate communities

¹⁶⁶ **2. Originators:**

¹⁶⁷ **Gilles Gauthier**, Centre d'études nordiques, Département de Biologie, Université Laval,
¹⁶⁸ Québec, QC, Canada

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¹⁷⁶ **3. Period of study**

¹⁷⁷ 1989 - continuing

¹⁷⁸ **4. Objectives**

¹⁷⁹ i) Understand the factors that shape the structure and drive the dynamics of Arctic ter-
¹⁸⁰ restrial vertebrate communities.

¹⁸¹ ii) Predict the effects of current global environmental changes on the structure and dy-
¹⁸² namics of Arctic terrestrial vertebrate communities.

¹⁸³ **5. Abstract**

¹⁸⁴ Arctic terrestrial vertebrate communities present low species richness, making those rela-
¹⁸⁵ tively simple communities ideal for studying ecological patterns and dynamics in terrestrial
¹⁸⁶ environments. Although, they present complex networks of interacting species, extreme
¹⁸⁷ seasonal changes of environmental conditions and a large portion of migratory species,
¹⁸⁸ which make challenging the identification of the key factors that shape their structure
¹⁸⁹ and dynamics. In the face of rapid global environmental changes, it is crucial to have a
¹⁹⁰ comprehensive understanding of the key processes shaping Arctic terrestrial communities

¹⁹¹ structure and dynamics in order to predict how global changes will impact them in the
¹⁹² future. Our research emphasizes long-term biodiversity monitoring, a community-wide
¹⁹³ perspective and food web modeling to achieve this understanding.

¹⁹⁴ **6. Sources of funding**

¹⁹⁵ Natural Sciences and Engineering Research Council of Canada, Fonds Québécois de
¹⁹⁶ Recherche Nature et Technologies, Centre d'études nordiques, Natural Resources Canada
¹⁹⁷ (Polar Continental Shelf Program), Network of Centers of Excellence Canada (Arctic-
¹⁹⁸ Net), Canada First Research Excellence Fund (Sentinel North Program), Polar Knowledge
¹⁹⁹ Canada, Environment and Climate Change Canada, Canada Foundation for Innovation,
²⁰⁰ Parks Canada Agency, International Polar Year program of the Government of Canada,
²⁰¹ Crown-Indigenous Relations and Northern Affairs Canada (Northern Contaminant Pro-
²⁰² gram), Duck Unlimited Canada, Kenneth M. Molson Foundation (Kenneth M. Molson
²⁰³ Foundation's donation for wildlife research, conservation, and habitat), Garfield Weston
²⁰⁴ Foundation, First Air—Canadian North, Nunavut Wildlife Management Board, Uni-
²⁰⁵ versité Laval, Université du Québec à Rimouski

²⁰⁶ **B. Specific subproject description**

²⁰⁷ **1. Site description**

²⁰⁸ **a. Site type**

²⁰⁹ The study area (389 km^2) represents a relatively productive tundra ecosystem in the
²¹⁰ eastern Canadian High-Arctic. An important biological characteristic of the area is the
²¹¹ presence of a large snow goose (scientific names of most vertebrate species can be found
²¹² in **Table 1**) colony of around 25 000 breeding pairs (Reed et al., 2002) spanning ap-
²¹³ proximately 70 km^2 . The vertebrate community within the study area comprises 30 bird
²¹⁴ species, with 29 of them being migratory or partially migratory, along with 5 mammal
²¹⁵ species (**Table 1**; Moisan et al. (2023); Gauthier et al. (2024b)). The study area experi-
²¹⁶ ences significant temporal fluctuations in the population of small mammals (lemmings),
²¹⁷ which in turn impact the occurrence and abundance of their avian and mammalian preda-
²¹⁸ tors such as snowy owls, rough-legged hawks, long-tailed jaegers, ermines and Arctic foxes
²¹⁹ (Legagneux et al., 2012). We exclude occasional visitors, namely: i) species lacking con-
²²⁰ firmed breeding occurrences on the study site, ii) species observed solely within a single
²²¹ year, and iii) species primarily breeding and foraging in nearby marine or coastal habitats
²²² (Moisan et al., 2023). The case of the red fox (*Vulpes vulpes*) was ambiguous. While the
²²³ presence of a breeding pair has been confirmed in the study area (Lai et al., 2022), the
²²⁴ extent of population establishment remains unclear and sightings are rare. Therefore, we
²²⁵ decided to exclude this species.

Table 1: Species composition of the vertebrate community of Bylot Island with the corresponding annual cycle strategy (i.e., resident, partial migrant, migrant).

Functional group	Scientific name	Name	Annual cycle strategy
ducks and loons	<i>Somateria spectabilis</i>	king eider	migrant
ducks and loons	<i>Clangula hyemalis</i>	long-tailed duck	migrant
ducks and loons	<i>Gavia pacifica</i>	Pacific loon	migrant
ducks and loons	<i>Gavia stellata</i>	red-throated loon	migrant
geese and swans	<i>Branta hutchinsii</i>	cackling goose	migrant
geese and swans	<i>Anser caerulescens</i>	snow goose	migrant
geese and swans	<i>Cygnus columbianus</i>	tundra swan	migrant
raptors	<i>Buteo lagopus</i>	rough-legged hawk	migrant
raptors	<i>Falco peregrinus</i>	peregrine falcon	migrant
raptors	<i>Bubo scandiacus</i>	snowy owl	migrant
ptarmigans	<i>Lagopus muta</i>	rock ptarmigan	resident
cranes	<i>Antigone canadensis</i>	sandhill crane	migrant
shorebirds	<i>Pluvialis dominica</i>	American golden-plover	migrant
shorebirds	<i>Pluvialis squatarola</i>	black-bellied plover	migrant
shorebirds	<i>Charadrius hiaticula</i>	common-ringed plover	migrant
shorebirds	<i>Arenaria interpres</i>	ruddy turnstone	migrant
shorebirds	<i>Calidris canutus</i>	red knot	migrant
shorebirds	<i>Calidris melanotos</i>	pectoral sandpiper	migrant
shorebirds	<i>Calidris bairdii</i>	Baird's sandpiper	migrant
shorebirds	<i>Calidris fuscicollis</i>	white-rumped sandpiper	migrant
shorebirds	<i>Calidris subruficollis</i>	buff-breasted sandpiper	migrant
shorebirds	<i>Phalaropus fulicarius</i>	red phalarope	migrant
gulls	<i>Larus hyperboreus</i>	glaucous gull	migrant
jaegers	<i>Stercorarius longicaudus</i>	long-tailed jaeger	migrant
jaegers	<i>Stercorarius parasiticus</i>	parasitic jaeger	migrant
ravens	<i>Corvus corax</i>	common raven	partial migrant
passerines	<i>Eremophila alpestris</i>	horned lark	migrant
passerines	<i>Anthus rubescens</i>	American pipit	migrant
passerines	<i>Calcarius lapponicus</i>	Lapland longspur	migrant
passerines	<i>Plectrophenax nivalis</i>	snow bunting	migrant
lemmings	<i>Lemmus trimucronatus</i>	brown lemming	resident
lemmings	<i>Dicrostonyx groenlandicus</i>	collared lemming	resident
hares	<i>Lepus arcticus</i>	Arctic hare	resident
ermes	<i>Mustela richardsonii</i>	ermine	resident
foxes	<i>Vulpes lagopus</i>	Arctic fox	partial migrant

b. Geography

Our 463 km² study area is located on the southern plain of Bylot Island, Nunavut, Canada (72.889 N, -79.906 W; **Figure 2**).

c. Habitat

The study area comprises a combination of mesic tundra mainly on hills (64 %), upland plateaus of sedimentary rock with drier/rockier habitat at higher elevation (20 %), low-lying wetlands interspersed with ponds (10 %) and larger bodies of water such as lakes and rivers (6 %).

d. Geology

see Klassen (1993) for a complete and detailed description of the geology of the study area.

237 **e. Hydrology**

238 Wetlands were delineated by photo-interpretation of high-resolution satellite images (30
239 cm; Ouellet, unpublished data), whereas lakes were delineated with aerial photos and
240 rivers with google satellite images, resulting in a coarser delineation.

241 **f. Site history**

242 see Gauthier et al. (2024b,a) for a complete and detailed history of the site.

243 **g. Climate**

244 The mean temperature in July is 6°C, and the study area typically remains free of snow
245 from mid-June to late September (Gauthier et al., 2013). The climate of the southern
246 plain of Bylot Island is generally milder than that of the surrounding latitudes, as the
247 plain present a southern exposure and the mountains to the north protect the plain from
248 cold northerly winds. (Gauthier et al., 2024b).

249 **2. Experimental or sampling design**

250 **a. Permanent plots**

251 The study area is divided into 9 zones based on the sampling method and the level of field
252 effort applied in each zone (**Figure 2**). Long-term monitoring of the community began in
253 the 1990s in the Qarlikturvik valley (Gauthier et al., 2013, 2024b), which represents the
254 zone of the study area with the highest annual sampling effort. Within the Qarlikturvik
255 valley, the sampling is concentrated on the southern side of the glacial river (**Figure 3**),
256 where the main research infrastructure is located. Another zone with extensive sampling
257 efforts is Camp 2, located at the core of the snow goose colony, where the primary focus
258 is to monitor snow goose nests. However, nests of many other avian species are also
259 monitored within and around the colony in this zone. Camp 3, Pointe Dufour, Goose
260 Point, and Malaview are zones where intensive sampling efforts are conducted annually,
261 albeit for a relatively brief period (approximately one week) during the breeding season
262 of most species (Gauthier et al., 2024b). The upland zones in the study area (defined as
263 areas approximately 300 meters above sea level or more) are the Black Plateau, Southern
264 Plateau, and Camp 3 Plateau. These zones are primarily visited to assess raptor nesting
265 activity (Beardsell et al., 2016). The zone between the Qarlikturvik valley and Camp 3
266 received very little sampling effort and is therefore excluded from the study area.

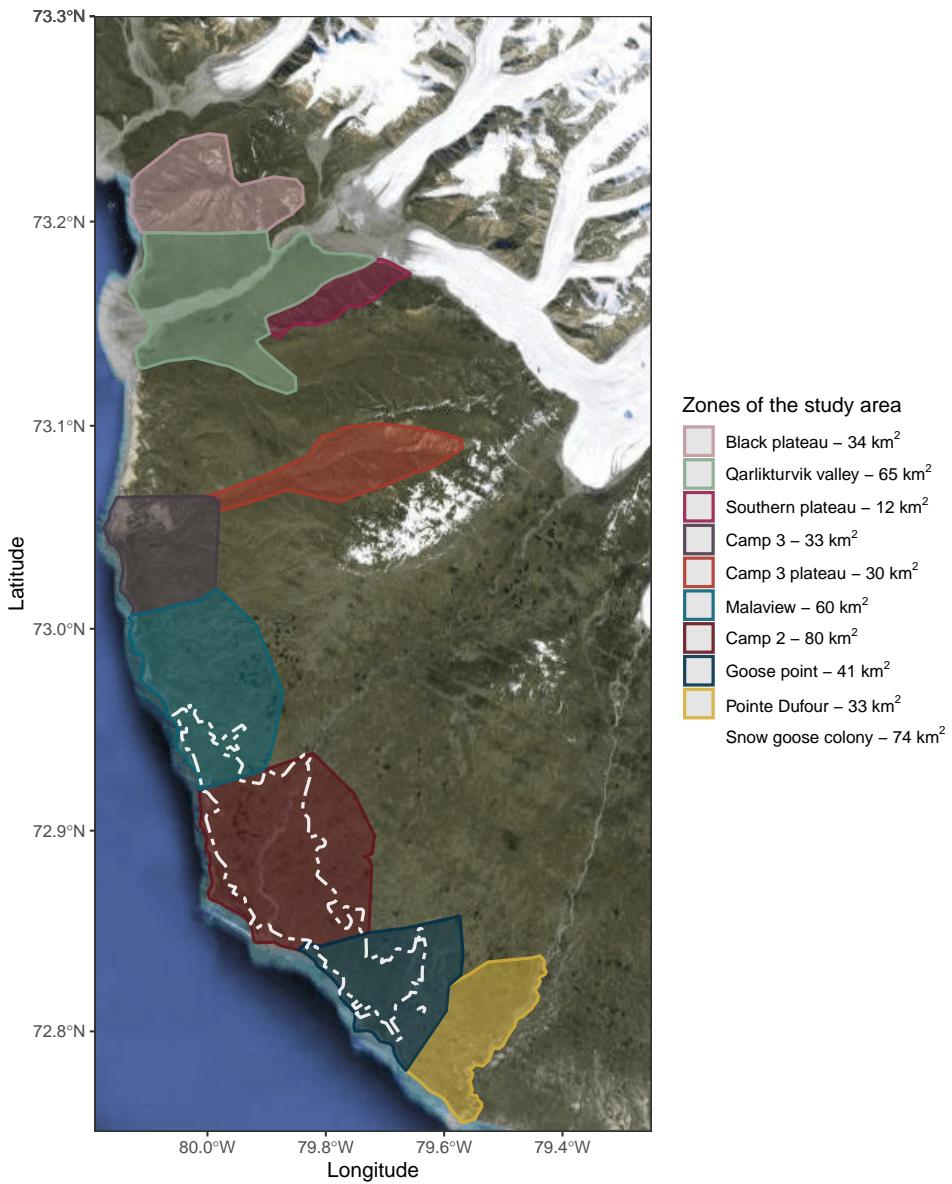


Figure 2: Map of the different zones (colored polygons) of the 463 km² study area located on the southern plain of Bylot Island, Nunavut Canada. The outline of the snow goose colony is presented with white dash; we used the outline of the colony in 2015 since it represents an average colony area (67 km²).

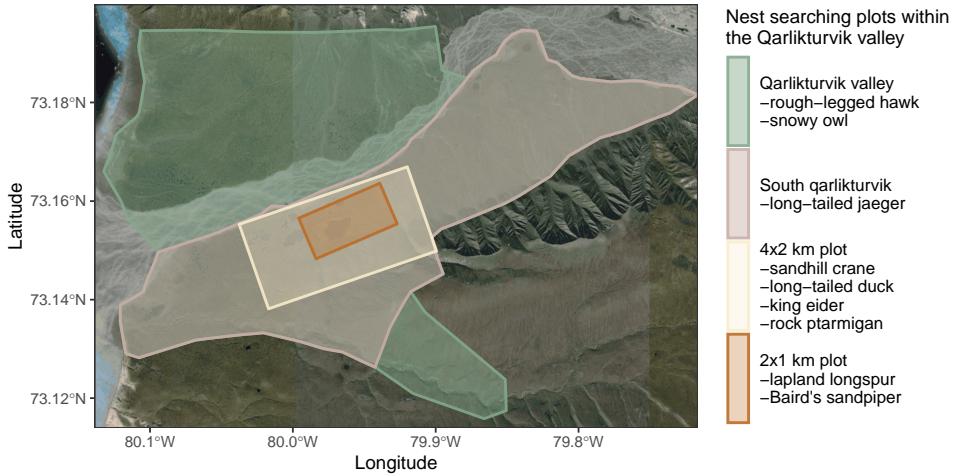


Figure 3: Intensive nests searching plots (8 km^2 and 2 km^2) located in the Qarlikturvik valley.

b. Avian nest monitoring

Avian nest monitoring was conducted annually except in 2020 and 2021 due to logistical constraints imposed by the COVID-19 pandemic. Systematic nest monitoring refers here to a systematic sampling approach aimed at documenting all nests within a specified area. Monitoring is considered opportunistic when there is a chance that some nests might not have been detected within a specific area. Nest densities derived from nest sampling could be underestimated due to early nest failure (i.e., failure that happened before our sampling period).

Pacific loon, red-throated loon, cackling goose, tundra swan and glaucous gull

Since 2004, systematic searches of wetland areas have been conducted on the southern side of the glacial river in the Qarlikturvik Valley, and since 2017, in other zones of the study area. This sampling aimed to find all nests of the cackling goose and the glaucous gull. Nest locations of other large wetland-nesting species, including the tundra swan, the red-throated loon and the Pacific loon, were also noted, as these species nest in the same habitat (Duchesne et al., 2021; Gauthier et al., 2024b). Each year, all known or potential nesting sites were revisited. Observers detected nests by walking and scanning around ponds and lakeshores to identify any active nesting sites. These large species can be seen from a relatively long distance sitting on the nest or when flushing from the nest. Most of them (geese, swans and gulls)

Table 2: Summary of vertebrate species monitoring in the Bylot Island study area. In this paper, we excluded certain years for specific species due to reduced sampling efforts. As a result, duration of times series presented here may differ slightly from those in Gauthier et al. (2024b).

Species	Zone	Years	Monitoring	References
snow goose	camp 2	1999-2019, 2023	systematic	Gauthier et Cadieux, 2020
rough-legged hawk	qarlikt., black & south plat.	2007-2019, 2022	systematic	Gauthier et al., 2020
peregrine falcon	qarlikt., black & south plat.	2007-2019, 2022	systematic	Gauthier et al., 2020
snowy owl	qarlikt., black & south plat.	1996-2019, 2023	systematic	Gauthier et al., 2020
Baird's sandpiper	qarlikturvik (2x1 km plot)	2005-2019, 2022-2023	systematic	Béty, 2020
Lapland longspur	qarlikturvik (2x1 km plot)	2005-2019, 2022-2023	systematic	Gauthier and Béty, 2020
king eider	qarlikturvik (4x2 km plot)	2005-2019, 2022	opportunistic	unpublished data
long-tailed duck	qarlikturvik (4x2 km plot)	2005-2019, 2022	opportunistic	unpublished data
rock ptarmigan	qarlikturvik (4x2 km plot)	2005-2019, 2022	opportunistic	unpublished data
sandhill crane	qarlikturvik (4x2 km plot)	2005-2019, 2022	opportunistic	unpublished data
brown lemming	qarlikturvik (trapping grids)	1995-2019, 2021-2022	systematic	Gauthier, 2020
collared lemming	qarlikturvik (trapping grids)	1995-2019, 2021-2022	systematic	Gauthier, 2020
Pacific loon	qarlikturvik valley	2004-2019, 2022	systematic	unpublished data
red-throated loon	qarlikturvik valley	2004-2019, 2022	systematic	unpublished data
cackling goose	qarlikturvik valley	2004-2019, 2022-2023	systematic	unpublished data
tundra swan	qarlikturvik valley	2004-2019, 2022	systematic	unpublished data
glaucous gull	qarlikturvik valley	2004-2019, 2022	systematic	Gauthier et al., 2020
long-tailed jaeger	qarlikturvik valley	2004-2019, 2022	systematic	Gauthier et al., 2020
parasitic jaeger	qarlikturvik valley	2004-2019, 2022	systematic	unpublished data
Pacific loon	whole study area	2017-2019, 2022	systematic	Duchesne et al., 2021
red-throated loon	whole study area	2017-2019, 2022	systematic	Duchesne et al., 2021
cackling goose	whole study area	2017-2019, 2022-2023	systematic	Duchesne et al., 2021
tundra swan	whole study area	2017-2019, 2022	systematic	Duchesne et al., 2021
rough-legged hawk	whole study area	2013-2019, 2022	systematic	Gauthier et al., 2020
peregrine falcon	whole study area	2013-2019, 2022	systematic	Gauthier et al., 2020
snowy owl	whole study area	2012-2019, 2022-2023	systematic	Gauthier et al., 2020
common-ringed plover	whole study area	2015-2017	systematic	Béty, 2020
glaucous gull	whole study area	2017-2019, 2022	systematic	Gauthier et al., 2020
parasitic jaeger	whole study area	2009-2019, 2022	opportunistic	unpublished data
common raven	whole study area	2013-2019, 2022	systematic	unpublished data
ermine	whole study area	1993-2019	opportunistic	Bolduc et al., 2023
Arctic fox	whole study area	2008-2016	systematic	Dulude-de Broin et al., 2023

can also reveal their presence with alarm calls or nest defense displays. We are confident that nest detection probability was high for these species given the open landscape.

Snow goose

Snow geese nest in a large colony in the study area (**Figure 2**), but also in small aggregations distributed on the island, especially in years when snowy owls are nesting (Lepage et al., 1996; Reed et al., 2002). Since 1994, goose nests were systematically monitored on a 0.24 km^2 wetland at the center of the colony. Since 1999, nests were also systematically monitored on a variable number of plots, measuring 0.01 km^2 in wetland habitat and 0.04 km^2 in mesic habitat, randomly distributed throughout the goose colony (Gauthier and Cadieux, 2020b). The total area covered by the randomly distributed plots averaged $0.79 \pm 0.37 \text{ km}^2$ per year. From 2010 onwards, except in 2020 and 2021, we traced the approximate boundary of the goose colony using a GPS receiver aboard a helicopter flying along the colony border (Duchesne

302 et al., 2021).

303 **Rough-legged hawk, peregrine falcon and common raven**

304 Peregrine falcons, rough-legged hawks and common ravens nest on cliffs, near ravines,
305 and on large rocky outcrops and tend to reuse the same nesting sites from one year
306 to the next (Beardsell et al., 2016). Systematic monitoring of every known or poten-
307 tial nesting site has been carried out in the Qarlikturvik valley, Black plateau and
308 Southern plateau since 2007 and throughout the study area since 2013 (Beardsell
309 et al., 2016; Gauthier et al., 2020). Observers walked along ridges and scanned sur-
310 rounding areas from vantage points to detect nesting birds. These large species can
311 be seen from a relatively long distance sitting on the nest or when flushing from the
312 nest. They can also reveal their presence with alarm calls or nest defense displays.
313 We are confident that nest detection probability was high for these species. Each
314 year the observers use slightly different paths to sample the areas, but locate the
315 nests in the same positions, which supports a high probability of detection for these
316 species. Most nesting sites were located in the upland zones of the study area, which
317 include the Black Plateau, Southern Plateau and Camp 3 Plateau.

318 **Snowy owl**

319 Snowy owls predominantly nest in habitats similar to other raptors, favoring ridges
320 in mountainous or hilly regions, although they can occasionally be found nesting
321 on mounds in lowland areas (Seyer et al., 2020). Since 1996, searches for snowy
322 owl nests have been conducted concurrently with searches for other raptor nests
323 in the Black and Southern plateaus, as well as during searches for jaeger nests on
324 the southern side of the glacial river in the Qarlikturvik Valley. Additionally, since
325 2012, nests have been recorded across the entire study area by scanning the land-
326 scape from hills and ridges during the nesting period (Duchesne et al., 2021). Given
327 that snowy owls nest on elevated mounds, exhibit contrasting colors with the land-
328 scape, emit alarm calls, and display defensive behaviors, active nesting sites have a
329 high probability of detection.

330

331 **Long-tailed jaeger and parasitic jaeger**

332 Since 2004, observers have walked parallel transects spaced 400 meters apart, cov-
333 ering the entire southern side of the glacial river in the Qarlikturvik Valley (33 km^2 ;
334 **Figure 3**), during the nesting period. The aim of those transects was to record nests
335 of long-tailed jaegers, parasitic jaegers, and sandhill cranes. Observers listened for
336 alarm calls to detect territorial birds, and then located nests by observing the birds
337 returning to their nests from elevated vantage points. We consider the sampling to
338 be systematic for long-tailed and parasitic jaeger, since those species tend to leave
339 their nest relatively far from the observer to perform mobbing behavior, and thus

340 increasing their detection probability. We do not consider the sampling to be sys-
341 tematic for sandhill cranes as they only display defensive behaviors near their nests
342 at relatively short distances (see opportunistic nest monitoring below).

343

344 ***Common-ringed plover***

345 Between 2015 and 2019, observers conducted surveys of the primary nesting areas of
346 the common-ringed plover. The survey involved walking in stony and sandy shores
347 and gravel bars with scarce vegetation along rivers. Nests were found by detecting
348 individuals exhibiting reproductive behaviors, such as incubation, alarm calls, or
349 distraction displays. The sampling effort was particularly intensive between 2015
350 and 2017. Small areas along the coast or on the banks of smaller rivers that could
351 potentially serve as nesting sites may have been overlooked.

352

353 ***Lapland longspur and Baird's sandpiper***

354 Since 2005, nests of passerines and sandpipers have been extensively monitored
355 across an 8 km² (4x2 km) area in the Qarlikturvik valley. We considered the sam-
356 pling to be most systematic within a core 2 km² (2x1 km) plot in this area (**Figure**
357 **3**). We excluded relatively large water bodies (0.26 km²) to calculate nest density
358 in the plot due to the presence of a large lake, which leaves an area of 1.74 km²
359 available for nesting. An observer conducted systematic searches of this plot during
360 the entire breeding season to locate and monitor as many passerine and shorebird
361 nests as possible. Assuming the observer can detect all nests within a 5 or 10 meter
362 radius, analysis of daily GPS tracks shows that the observer covered a minimum
363 area of 0.72 ± 0.12 (5 m) or 1.09 ± 0.17 km² (10 m) of the core area annually (n=
364 3 years). Additionally, several other observers conducting related field work in the
365 same zone reported all passerine and shorebird nests found opportunistically.

366

367 ***Opportunistic nest monitoring***

368 Since 2005, we also noted the nest location of any other bird species encountered
369 opportunistically during travel or while carrying out the protocols for the previously
370 described species. The sampling was particularly intensive in the defined 8 km² (2x4
371 km plot) area in the Qarlikturvik valley. The accuracy of nest monitoring in this
372 plot thus depends on the species detection probability. We are confident to obtain
373 a realistic order of magnitude for the number of nests present for relatively large
374 bodied species in this area (i.e., sandhill crane, rock ptarmigan, long-tailed duck
375 and king eider). Additionally, starting in 2009, a significant effort has been made
376 each year, though not systematically, to visit known nesting territories of parasitic
377 jaegers throughout the study area.

Table 3: Annual nest density (nests/km²) of selected avian species estimated on different zones of Bylot Island.

Species	Zone	Mean \pm SD	Number of years
Baird's sandpiper	qarlikturvik (2x1 km plot)	5.000 \pm 3.558	17
Lapland longspur	qarlikturvik (2x1 km plot)	13.559 \pm 5.849	17
king eider	qarlikturvik (4x2 km plot)	0.115 \pm 0.138	16
long-tailed duck	qarlikturvik (4x2 km plot)	0.092 \pm 0.138	16
rock ptarmigan	qarlikturvik (4x2 km plot)	0.031 \pm 0.055	16
sandhill crane	qarlikturvik (4x2 km plot)	0.161 \pm 0.087	16
long-tailed jaeger	qarlikturvik valley	0.362 \pm 0.380	17
Pacific loon	whole study area	0.005 \pm 0.004	4
red-throated loon	whole study area	0.082 \pm 0.019	4
cackling goose	whole study area	0.177 \pm 0.064	5
tundra swan	whole study area	0.001 \pm 0.001	4
rough-legged hawk	whole study area	0.157 \pm 0.151	8
peregrine falcon	whole study area	0.053 \pm 0.007	8
snowy owl	whole study area	0.022 \pm 0.058	10
common ringed plover	whole study area	0.070 \pm 0.012	3
glaucous gull	whole study area	0.091 \pm 0.011	4
parasitic jaeger	whole study area	0.010 \pm 0.004	12
common raven	whole study area	0.003 \pm 0.003	8

378 c. Observation of individuals

379 *Vertebrate count transects*

380 From 2010 to 2023, observers walked 500-meter linear transects where all vertebrate
 381 individuals observed within 150 meters on either side were counted (146 to 320
 382 transects per year). Transects were distributed across all lowland zones of the study
 383 area, typically in mesic habitat, and were carried out during the nesting period
 384 (between June 21 and July 14; Duchesne et al. (2021); **Figure 4**). Furthermore,
 385 specifically for American golden-plovers, we measured the distance of each observed
 386 individual to the transect path.

387

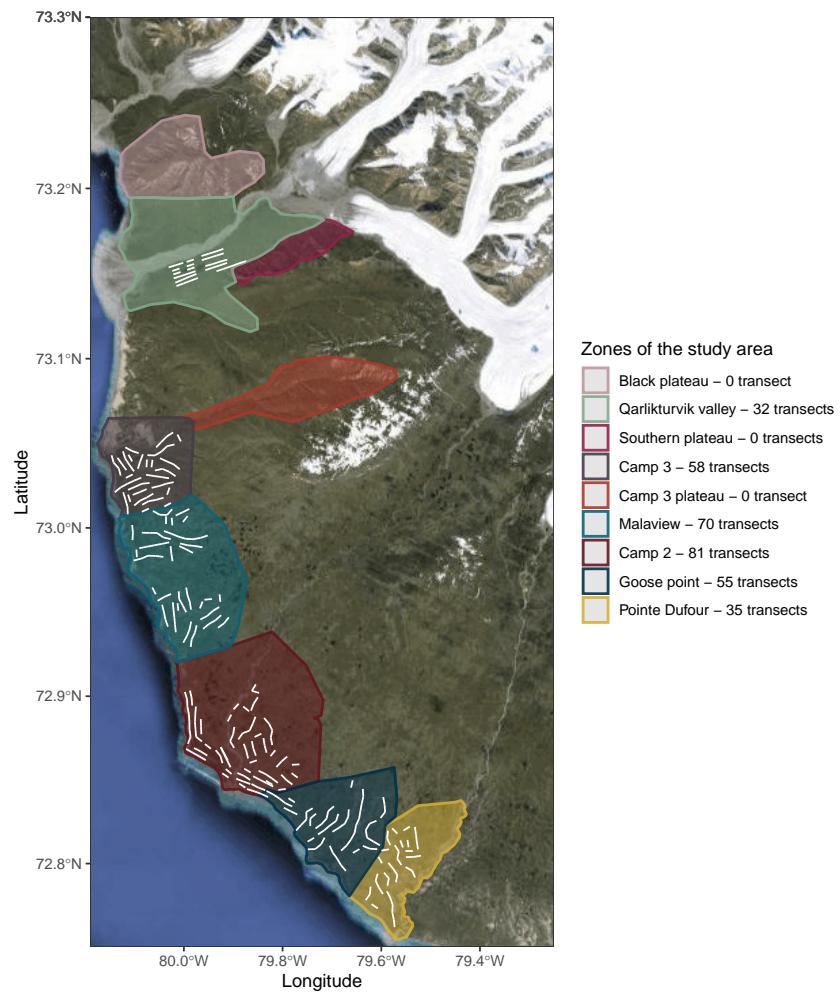


Figure 4: Spatial distribution of vertebrate count transects (white lines) on the south plain of Bylot Island (146 to 320 transects per year).

388 ***Snow goose point count***

389 At the start, middle, and end of each vertebrate count transect, a point count with a
390 radius of 125 meters was conducted to determine the number of snow goose breeding
391 pairs. On average, 613 ± 142 point counts were sampled each year, covering an area
392 of $30 \pm 7 \text{ km}^2$.

393

394 ***Incidental observations***

395 Since 2007, observers have recorded all vertebrate species observed opportunistically
396 during field work and tallied the total number of individuals at the end of each day
397 (Gauthier and Cadieux, 2020a; Gauthier et al., 2024b). The number of hours spent
398 in the field served as a proxy for the sampling effort. We used the number of indi-
399 viduals observed per hour spent in the field calculated by Gauthier et al. (2024b)
400 as an index of relative abundance for each species. However, we separated observa-
401 tions made in lowland from those in upland zones to have a relative abundance of
402 each species in each of these two broad categories (**Table 4**). Given that inciden-
403 tal observations lacked georeferencing, we opted to extract upland observations by
404 focusing on observations made during visits to rough-legged hawk nests, which are
405 mostly located in uplands.

406

Table 4: Index of relative abundance (i.e., number of individuals observed per hour) derived from incidental daily observations for selected vertebrate species in lowland (i.e., Qarlikturvik valley, Camp 3, Malaview, Camp 2, Goose point and Pointe Dufour) and upland (i.e., Black plateau, Southern plateau and Camp 3 plateau) zones of the Bylot Island study area. The ratio compares relative abundance indexes between these two types of zones, calculated by dividing the upland by the lowland index of relative abundance.

Species	Individuals/hour		
	Upland	Lowland	Ratio
rock ptarmigan	0.03	0.03	1
sandhill crane	0.42	0.287	1.5
American golden-plover	0.26	0.394	0.7
black-bellied plover	0.02	0.032	0.6
ruddy turnstone	0.01	0.007	1.3
red knot	0.00	0.033	0
pectoral sandpiper	0.02	0.034	0.6
Baird's sandpiper	0.31	0.32	1
white-rumped sandpiper	0.04	0.137	0.3
buff-breasted sandpiper	0.00	0.001	0
red phalarope	0.01	0.038	0.2
horned lark	0.24	0.154	1.6
American pipit	0.34	0.024	14.2
snow bunting	0.59	0.092	6.4
Arctic hare	0.02	0.009	2

407 ***Testimonials of ermine sightings***

408 There was no direct estimation of ermine abundance on Bylot Island as they are
409 quite difficult to obtain. The density estimates for ermine were derived from an
410 annual abundance index established by Bolduc et al. (2023), which relied on testi-
411 monials provided by observers across the whole study area from 1993 to 2019. The
412 testimonials provided by observers were used to create an abundance index ranging
413 from 0 to 3 (Bolduc et al., 2023). In this index, a score of 0 corresponds to the
414 absence of ermine sightings, 1 indicates a single sighting of a lone individual, 2 rep-
415 resents multiple sightings of lone individuals, and 3 signifies at least one sighting of
416 a family group. Scores of individual participants were averaged annually as detailed
417 in Bolduc et al. (2023).

418 d. Capture of individuals

419 ***Lemming trapping***

420 Since 2004, brown and collared lemmings were live-trapped 3 times during the sum-
421 mer (mid-June, mid-July, and mid-August) in two 11 ha grids. Each grid is made
422 of 144 traps separated by 30 m according to a cartesian plane, one in mesic habitat
423 and the other in wet habitat, located in the Qarlikturvik valley (Fauteux et al.,
424 2015; Gauthier, 2020). Density of each species was estimated at each occasion using
425 spatially explicit capture-recapture methods (see Fauteux et al. (2015) for details).
426 From 1995 to 2016 snap-trapping was performed once a year (mid-July) along 2
427 groups of transects located in the same habitats than the trapping grids (Gruyer
428 et al., 2008). Index of abundance derived from snap-trapping were transformed
429 in density estimates in each habitat for the period 1995-2003 using the equation
430 provided by Fauteux et al. (2018) based on the period of overlap between the two
431 sampling methods (2004 to 2016).

433 ***Arctic fox movement tracking***

434 In order to assess fox abundance based on the size of their home range, 109 Arctic
435 foxes were fitted with Argos Platform Transmitter Terminals mounted on collars
436 between 2008 and 2016 (Lai et al., 2015; Christin et al., 2015; Dulude-de Broin
437 et al., 2023). Foxes were captured between May and August across the study area,
438 within and outside the goose colony (Dulude-de Broin et al., 2023). Sampling of
439 animal locations was set for an interval of 1 or 2 days and only locations between
440 May 1 and October 30 were retained (Dulude-de Broin et al., 2023).

442 ***Parasitic jaeger banding***

443 In 2009, a significant effort was made to band as many parasitic jaegers as possible

444 within the study area. This effort resulted in the banding of 17 adult individuals
445 (Therrien and Gauthier, unpublished data).

446 **e. Species body mass**

447 All vertebrate individuals captured for marking purposes were systematically weighed
448 (snow goose (unpublished data), snowy owl (Therrien et al., 2012; Robillard et al., 2018),
449 American-golden plovers (Lamarre et al., 2021), common-ringed plovers (Léandri-Breton
450 et al., 2019), other shorebirds (Bêty, unpublished data), glaucous gulls (Gauthier et al.,
451 2015), long-tailed jaeger (Seyer et al., 2019), parasitic jaegers (Gauthier and Therrien,
452 unpublished data), Lapland longspurs (Gauthier and Bêty, unpublished data), lemmings
453 (Gauthier, 2020), ermine (Bilodeau and Bolduc, unpublished data) and Arctic foxes (Lai
454 et al., 2015)). Mean body mass of vertebrate species was determined in priority with
455 measurements from Bylot Island. When not available, we extracted mean body mass
456 from the literature (Wilman et al., 2014).

457 **3. Research methods**

458 **a. Field/laboratory**

459 We estimated the abundance of breeding individuals for most species, but there were
460 a few exceptions. For common ravens, parasitic jaegers, long-tailed ducks, and king
461 eiders, we suspect the presence of a significant number of non-breeding individuals in the
462 study area. Therefore, the estimates we provided for these species include both breeding
463 and potentially non-breeding individuals. Additionally, we did not distinguish between
464 breeding and non-breeding individuals for mammals such as brown and collared lemmings,
465 Arctic fox, ermine, and Arctic hare. The methods used for each species are summarized
466 in (**Table ??**).

467 ***Pacific loon, red-throated loon, cackling goose, tundra swan and glau-***
468 ***cous gull***

469 Based on the systematic and intensive search for the glaucous gull, cackling goose,
470 tundra swan, red-throated loon and Pacific loon nests in wetlands, we are con-
471 fident that we have found nearly all nests across the study area from 2017 to 2019
472 and in 2022. We transformed the number of nests to abundance of individuals by
473 multiplying it by a factor of two.

474 We observed a relatively strong correlation between the nest density of glaucous
475 gulls in the Qarlikturvik valley and the nest density across the entire study area
476 ($R^2 = 0.84$, $p = 0.16$, $n = 4$). Consequently, we estimated the density of glaucous
477 gulls at the scale of the study area between 2004 and 2016 based on the nest density
478 in the Qarlikturvik valley ($y = 0.12406x + 0.13775$). However, we did not observe
479 such strong relationships for loons and swans and thus we did not extend the time
480 series. Regarding cackling geese, we observed signs of an exponential increase over
481 time based on the annual number of nests found in various zones of the study area.
482 We thus fitted an exponential model using the number of nests found annually
483 over two distinct periods: in 1996 when the first nest was discovered, and then
484 from 2017 to 2023 when sampling effort was systematic across the whole study area
485 (**Figure 5**). We used the fitted model to estimate abundance between 1996 and
486 2016 when monitoring was less systematic, which could potentially underestimate
487 observed abundance as seen on **Figure 5**. We multiplied nest density by two to
488 obtain the abundance.

489 ***Snow goose***

490 Between 1999 and 2023, we assessed the abundance of snow geese in the study area
491 through a multi-step process. We calculated the mean annual density of snow goose
492 nests separately in the mesic and wetland habitats of the area occupied by the goose
493 colony annually. We made slight adjustments to the goose colony perimeter defined
494 from helicopter surveys to include all snow goose point counts where at least one
495 breeding pair had been observed (**Figure 6**). To determine the mean density of
496 nesting geese in wetlands, we divided two times (assuming two individuals per nest)
497 the total number of nests found during systematic nest searches by the total area
498 of wetlands sampled. The density of geese nesting in mesic habitat, a less preferred
499 nesting habitat (Lecomte et al., 2008), was averaged from three independent meth-
500 ods: systematic nest searches, vertebrate count transects, and snow goose point
501 counts. Systematic nest searches were highly precise, but covered a relatively small
502 area, whereas transects and snow goose point counts were less precise but covered
503 larger areas. For each method, we calculated the mean density of breeding indi-
504 viduals in mesic habitat by dividing the number of birds (or nests) recorded by

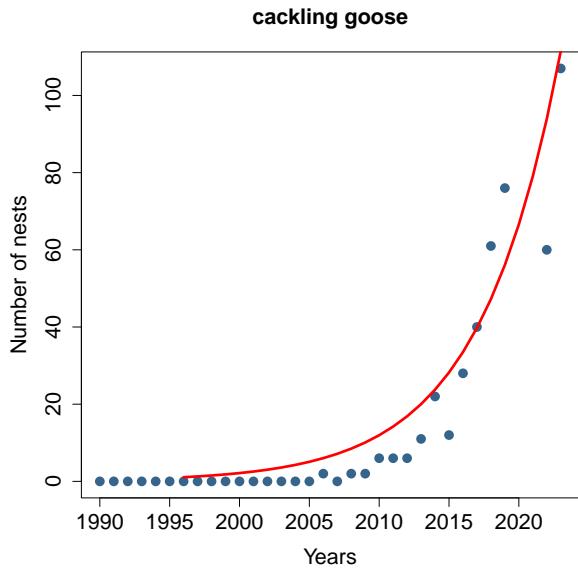


Figure 5: Number of cackling goose nests found across the study area over time. The red line represents the fitted model over the period 1996-2023 ($y = e^{0.1717x - 342.684}$), which was used to estimate the annual abundance of cackling goose between 1996 and 2016. The model presents a strong fit with the number of nests found between 2017 and 2023, when nest monitoring was systematic across the study area ($R^2 = 0.74$, $p = 0.15$, $n = 5$).

505 the area sampled. Despite methodological differences, the three approaches showed
 506 similar inter-annual variations, supporting the use of a mean values to estimate
 507 nest density in mesic habitat **Figure 7**). Lastly, to transform the densities in total
 508 abundance, we determined the annual proportion of wetland and mesic habitats
 509 within the goose colony and multiplied the area of each habitat by the density of
 510 breeding individuals. For the period 1999 to 2009, we used the average limits of
 511 the colony over the period 2010 to 2023 because we did not conduct aerial survey
 512 of the colony. Moreover, nest density in the mesic habitat was derived from a single
 513 method (**Figure 7**).

514 ***King eider and long-tailed duck***

515 We estimated the abundance of both king eiders and long-tailed ducks based on
516 the annual nest density of each species found in the 8 km² extensive nest search
517 area located in the Qarlikturvik valley. We extrapolated the mean nest density in
518 the wetlands of the Qarlikturvik valley to the wetlands of the study area (38.35
519 km²). We transformed nest density to abundance of breeding individuals by mul-
520 tiplying it by a factor of two. We acknowledge that the opportunistic monitoring
521 of these species likely underestimated their true nest density. However, considering
522 the extensive sampling effort deployed annually within this area, we are confident
523 to obtain a realistic order of magnitude for the number of nests present. Because
524 duck sightings are frequent, yet only a few nests are found, we believe there may
525 be non-breeding individuals. Therefore, we employed an additional method to es-
526 timate the overall duck populations without differentiating between breeding and
527 non-breeding individuals. As an alternative approach, we estimated the abundance
528 of ducks based on the indices of relative abundance (i.e., the number of individuals
529 observed per 100 hours) presented by Gauthier et al. (2024b). We assumed that the
530 ratios between relative and actual abundance are the same (i.e., similar detection
531 probability) in duck and loon species. We therefore derived the absolute abundance
532 of long-tailed ducks and king eiders from their relative abundances using the ratio
533 between relative and absolute abundances of red-throated loons as a reference.

534 ***Rough-legged hawk, peregrine falcon and snowy owl***

535 We estimated the abundance of breeding rough-legged hawks, peregrine falcons and
536 snowy owls based on systematic nest monitoring conducted throughout the study
537 area for these species. To convert the number of nests into breeding abundance, we
538 multiplied it by two. For snowy owls, we extended the time series from 1996 to 2011
539 based on a linear regression between nest density in the Qarlikturvik valley and
540 nearby plateaus (Black and Southern plateaus) and nest density across the entire
541 study area ($y = 0.68867x - 0.00173$; R²= 0.99; p < 0.0001, n= 10). We used the
542 same approach for rough-legged hawks ($y = 0.49851x$, R²= 0.99, p < 0.0001, n= 8)
543 to extend the time series from 2007 to 2012. We did not extend the time series for
544 peregrine falcons because the correlation is not as strong (R²= 0.44, p= 0.27, n=8).

545 ***Rock ptarmigan***

546 We estimated the abundance of rock ptarmigans based on the annual nest density
547 measured in the 8 km² extensive nest search area of the Qarlikturvik valley. While we
548 acknowledge that the opportunistic monitoring of this species likely underestimates
549 nest density, the extensive sampling effort deployed annually within this area gives
550 us confidence in obtaining a realistic number of nests. We then extrapolate the
551 density to the whole study area, without distinction between mesic, wetland and

552 upland habitats (**Table 4**). Among the 6 nests found in the study area, 4 were
553 located in mesic habitat, while one nest was found in a wetland and another in
554 an upland habitat. To convert the number of nests into breeding abundance, we
555 multiplied it by two.

556 **Sandhill crane**

557 We estimated the mean abundance of sandhill cranes in the lowland zones of the
558 study area based on a regression between nest density and the number of individuals
559 observed per transect (**Figure 8**). In this relationship, nest density and transect
560 observations come from the 8 km² area of the Qarlikturvik valley where extensive
561 nest search is performed. We acknowledge that the opportunistic monitoring of
562 this species likely underestimated the true nest density. However, considering the
563 extensive sampling effort deployed annually within this area, we are confident in
564 obtaining a realistic order of magnitude for the number of nests present. Number of
565 individuals observed along transects in each lowland zone was converted into nest
566 density using the regressions, and then in total number of individuals in each zone by
567 multiplying by the area of the zone and a factor 2. We estimated the density in the
568 upland zones by applying a correction factor to the annual mean density in lowland
569 zones. This correction factor was determined based on the relative abundance ratio
570 between the upland and lowland zones (**Table 4**).

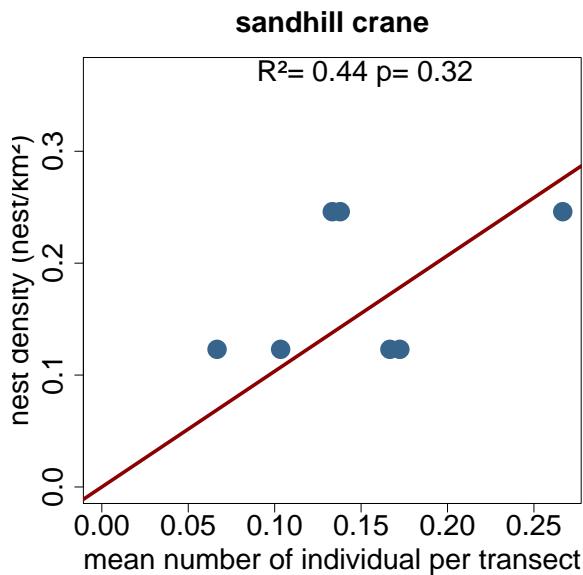


Figure 8: Linear regression between the nest density of sandhill cranes and the number of individuals observed per transect (nest density = 1.12 x number of individuals per transect; regression was forced to pass through the origin). The fit (R^2 and p value) of the regression (red line) with the empirical data from the Qarlikturvik valley is presented (blue dots). Data points represent annual values.

571

American golden-plover and black-bellied plover

We applied a distance sampling approach to the observations of American golden-plovers made along vertebrate count transects to estimate the abundance of individuals in the mesic habitat of the study area between 2014 and 2023. We used perpendicular distance between detected individuals and transect ($n= 1015$) to estimate a detection function with the *ds* function from the *Distance* package (Miller et al., 2019). We applied a truncation distance of 150 m (i.e., maximum distance on either side of the observer where observations have been considered). We selected the model with the lowest AIC, which included a "hn" key and a single "cos" adjustment term. We excluded observations of more than four individuals, as these likely indicated groups of non-breeders passing through the area. We did not estimate abundance in wetland habitat because American golden-plovers nest almost exclusively in mesic habitat (Parmelee et al., 1967). We estimated the abundance in the upland zones (i.e., plateaus) by applying a correction factor to the abundance in lowland zones. This correction factor was determined based on the relative abundance ratio between the upland and lowland zones (**Table 4**).

To determine the abundance of black-bellied plovers, we used the mean number of black-bellied plovers and American golden-plovers observed per transect as an index of relative abundance. We assumed that the ratios of between relative and actual abundance are the same (i.e., similar detection probability) among those species. This assumption is realistic as those species present similarities in size, color, and reproductive behavior. We therefore derived the absolute abundance of black-bellied plovers from their relative abundance using the ratio between relative and absolute abundances of American golden-plover as a reference.

As an alternative approach to determine black-bellied plover abundance, we used the same approach as previously described, but with the indices of relative abundance presented by Gauthier et al. (2024b), which was derived from incidental daily observations.

Common-ringed plover

To estimate the abundance of common-ringed plovers in the study area, we relied on the total number of nests recorded annually from 2015 to 2017, during which the primary nesting sites underwent intensive sampling. We multiplied the total nest count by two to represent the abundance of breeding individuals.

Lapland longspur and Baird's sandpiper

We estimated the mean abundance of Lapland longspur in the different lowland zones of the study area based on a regression between nest density and the number of individuals observed per transect (**Figure 9**). For Baird's sandpiper, we employed a similar approach, but instead of using the mean number of individuals

609 observed per transect, we used the mean proportion of transects where at least one
 610 individual was detected. We made this adjustment because this species was less
 611 frequently observed. In this relationship, nest density for these two species came
 612 from the intensive nest sampling conducted within the core 2 km² area of the Qar-
 613 likturvik valley and observations of individuals from transects carried out in the
 614 larger 8 km² area in which the core area was located. This approach allowed us
 615 to incorporate a larger sample size from the transects while focusing on a measure
 616 of nest density determined systematically. Transects observations in lowland were
 617 then converted into nest density using the regressions, and then in total number of
 618 individuals by multiplying by the area and a factor 2. We estimated the density
 619 of both species in the upland zones by applying a correction factor to the annual
 620 mean density in lowland zones. This correction factor was determined based on the
 621 relative abundance ratio between the upland and lowland zones (**Table 4**). We ac-
 622 knowledge that the regression for Baird's sandpiper is weak; however, it offers some
 623 refinement compared to assuming a uniform density throughout the study area.

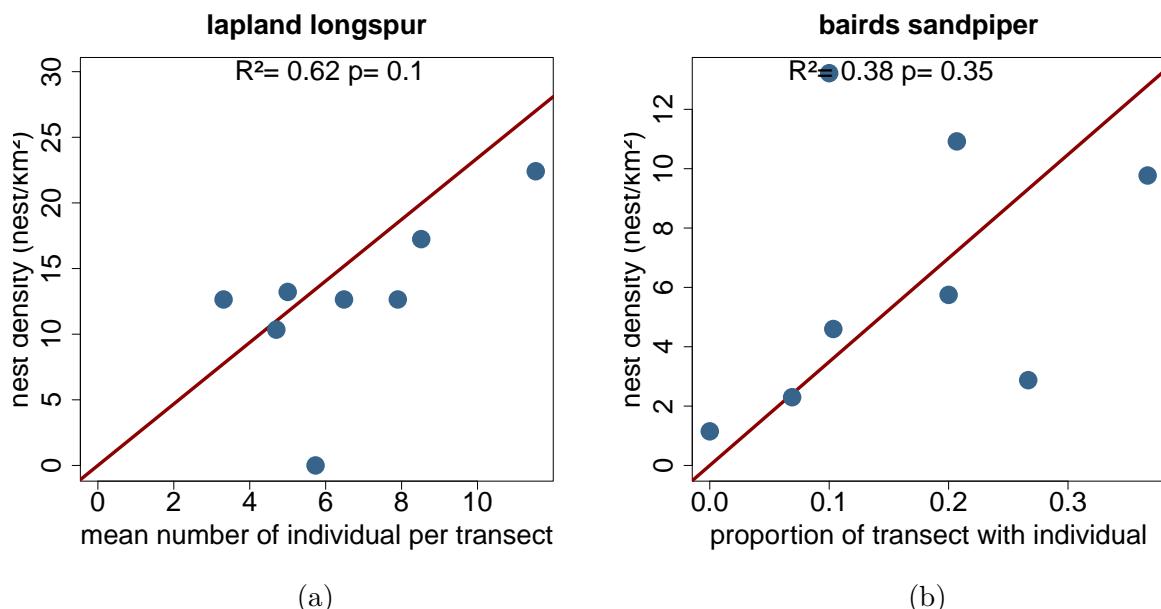


Figure 9: a) Linear regression between the nest density of Lapland longspurs and the number of individuals observed per transect (nest density= 2.3422 x number of individuals per transect; regression was forced through the origin). The fit (R^2 and p value) of the regression (red line) with the empirical data from the Qarliketurvik valley is presented (blue dots). Data points represent annual values. b) Linear regression between the nest density of Baird's sandpiper and the proportion of transect with at least one individual observed (nest density= 34.9248 x proportion of transects with at least one individual; regression was forced through the origin). The fit (R^2 and p value) of the regression (red line) with the empirical data from the Qarliketurvik valley is presented (blue dots). Data points represent annual values.

624 ***Other passerines and sandpipers***

625 We estimated the abundance of other passerines (horned lark, American pipit, and
626 snow bunting) in the lowland zones of the study area with the regression equa-
627 tion between number of individuals per transect and nest density of the Lapland
628 longspur (see section 3.9). We assumed here a similar detection probability for all
629 species. We used the same approach for other sandpiper species (white-rumped
630 sandpiper, pectoral sandpiper, buff-breasted sandpiper, red knot, ruddy turnstone
631 and red phalarope) based on the regression equation for the Baird's sandpiper (see
632 section 3.9). For all these species, we estimated the density in the upland zones by
633 applying a correction factor to the mean density in lowland zones. This correction
634 factor was determined based on the relative abundance ratio between the upland
635 and lowland zones (**Table 4**). Nest density was then converted in number of in-
636 dividuals by multiplying by the area and a factor 2. As an alternative approach,
637 we estimated the abundance of other passerines and sandpipers based on the in-
638 dices of relative abundance (i.e., the number of individuals observed per 100 hours)
639 presented by Gauthier et al. (2024b). We assumed that the ratios between relative
640 and actual abundance are the same (i.e., similar detection probability) among both
641 passerine and sandpiper species. We therefore derived the absolute abundance of
642 other passerine and sandpiper species from their relative abundances using respec-
643 tively, the ratios between relative and absolute abundances of Lapland longspur
644 (passerines) and Baird's sandpiper (sandpipers) as references.

645 ***Long-tailed jaeger***

646 We determined the annual nest density of long-tailed jaegers from the systematic
647 nest sampling between 2004 and 2023 on the southern side of the glacial river in
648 the Qarlikturvik valley. We determined nest density by dividing the annual number
649 of nests recorded by the area of the surveyed zone (33 km^2). As long-tailed jaegers
650 typically nest in mesic habitat (Andersson, 1971), we multiplied the area occupied
651 by mesic habitat across the study area by the nest density obtained in the surveyed
652 zone and by two to obtain the total abundance of breeding individuals.

653 ***Parasitic jaeger***

654 Based on the opportunistic nest monitoring of parasitic jaegers across the study
655 area, an average of 3.75 nests is found annually, a small number considering that
656 parasitic jaegers were frequently observed at the study site (Gauthier et al., 2024b).
657 This suggests that there may be non-breeding individuals present at the study site,
658 or alternatively, individuals may regularly travel long distances, potentially from
659 outside the study area, to forage during the breeding season. Due to limited data
660 availability for estimating the abundance of non-breeding parasitic jaegers, we relied
661 on the maximum number of adults banded during a single year (17 individuals in

662 2009; Therrien, unpublished data) as the minimum abundance on the study area.
663 This corresponds to a density of 0.04 individuals/km². For comparison, Taylor
664 (1974) measured a density of 0.06 individual/km² on Bathurst Island.

665 ***Common raven***

666 Despite the intensive nest searches for raptors in upland zones, we never found more
667 than one common raven nest each year, a small number considering the frequent
668 raven observations at the study site (Gauthier et al., 2024b). This indicates the
669 potential presence of non-breeding individuals or individuals that breed outside the
670 study area but use it for foraging. Therefore, we opted for alternative approaches
671 based on individual counts to estimate the abundance of both breeding and non-
672 breeding ravens. As a first approach, we based our estimate of ravens on the number
673 of glaucous gulls observed per transect. We assumed that the ratios between relative
674 and actual abundance are the same (i.e., similar detection probability) among
675 those species. This assumption is reasonable as those species present similarities in
676 size and foraging strategy. We therefore derived the absolute abundance of common
677 ravens from their relative abundance using the ratio between relative and absolute
678 abundances of glaucous gulls as a reference. Independently, we estimated the abun-
679 dence of common ravens with the same approach but using the indices of relative
680 abundance presented by Gauthier et al. (2024b), which was derived from incidental
681 daily observations, rather than observations from the transects.

682 ***Brown and collared lemming***

683 Between 1995 and 2003, we used the density estimates derived from the snap-
684 trapping indices obtained in late July in each habitat. Between 2004 and 2007,
685 annual abundance of each lemming species was based on the late-July density esti-
686 mates on trapping grid in wet and mesic habitats. However, starting from 2008, es-
687 timates were derived from the mean density recorded in mid-July and mid-August,
688 except for two instances: 2019 and 2021. In 2019, due to an exceptionally early
689 snowmelt and thus an early decline in lemmings during the summer, we only re-
690 tained value from mid-July. In 2021, we relied solely on data gathered in August
691 because it was the only trapping period carried out that year. To scale the es-
692 timated densities from the wet and mesic grids to the entire study area, we used the
693 proportions of mesic habitats (64%) and wet habitats (10%) measured within the
694 study area.

695 ***Arctic hare***

696 Arctic hares are primarily observed in the upland zones of the study area, where
697 sampling effort is limited. We thus derived abundance of hares from the estimated
698 abundance of Arctic foxes based on indices of relative abundance presented in (Gau-
699 thier et al., 2024b), which were derived from incidental daily observations. We dou-

bled the density of Arctic hares in the upland zones (i.e., plateaus), as twice as many individuals were observed per hour of fieldwork there compared to lowland zones (**Table 4**). However, it is worth noting that assuming a similar detection probability between foxes and hares might lead to an overestimation of hare detection probability due to behavioral differences between the species. Therefore, we most likely underestimate the actual abundance of Arctic hares in the study area.

Ermine

We estimated the annual abundance of ermines by transforming the annual index of relative abundance provided in Bolduc et al. (2023) into individual density. Annual values ranged from 0, indicating no ermine sighting, to 2.88, which signifies that nearly all observers observed at least one family group during their field season. We independently obtained measures of minimum (0.02 ind./km²) and maximum (0.4 ind./km²) ermine density, which were determined from estimates of individual home range obtained from radio-tracking data, observations on Bylot Island, and existing literature (Legagneux et al., 2012; Bilodeau, 2013). We associated the minimum and maximum scores of relative abundance with the minimum and maximum density of individuals, respectively. Ultimately, we calculated the ermine density by linearly interpolating between these two density extremes using the annual index of relative abundance.

Arctic fox

We estimated the abundance of Arctic foxes in the study area based on their estimated home range size inside and outside the goose colony. We used the data and methodologies outlined in Dulude-de Broin et al. (2023) to estimate home range size. However, here, we did not account for annual variations in lemming density as presented in Dulude-de Broin et al. (2023) in order to obtain mean fox home range. Given that foxes are territorial and exhibit an average spatial overlap with adjacent territories of 18% (Clermont et al., 2021), we converted home range size into individual density using the following formula: $density\ of\ individuals = \frac{2}{0.82 \times home\ range}$. We used two as numerator because we assumed each territory was held by a pair of fox, either breeding or non-breeding fox pair, without accounting for potential nomadic or transient individuals. We used values of 12.26 km² to represent the mean home range of foxes within the goose colony and 20.02 km² for foxes outside the goose colony. We estimated the mean density of foxes in each zone of the study area according to the mean proportion of the zone covered by the goose colony. We derived the mean annual proportion of each zone covered by the goose colony from the colony outline between 2010 and 2023. We estimated a mean density of 0.14 individuals/km² for the study area. Previously, the minimum density of foxes in the study area was estimated to be between 0.03 and 0.13 individuals per km² based on

camera traps (Royer-Boutin, 2015).

739 **b. Taxonomy and systematics**

740 Bird scientific names were obtained from the IOC World Bird List 14.2 (Gill et al., 2024).
741 Mammal scientific names were obtained from the Mammal species of the world: a tax-
742 onomic and geographic reference (Wilson, 2005). However, we considered here *Mustela*
743 *erminea richardsonii* as *Mustela richardsonii* due to recent genetic analysis (Colella et al.,
744 2021).

745 **c. Permit history**

746 All research involving animals on Bylot Island has been approved by an institutional
747 Animal Care Committee. In 1999, the study area became part of Sirmiliik National Park,
748 managed by Parks Canada. Since then, all research activities in the park have been
749 approved by a Joint Park Management Committee.

750 **d. Project personnel**

751 ***Principal and associated investigators***

752 Gilles Gauthier, Eric Reed, Jean-François Giroux, Dominique Berteaux, Joël Béty,
753 Josée Lefebvre, Dominique Gravel, Jean-François Therrien, Nicolas Lecomte, Do-
754 minique Fauteux, Pierre Legagneux (Gauthier et al., 2024a)

755 ***Students***

756 By combining animal and plant ecology, 24 doctoral theses and 56 master theses have
757 been completed in relation to the Bylot Island South Plain study area (Gauthier
758 et al., 2024a).

759 **Class III. Data set status and accessibility**

760 **A. Status**

761 **1. Latest update**

762 19th September 2024

763 **2. Latest archive date**

764 XXXXXX October 2024

765 **3. Metadata status**

766 XXXXXX October 2024

767 **4. Data verification**

768 The methods used to extract final species abundance estimates were subject to several
769 rounds of revision by the principal investigators.

770 **B. Accessibility**

771 **1. Storage location and medium**

772 Data are publicly available at <https://datadryad.org/>.

773 Raw data and codes used to extract the presented data set are publicly available at
774 https://github.com/chaireBioNorth/BYLOT_species_abundance_dataset.

775 **2. Contact persons**

776 ***Overall project***

777 Joël Béty; *joel_bety@uqar.ca*; 418 723-1986 #1701; 300 allée des Ursulines, Ri-
778 mouski, Québec, Canada, G5L 3A1, Office B-002

779 ***Data and codes***

780 Louis Moisan, *louis.moisan.bio@gmail.com*

⁷⁸¹ **3. Copyright restrictions**

⁷⁸² None

⁷⁸³ **4. Proprietary restrictions**

⁷⁸⁴ **a. Release date**

⁷⁸⁵ None

⁷⁸⁶ **b. Citation**

⁷⁸⁷ Please cite this data paper when using the data.

⁷⁸⁸ **c. Disclaimer**

⁷⁸⁹ None

⁷⁹⁰ **5. Costs**

⁷⁹¹ None , the data can be used free of charge.

792 **Class IV. Data structural descriptors**

793 **A. Data set file**

794 **1. Identity**

- 795 a. BYLOT-species_taxonomy.csv
796 b. BYLOT-species_abundance.csv
797 c. BYLOT-mean_species_abundance.csv
798 d. BYLOT-mean_species_body_mass.csv
799 e. BYLOT-interannual_variation_nest_density.csv

800

801 **2. Size**

- 802 a. 35 records, not including header row (2.3 kB)
803 b. 273 records, not including header row (17.0 kB)
804 c. 35 records, not including header row (2.1 kB)
805 d. 51 records, not including header row (1.8 kB)
806 e. 18 records, not including header row (1.1 kB)

807 **3. Format and storage mode**

808 All files are in a comma-separated value format (.csv).

809 **4. Header information**

810 **a. BYLOT-species_taxonomy.csv**

811 functional_group; scientific_name; species; annual_cycle_strategy

812 **b. BYLOT-species_abundance.csv**

813 species; year; status; method; abundance

814 **c. BYLOT-mean_species_abundance.csv**

815 species; method; mean_abundance; sd_abundance; sample_size_abundance

816 **d. BYLOT-mean_species_body_mass.csv**

817 species; source; body_mass_g

818 e. BYLOT-interannual_variation_nest_density.csv
819 species; zone; mean_nest_density_km2; sd_nest_density_km2; sample_size_nest_density_km2

820 **5. Alphanumeric attributes**

821 Mixed

822 **6. Special characters/fields**

823 Unavailable values are indicated by NA.

824 **7. Authentication procedures**

825 Sums of the numeric columns:

826 b. BYLOT-species_abundance.csv: abundance= 2291027
827 c. BYLOT-mean_species_abundance.csv: mean_abundance= 107875; sd_abundance= 116687; sample_size_abundance= 207
828 d. BYLOT-mean_species_body_mass.csv: body_mass_g= 46223
829 e. BYLOT-interannual_variation_nest_density.csv: mean_nest_density_km2= 19.991;
830 sd_nest_density_km2= 10.539; sample_size_nest_density_km2= 185

832 **B. Variable information**

833 **1. Variable identity**

834 See Table 5

835 **2. Variable definition**

836 See Table 5

837 **3. Units of measurement**

838 See Table 5

Table 5: Summary of variable definitions, units, and data types for each data set file.

Data file	Variable identity	Variable definition	Units	Type
a.	functional_group	Functional group for each species. The classification of species into functional groups is based on Moisan et al. (2023).		string

a.	scientific_name	Bird scientific names were obtained from the IOC World Bird List 14.2 (Gill et al., 2024). Mammal scientific names were obtained from the Mammal species of the world: a taxonomic and geographic reference (Wilson, 2005). However, we considered here <i>Mustela erminea richardsonii</i> as <i>Mustela richardsonii</i> due to recent genetic analysis (Colella et al., 2021).		string
a.	species	Common species english name.		string
a.	annual_cycle_strategy	Annual cycle strategy of each species (i.e., resident, partially migratory or migratory). The classification of species annual cycle strategy is based on Gauthier et al., (2011) and Moisan et al. (2023).		string
b.	species	Common species english name.		string
b.	year	Year corresponding to the estimate of annual abundance.	years	integer
b.	status	Reproductive status of the individuals (i.e., undetermined or breeding).		string
b.	method	Brief overview of the method used to estimate the species abundance.		string
b.	abundance	Estimate of the annual number of individuals found within the 389 km ² study area located on the southern part of Bylot Island during the breeding season (May to August). This includes both breeding and non-breeding individuals that stay in the study area for a significant period of time, and excludes non-breeding individuals that stop for only a few days during their migration. The estimates only consider adults, with the exception of lemmings, for which no distinction has been made between juveniles and adults.	individuals	integer
c.	species	Common species english name.		string
c.	method	Brief overview of the method used to estimate the species abundance.		string
c.	mean_abundance	Estimate of the mean annual number of individuals found within the 389 km ² study area located on the southern part of Bylot Island during the breeding season (May to August). This includes both breeding and non-breeding individuals that stay in the study area for a significant period of time, and excludes non-breeding individuals that stop for only a few days during their migration. The estimates only consider adults, with the exception of lemmings, for which no distinction has been made between juveniles and adults.	individuals	integer
c.	sd_abundance	Standard deviation of the annual species abundance.	individuals	numeric
c.	sample_size_abundance	Number of years consider in the calculation of mean annual abundance.	years	integer
d.	species	Common species english name.		string
d.	source	Source from which estimate were derived (i.e., measurements from the study area or extracted from Wilman et al. 2014).		string
d.	body_mass_g	Mean individual body mass.	grams	numeric

e.	species	Common species english name.		string
e.	zone	Sampled zone of the study area (see figure 2 and 3).		string
e.	mean_nest_density_km2	Estimate of the mean annual nest density measured within the corresponding zone of the study area.	nests per square kilometer	numeric
e.	sd_nest_density_km2	Standard deviation of the annual nest density measured within the corresponding zone of the study area.	nests per square kilometer	numeric
e.	sample_size_nest_density_km2	Number of years consider in the calculation of the nest density.	years	integer

4. Data type

- a. Storage type: Integer, floating point, character, string, etc.
- b. List and definition of variable codes: Description of any codes associated with variables
- c. Range for numeric values: Minimum, maximum
- d. Missing value codes: Description of how missing values are represented in data set
- e. Precision: Number of significant digits

5. Data format

- a. Fixed, variable length
- b. Columns: Start column, end column
- c. Optional number of decimal places

C. Data anomalies: Description of missing data, anomalous data, calibration errors, etc.

852 **Class V. Supplemental descriptors**

853 **A. Data acquisition**

- 854 1. Data forms or acquisition methods: Description or examples of data forms, auto-
855 mated data loggers, digitizing procedures, etc.
- 856 2. Location of completed data forms
- 857 3. Data entry verification procedures: Procedures employed to verify that digital data
858 set is free of errors

859 **B. Quality assurance/quality control procedures**

- 860 Identification and treatment of outliers, description of quality assessments, calibration of
861 reference standards, equipment performance results, etc.

862 **C. Related materials**

- 863 References and locations of maps, photographs, videos, GIS data layers, physical speci-
864 mens, field notebooks, comments, etc.

865 **D. Computer programs and data-processing algorithms**

- 866 1. **Program:** R version 4.3.2 (2023-10-31)
- 867 2. **Operating system:** x86_64-pc-linux-gnu (64-bit) with Ubuntu 22.04.3 LTS
- 868 3. **Packages:** dplyr, tidyverse, sf, stringr, xtable, Distance, ggplot2, lme4, AICmodavg,
869 scales, ggmap
- 870 4. **Codes:** All raw data and codes are publicly available at <https://github.com/>
871 chaireBioNorth/BYLOT_species_abundance_dataset.git

872 **E. Archiving**

- 873 1. **Archival procedures:** Data will be archived on Dryad upon acceptance for pub-
874 lication
- 875 2. **Redundant archival sites:** n/a

⁸⁷⁶ **F. Publications and results:** Electronic reprints, lists
⁸⁷⁷ of publications resulting from or related to the study,
⁸⁷⁸ graphical/statistical data representations, etc.

⁸⁷⁹ List of publications that include data from the data set:

⁸⁸⁰ 1.

⁸⁸¹ **G. History of data set usage**

- ⁸⁸² 1. Data request history: n/a
- ⁸⁸³ 2. Data set update history: n/a
- ⁸⁸⁴ 3. Review history: n/a
- ⁸⁸⁵ 4. Questions and comments from secondary users: n/a

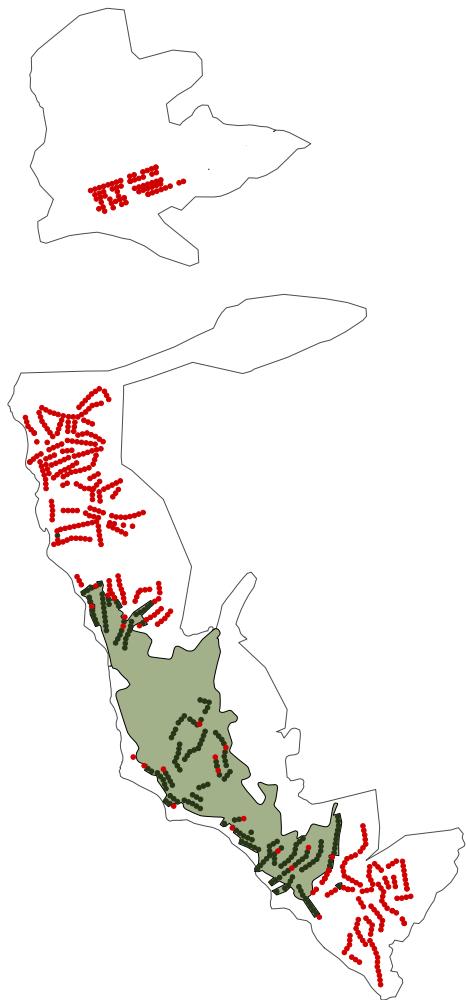


Figure 6: Map showing the region occupied by the snow goose colony in 2017 (green polygon) as an example. The perimeter was first defined from a helicopter surveys and then slightly adjusted to include all snow goose point counts where at least one breeding pair had been observed in that year (green dots). Snow goose point counts where no breeding geese were observed in that year are presented as red dots.

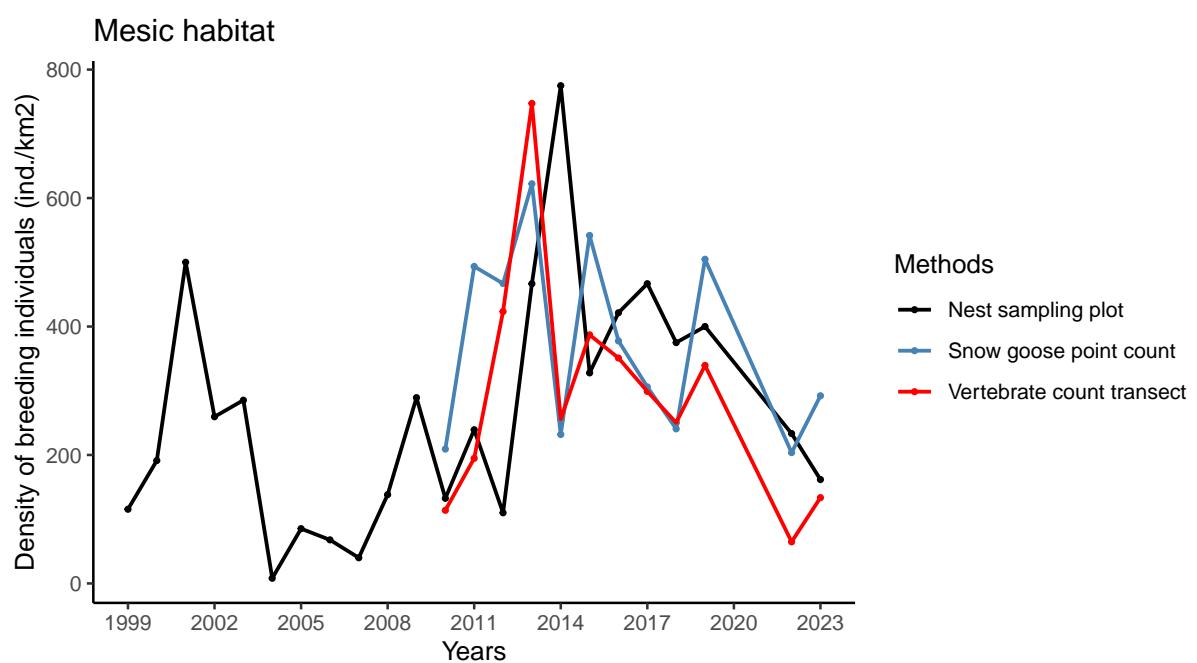


Figure 7: Estimates of breeding goose density in mesic habitat of the Bylot Island study area using three independent methods: Nest sampling plot, Snow goose point count, Vertebrate count transect.

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