Aerial survey of the Torngat Mountains caribou herd in March 2024 and comparisons with previous surveys.

Couturier, S.[1], Dale, A.[2], Brodeur, V.[3], McCarthy, S.[4], and Guindon, R.[5]

[1] caribou2026@gmail.com [2] aaron.dale@torngat.com
[3] vincent.brodeur@environnement.gouv.qc.ca [4] saramccarthy@gov.nl.ca
[5] rguindon@makivvik.ca

Torngat Wildlife, Plants and Fisheries Secretariat
19 Burnwood Dr, P.O. Box 2050 Stn. B
Happy Valley-Goose Bay. NL. A0P 1E0

In collaboration with the Torngat Caribou Technical Committee:
Government of Québec, Government of Newfoundland & Labrador, Nunatsiavut Government, Parks Canada, Makivvik and Kativik Regional Government (Nunavik Parks).

Torngat Wildlife and Plants Co-Management Board

Torngat Wildlife, Plants and Fisheries Secretariat

The primary responsibilities of the Torngat Wildlife and Plants Co-management Board and the Torngat Joint Fisheries Board are to establish total allowable harvests for non-migratory species of wildlife and for plants, recommend conservation and management measures for wildlife, plants, and habitat in the Labrador Inuit Settlement Area (LISA) and to make recommendations in relation to the conservation of species, stocks of fish, aquatic plants, fish habitat, and the management of fisheries in the Labrador Inuit Settlement Area. The Secretariat is the implementation agent of the Torngat Joint Fisheries Board and the Torngat Wildlife and Plants Co-Management Board.

Torngat Omajunik, Piguttunik Oganniaganillu Suliangit

Suliagigumajangit Torngat Omajunik, Piguttunillu AulatsiKatigengita AngajukKauKatigengit ammalu Torngat Ikajuttiget Oganniatuligijingita AngajukKauKatigengit sakKititsigiamut pijaugunnatunik katillugit aullaigatsatagiamut nokataKattangitunik omajunik ammalu piguttunik, uKautjigiajut asikKitailigiamut ammalu aulatsigiamut omajunik, piguttunik, ammalu inigiKattajanginnik Labradorimi Inuit Satusasimajanginni Nunani (LISA) ammalu uKautjigiagutinik ilingajunik asikKitailigiamut omajunik, oganniaganik, piguttunik, oganik, ammalu aulatsigiamut oganniaganik Labradorimi Inuit Satusasimajanginni Nunani.

SuliaKattet atuliaKititsigumajut kiggatuttinganik Torngat Ikajuttiget Oganniatuligijingita AngajukKauKatigenginnik ammalu Torngat Omajuligijinginnik Piguttunillu AulatsiKattajut AngajukKauKatigenginnik, sunatuinnanik, suliatsanik aulatsigiamut ammalu ikajutsitaullutik tamâginnut angajukKauKatigenut.

Torngat Wildlife, Plants & Fisheries Secretariat Series

2026

Aerial survey of the Torngat Mountains caribou herd in March 2024 and comparisons with previous surveys.

Couturier, S., Dale, A., Brodeur, V., McCarthy, S., and Guindon, R.

Torngat Wildlife Plants and Fisheries Secretariat
19 Burnwood Dr, P.O. Box 2050 Station B,
Happy Valley-Goose Bay, NL
A0P 1E0

Published by:
Torngat Wildlife, Plants and Fisheries Secretariat
19 Burnwood Dr, P.O. Box 2050 Stn. B
Happy Valley-Goose Bay, NL
A0P 1E0

Correct citation for this publication:
Couturier, S., Dale, A., Brodeur, V., McCarthy, S., and Guindon, R. (2026). Aerial survey of the Torngat Mountains caribou herd in March 2024 and comparisons with previous surveys. *Torngat Wildlife, Plants and Fisheries Secretariat. Ser*. 2026/ 36 p+ 8 p.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Acknowledgements

This project represents an important co-management program supported by the people of Nunavik and Nunatsiavut. The survey project was done in partnership with organizations of the Torngat Caribou Technical Committee: Government of Québec (Vincent Brodeur), Newfoundland and Labrador Government (Sara McCarthy), Nunatsiavut Government (Jim Goudie and Jason Dicker), Kativik Regional Government and Nunavik Parks (Corentin Chaillon), Makivvik (Rachel Guindon), Parks Canada (Tom Knight and Nathan Kennedy), and the Torngat Wildlife, Plants & Fisheries Secretariat (Aaron Dale, Jazlyn Burrell and Katrien Kingdon). Not only did the Torngat Committee members collaborate in the planning and realization of the project, but they also supported it through direct funding and in-kind contributions (fuel, etc.). Many thanks to Tom Knight and Parks Canada for the major direct funding that allows the cost sharing of the helicopter charter.

Inuit observers and bear monitors, Colin Webb from Nain and Ned Annanack from Kangiqsualujjuaq, provided invaluable assistance in the field. A special thanks to pilot Peter Jefford of Newfoundland Helicopters who provided not only a safe operation of the helicopter, but also a strong commitment to the success of the survey. Thanks to Nunavik Rotors and pilot Peter Duncan, and to Héli-Boréal and pilot Raphaël Dumas, for their assistance with fuel deployment and cleanup. The GIS work was done by Shawn Rivoire and James Williamson at the Torngat Secretariat. Thanks to the people of Kangiqsualujjuaq who helped us during our stay in March 2024.

Executive Summary

The first-ever systematic aerial population survey of Torngat Mountains caribou herd (TMCH) was carried out in March 2014 and concluded with an estimated herd size of 930 caribou (Couturier et al. 2015). Survey results were discussed with the Inuit communities of Kangiqsualujjuaq and Nain, and the need to continue the herd size monitoring was expressed. In spring 2017, the survey design was slightly modified to increase the sampling effort which estimated the herd size at 1,326 caribou (Couturier et al. 2018). Using the same method in 2021, a third survey assessed the herd size at 2,422 caribou estimating that herd has increased by 14.7% annually between 2014 and 2021 (Couturier et al. 2024). A fourth survey was done in March 2024, and the results are presented in this report. These survey results will be shared with the Inuit communities to inform conservation and management discussions on the TMCH.

The fieldwork extended from March 8 to March 21, 2024, including positioning and repositioning from Happy Valley-Goose Bay (NL). The survey team was able to cover 98% of the planned transects in a relatively short period of time and experienced no significant weather delays or helicopter-related issues. A total of 70 parallel W-E transects, each separated by 4 km, were flown for a total length of 6,392 km. As with the first three surveys, the Distance Sampling method was used during the flight over transects. Four observers, including the pilot, recorded caribou groups (1 to 50 caribou) during low-altitude flights over a survey area of 26,399 km^2. From the 121 caribou groups (total of 1,075 caribou seen) that were recorded over transects, the TMCH size was estimated at 2,997 caribou (including 10-month-old calves) with a 90% confidence interval of 2,359 (-21.3%) to 3,851 (+28.5%). If only 22-month-old and older caribou are considered, the adult population size is estimated at 2,293 caribou based on the evaluation of 23.5% calves in the population.

This study has shown that the TMCH has continued an increasing trend, with an annual rate of increase of 12.4% on average since 2014. The monitoring of population dynamics also suggests that recruitment remained high and explains in part the TMCH growth. However, the rate of increase has slowed down recently with an annual rate of 7.4% between 2021 and 2024, compared to 16.3% between 2017 and 2021.

AngajukKauniujuit Kaujititsiutinga Nailittisimajuk

Tânna sivullipâmmagimmik piusigijausimajuk tingijokkut omajunnut Kaujisannik taikkununga Tungait KakKasuanginni tuttuKutinginnut suliagijaulauttuk Mertz 2014 ammalu pijagemmata kititangit anginingit 930 omajunnut. Kaujijausimajut uKâlautigijaulauttut taikkununga Inuit nunalinnut Kangiqsualujjuami ammalu Nain, ammalu suli kajusiutigijaugialik tuttuKutet angininginnik kamagiamut uKattaulauttuk. Upingasâmi 2017, tamanna Kaujisannik piusigisimajanga asiangutitaugalâlauttuk anginitsamik tigusigunnagiamut piggatutigijaujumut kititangit tuttuKutiujunut anginga imailingatluni 1,326 tuttuit. Atutlutik taimâtsainak jâringani 2021, pingajua Kaujisannik kititangit omajunnut anginga imailingatluni 2,422 tuttuit takutitsijut taikkua tuttuKutet puttuvalliasimajut ominga 14.7 % jâri tamât akungani 2014 ammalu 2021. Sitamak Kaujisannik suliagijaulauttuk Mertz 2024, ammalu Kaujijausimajut tunijaumajut tapvani iluani allaKutimmi. Tamakkua Kaujijausimajut takutitaulauttut Inuit nunalinnut Kaujititsigiamut nungotsitailigiamut ammalu aulatsigunnagiamut uKâlautigijausongutillugit ilingajunut Tungait KakKasuangita tuttuKutinginnut.

Tamanna nunami suliagijausimajuk pisimalauttuk Mertz 8-iminit tikijumut Mertz 21, 2024, ilautigillugit inigisimajangit ammalu inigijaugiallasimajunut pisimajumit Happy Valley-Goose Bay (NL). Tamakkua Kaujisattet iligengit kamagunnalauttut 98 % taikkuninga Kaujisattaujop ininginnik akunigalaungitumik ammalu atutlutillu ajunnangitumik silamut apviataulugatik upvalu Kulimigot-ilinganiKajunut pitjutaulugatik. Ilonnangit kitillugit 70 avittutausimajut W-E sittungajut, atunik avittusimatlutik 4 km, tingipviulauttut ilonnanga kitillugit takiniKajumut 6,392 km. Isumagillugit sivullipât pingasuit Kaujisattausimajut, tamanna Kaningitigijut Ottugattausimajut piusigijangit atuttausimavut Kulautlugit sittungajuit. Sitamat takunnâgiattusimatlutik, ilautigillugit tingijottik, nipiliulauttut tuttunik katingaKatigejunut (1 tikijumut 50 tuttut) puttujukkut tinginiammata Kaujisattaujop ininganut ilingajumut 26,399 km^2. Pisimajut tamanna 121 tuttut katingaKatigejut (ilonnatik kitillugit 1,075 tuttut takujaulauttut) taikkunangat nipiliuttausimajunut ungatânut sittungajunut, taikkua Tungait KakKasuangita TuttuKutingit anginingit kititangit imailingalauttut 2,997 tuttut (ilautigillugit 10-takKiKajut noggait) isumagijautsiatluni ominga 90 % Kaujimajautsiatumut sakKivallianingit ominga 2,359 (-21.3 %) tikijumut 3,851 (+28.5 %). JâriKatuinnasimappat 22-takKinik ammalu jârikkutujonitsait tuttuit isumagijauvut, taikku pigugesimajut anginingit kititangit imailingatillugit 2,293 tuttuit ilinganiKajumut kititangit omunga 23.5 % noggait iluani tuttuKutiujunut.

Tamanna Kaujisannik takutitsisimavuk taikkua Tungait KakKasuangita TuttuKutingit takutitsivut unutsivallininginnik piusiKavuk, jâri tamât imâk puttuvalliatillugit 12.4 % Kanitanganiuluak taimanganit 2014. Tamanna kamagijauKattaningit tuttuKutinnut atuttaujut pikKujimmijuk tigujauKattajut suli puttujovuk ammalu tukiKattisigajattuk ilanganik taikkununga Tungait KakKasuangita TuttuKutingit piguvut. Tâvatuallik, sukkaninga puttuvallianinga sukkailisimajuk mânnaKammik imailingatluni jâri tamât sukkaninga imailingatluni 7.4 % akungani 2021 ammalu 2024, atjigingitamminik omunga 16.3 % akungani 2017 ammalu 2021.

ᐳᕐᑐᓂᕐᓭᑦ ᓇᓗᓐᓯᐅᑎᖏᑦ

ᓱᕗᓪᓕᐹᑦᓯᐊᖅ ᐃᓂᓪᓚᑎᕐᓯᒪᔪᖅ ᖃᖓᑕᓂᒃᑯᑦ ᐅᓄᕐᓂᖏᓐᓂᑦ ᖃᐅᔨᓭᕐᓂᖅ ᑑᕝᒍᑦ ᖃᕐᖃᖏᑦᑕ ᑐᒃᑐᖏᓐᓂᑦ (TMCH) ᑲᔪᓯᑎᑕᐅᓚᐅᔪᖅ ᒫᑦᓯ 2014 ᐊᒻᒪᓗ ᓄᐃᑦᓯᓯᒪᕚᖅ ᑐᒃᑐᐃᑦ ᐅᓄᕐᓂᖏᑦ 930. ᑭᓱᑦᓯᓂᐅᑉ ᑭᖑᓂᖓᒍᑦ ᑐᓴᕐᑎᓱᒍᑎᖃᕐᓯᒪᓕᕐᑐᑦ ᐃᓄᐃᑦ ᓄᓇᓕᖏᓐᓂᑦ ᑲᖏᕐᓱᐊᓗᑦᔪᐊᖅ ᐊᒻᒪᓗ ᓐᓄᓐ, ᐊᒻᒪᓗ ᑲᔪᓯᕐᑯᔭᐅᑦᓱᓂ ᐃᐸᑎᔭᖃᕋᓱᐊᕐᓂᖅ ᐅᓄᕐᓂᖏᓐᓂᑦ ᖃᐅᔨᒪᒪᔪᐊᕐᓂᖅ ᑐᒃᑐᓂᑦ. ᐅᐱᕐᖓᓭᖓᓂᑦ 2017, ᑭᓱᑦᓯᓂᖅ ᐊᓱᑦᓵᒋᐊᕐᑕᐅᒐᔫᐱᓚᐅᔪᖅ ᐅᓄᕐᓂᓭᐅᒍᓐᓇᕋᔭᕐᒪᖔᑕ ᐆᑦᑐᕋᐅᑎᒋᑦᓱᒍ ᑭᓱᑦᓯᓂᖅ ᓄᐃᑦᓯᓚᐅᔪᖅ ᐅᓄᕐᓂᖏᓐᓂᑦ 1,326 ᑐᒃᑐᐃᑦ. ᑌᓛᑦᓴᓇᖅ ᑭᓱᑦᓯᒍᓯᐅᓯᒪᔪᖅ ᐊᑑᑎᑦᓱᒍ 2021-ᒥᑦ, ᐱᖓᔪᐊᑦ ᑭᓱᑦᓯᓂᖅ ᓄᐃᑦᓯᓯᒪᕚᖅ ᐅᓄᕐᓂᖏᑦ 2,422 ᑐᒃᑐᐃᑦ ᐅᓄᕐᓯᐅᒥᓯᒪᔪᑦ 14.7 %-ᒨᑦ ᐊᕐᕌᒍ ᑕᒫᑦ ᐊᑯᓐᓂᖏᓐᓂᑦ 2014 ᐊᒻᒪᓗ 2021. ᓯᑕᒪᖓᑦ ᑭᓱᑦᓯᓂᖅ ᑲᔪᓯᑎᑕᐅᓚᐅᔪᖅ ᒫᑦᓯ 2024, ᐊᒻᒪᓗ ᐅᓄᕐᓂᖏᑦ ᓴᕿᑎᑕᐅᔪᑦ ᑖᒃᓯᓂ ᑐᓴᕐᑎᓯᒍᑎᐅᔪᒥᑦ. ᑖᒃᑯᐊ ᑭᓱᑦᓯᓂᕕᓃᑦ ᑐᓴᕐᑎᓯᒍᑎᐅᒍᒫᕐᑐᑦ ᐃᓄᐃᑦ ᓄᓇᓕᖏᓐᓄᑦ ᑐᓴᕐᑎᓯᒍᑎᒋᓗᒍ ᐃᐸᑎᔭᑦᓴᐅᔪᓂᑦ ᐊᒻᒪᓗ ᐊᐅᓚᑕᐅᓂᑦᓴᖏᓐᓄᐊᖓᔪᓂᑦ ᑑᕝᒍᑦ ᖃᕐᖃᖏᑦᑕ ᑐᒃᑐᖏᓐᓂᑦ (TMCH).

ᑭᓱᑦᓯᓂᖅ ᑲᔪᓯᓂᖃᓚᐅᔪᖅ ᒫᑦᓯ 8-ᒥᑦ ᒫᑦᓯ 21-ᒧᑦ, 2024, ᐃᓚᐅᑎᓪᓗᒍ ᐃᓂᓪᓚᑎᑎᓂᖅ ᐊᒻᒪᓗ ᐃᓂᓪᓚᑎᑎᒋᐊᑦᓯᐊᓂᖅ ᖄᐱ ᕚᓕ ᑰᔾᐯ-ᒥᑦ (NL). ᑭᓱᑦᓯᔫᑦ ᑭᓱᑦᓯᕙᒋᒍᒪᓯᒪᔭᒥᓂᒃ ᑭᓱᑦᓯᕙᖃᕐᓯᒪᔪᑦ 98 %-ᖓᓂᑦ ᐅᓪᓗᓂᑦ ᓯᕙᑮᑦᑐᓂᑦ ᐊᒻᒪᓗ ᑭᖑᕙᕐᑎᑕᐅᓇᖏᑦᑐᑦ ᓯᓚ ᐱᑦᔪᑎᐅᑎᓪᓗᒍ ᐅᕙᓘᓃᑦ ᖁᓕᒥᒌᓕᒃ-ᐱᓐᓄᑕᖃᕐᑎᓇᒍ. ᑲᑎᑦᓱᒋᑦ 70 ᑐᑭᒧᐊᕐᑐᑯᑖᑦ W-E ᐊᕙᑦᑐᓯᒪᔪᑦ ᑭᓱᑦᓯᕖᑦ, ᐊᑐᓂ ᐅᖓᓯᓐᓂᓃᑦ 4 ᑭᓃᒥᑕᓂᑦ, ᖃᖓᑕᕙᐅᓚᐅᔪᑦ ᑲᑎᑦᓱᒍ ᓄᓇᖓᑕ ᐊᖏᓂᖓ 6,392 ᑭᓃᒥᑕ. ᓱᕗᓪᓕᖏᓐᓂᑦ ᐱᖓᓱᑦ ᑭᓱᑦᓯᓂᕐᓂᑦ, ᐅᖓᓱᓐᓂᖏᑦ ᑌᓛᑦᓴᓈᕐᑎᓗᒋᑦ ᐊᑐᕐᑕᐅᖃᑦᑕᓚᐅᔪᑦ ᖃᖓᑕᑦᓱᑎᑦ. ᓯᑕᒥᑦ ᑭᓱᑦᓯᔫᑦ, ᐃᓚᐅᑎᓪᓗᒍ ᐊᕐᑯᕐᑎᖓ, ᓇᓗᓐᓂᓚᐅᔪᑦ ᑐᒃᑐᐃᑦ ᐊᕙᑦᑐᓯᒪᔪᑦ (1-ᒥᑦ 50-ᒧᑦ ᑐᒃᑐᐃᑦ) ᐳᒃᑭᑐᒥᑦ ᖃᖓᑕᓂᖃᕐᓱᑎᑦ ᑭᓱᑦᓯᕙᖓ 26,399 ᑭᓃᒥᑕ ᓯᒃᑭᑕᓪᓗᐊᖅ. 121 ᑐᒃᑐᐃᑦ ᐊᕙᒃᑐᓯᒪᔪᓂᑦ (ᑲᑎᑦᓱᒋᑦ 1,075 ᑐᒃᑐᐃᑦ ᑕᑯᔭᕙᓃᑦ) ᓇᓗᓐᓂᑦᑕᐅᓯᒪᔪᑦ ᑭᓱᑦᓯᓂᒃᑯᑦ ᑐᑭᒧᐊᕐᑐᑯᑖᒃᒥᑦ, ᑑᕝᒍᑦ ᖃᕐᖃᖏᑦᑕ ᑐᒃᑐᖏᑦ ᓇᓗᓐᓂᑦᑕᐅᓯᒪᔪᑦ ᐅᓄᕐᓂᖏᑦ 2,997 (ᐃᓚᐅᑎᓪᓗᒋᑦ 10-ᓂᑦ ᑕᕐᕿᓃᑦ ᓄᕐᑌᑦ) 90%-ᒥᑦ ᓱᕐᕐᑯᐃᓚᓇᑦᑐᒥᑦ ᐅᓄᕐᓂᖏᓐᓂᑦ 2,359 (-21.3 %) ᑎᑭᐅᑎᑦᓱᒍ 3,851 (+28.5 %). 22-ᓂᑦ ᑕᕐᕿᓃᑦ ᐊᒻᒪᓗ ᐊᖓᔪᕐᔫᑦ ᐃᓚᐅᑎᑕᐅᑉᐸᑕ, ᐊᖓᔪᕐᔫᑦ ᑐᒃᑐᐃᑦ ᐅᓄᕐᓃᑦ 2,293 ᒪᓕᑦᓱᒍ 23.5 % ᓄᕐᑌᑦ ᐅᓄᕐᓂᖏᑦ.

ᑖᓐᓇ ᖃᐅᔨᓭᕐᓂᖅ ᓄᐃᑦᓯᓯᒪᕚᖅ ᑑᕝᒍᑦ ᖃᕐᖃᖏᑦᑕ ᑐᒃᑐᖏᑦ ᐅᓄᕐᓯᐅᒥᓯᒪᒋᐊᖏᓐᓂᑦ, ᐊᕐᕌᒍ ᑕᒫᑦ ᐅᓄᕐᓯᕗᓪᓕᐊᓂᖏᑦ 12.4 %-ᒥᑦ ᑌᒣᓪᓗᐊᖏᓐᓇᑐᑦ 2014-ᒥᓂᒃ. ᐃᐸᑎᔭᖃᕐᓂᖅ ᐅᓄᕐᓂᖏᓐᓂᑦ ᐊᓱᑦᓴᑕᕐᓂᖏᑦ ᐃᐱᓇᕐᑐᑦ ᐃᓚᒋᐊᕐᓂᕆᖃᑦᑕᓚᖓᔭᖏᓐᓂᑦ ᐳᕐᑐᔫᒥᐊᖏᑦ ᐊᒻᒪᓗ ᓇᓗᓐᓯᕗᖅ ᑑᕝᒍᑦ ᖃᕐᖃᖏᑦᑕ ᑐᒃᑐᖏᑦ ᐅᓄᕐᓯᕗᓪᓕᐊᓂᖏᓐᓂᑦ. ᑌᒣᓚᓗᐊᕐᑎᓗᒍ, ᐅᓄᕐᓯᕗᓪᓕᐊᓂᖏᑦ ᓱᒃᑫᓕᐅᒥᓯᒪᔪᑦ ᖃᒻᒥᑯᑦ ᐊᕐᕌᒎᑉ ᐃᓗᐊᓂ ᐅᓄᕐᓯᐅᒥᓯᒪᓂᖏᑦ 7.4 %-ᒦᑦᑐᑦ ᐊᑯᓐᓂᖏᓐᓂᑦ 2021 ᐊᒻᒪᓗ 2024, ᑕᑯᓐᓇᕋᔭᒍᑦᑎᒋ 16.3 % ᐊᑯᓐᓂᖏᓐᓂᑦ 2017 ᐊᒻᒪᓗ 2021.

Résumé

Le tout premier relevé aérien systématique du troupeau de caribous des monts Torngat (TCMT) a été réalisé en mars 2014 et a conclu à une taille de population estimée à 930 caribous (Couturier et al. 2015). Les résultats de l'inventaire ont été discutés avec les communautés inuites de Kangiqsualujjuaq et de Nain, et la nécessité de poursuivre le suivi de la taille du troupeau a été exprimée. Au printemps 2017, le plan d'inventaire a été légèrement modifié afin d'augmenter l'effort d'échantillonnage, ce qui a permis d'estimer la taille du troupeau à 1 326 caribous (Couturier et al. 2018). En utilisant la même méthode en 2021, un troisième inventaire a estimé la taille du troupeau à 2 422 caribous montrant que la population avait augmenté de 14,7 % annuellement entre 2014 et 2021 (Couturier et al. 2024). Un quatrième inventaire a été réalisé en mars 2024, et les résultats sont présentés dans ce rapport. Ces résultats seront partagés avec les deux communautés inuites afin d'éclairer les discussions sur la conservation et la gestion du TCMT.

Le travail sur le terrain s'est déroulé du 8 au 21 mars 2024, y compris la mise en place et le retrait de l'équipe à partir de Happy Valley-Goose Bay (NL). L'équipe d'inventaire a pu couvrir 98 % des transects prévus dans un laps de temps relativement court, sans retard météorologique important ni problème lié à l'hélicoptère. Au total, 70 transects parallèles W-E, séparés chacun de 4 km, ont été parcourus pour une longueur totale de 6 392 km. Comme pour les trois premiers inventaires, la méthode d'échantillonnage par distance a été utilisée pendant le survol des transects. Quatre observateurs, dont le pilote, ont enregistré des groupes de caribous (1 à 50 caribous) lors de vols à basse altitude au-dessus de la zone d'étude de 26 399 km². À partir des 121 groupes de caribous (total de 1 075 caribous vus) enregistrés sur les transects, la taille du TCMT a été estimée à 2 997 caribous (incluant les faons de 10 mois) avec un intervalle de confiance de 90 % allant de 2 359 (-21,3 %) à 3 851 (+28,5 %). Si l'on ne tient compte que des caribous âgés de 22 mois et plus, la population adulte est estimée à 2 293 caribous, sur la base d'une évaluation de 23,5 % de faons dans la population.

Cette étude a montré que le TCMT a poursuivi sa tendance à la hausse avec un taux d'accroissement annuel de 12,4 % en moyenne depuis 2014. Le suivi de la dynamique de la population suggère également que le recrutement est resté élevé et explique en partie de la croissance du TCMT. Cependant, le taux d'accroissement a ralenti récemment avec un taux annuel de 7,4 % entre 2021 et 2024, contre 16,3 % entre 2017 et 2021.

1. Introduction

Inuit from Labrador and Québec have known Torngat Mountains Caribou Herd (thereafter TMCH or Torngat caribou) to be different from the migratory caribou, like the George River Herd (GRH), and the sedentary woodland caribou living in the south of Labrador (Wilson et al. 2014). In 2011, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recognized the Torngat Mountains caribou herd as one of eleven living Designatable Units for caribou (*Rangifer tarandus*) conservation across Canada (COSEWIC 2011). In 2016, COSEWIC recommended listing the Torngat Mountains caribou herd as endangered because the population was estimated as decreasing and at less than 1,000 adult caribou (COSEWIC 2017).

North of Hebron Fjord over the last decade, the Torngat caribou have roamed from the Ungava coast in the west of their range to the Labrador Sea in the east, crossing the highest mountains in eastern Canada and across the Québec - Labrador boundary. These montane ecotype caribou are an important wildlife resource to two Inuit communities, Kangiqsualujjuaq in Nunavik and Nain in Nunatsiavut. The Torngat caribou are even more essential now for these Inuit communities since the GRH collapsed to an extremely low population level. Out of this shared interest by the two Inuit communities, a Torngat Caribou Technical Committee has been in place since 2013. The shared goal of this Torngat Committee is to lead a coordinated monitoring effort for the herd. It includes representatives from the Government of Québec, the Government of Newfoundland & Labrador, Nunatsiavut Government, Makivvik, Kativik Regional Government (Nunavik Parks), Parks Canada, and the Torngat Wildlife and Plants Co-Management Board who is represented by the Torngat Wildlife, Plants and Fisheries Secretariat (thereafter the Torngat Secretariat).

Since 2014, management actions were discussed with the communities of Kangiqsualujjuaq and Nain, and the need for estimating the population size of the Torngat caribou was always expressed. The first ever systematic aerial population survey of Torngat caribou occurred in March 2014 and concluded in an estimated herd size of 930 caribou including calves with a confidence interval at 90% (CI) of 645 (lower CI: -30.6%) to 1,369 (upper CI: +47.2%) (Couturier et al. 2015). The second aerial survey in 2017 estimated the herd size at 1,326 caribou including calves with a CI of 912 (lower CI: -31.2%) to 1,986 (upper CI: +49.7%) (Couturier et al. 2018). Due to the COVID pandemic restrictions, the survey planned for spring 2020 was postponed to 2021. The third survey done in March-April 2021 estimated the Torngat caribou population size at 2,422 caribou including calves with a CI of 1,892 (lower CI: -21.9%) to 3,140 (upper CI: +29.6%) (Couturier et al. 2024).

To continue the monitoring of the Torngat caribou population trend, a fourth survey was done in March 2024. This report presents main findings of the March 2024 aerial survey in relation to previous survey results. These survey results will be shared with the two Inuit communities to inform conservation and management discussions.

2. Methods

An aerial survey was completed using an A-Star AS350B3 helicopter chartered from Newfoundland Helicopters. A timeline of the survey project with daily flying time is reported in Appendix A. Five people were involved in the field work (Figure 1): Peter Jefford (pilot), Serge Couturier (biologist lead), Jazlyn Burrell (wildlife analyst, Torngat Secretariat), Colin Webb (Nunatsiavut observer, March 8 to March 15), and Ned Annanack (Nunavik observer, March 16 to March 20). Aaron Dale (Torngat Secretariat, not pictured) was the project manager.

A.

B.

Figure 1. The survey field team of the Torngat caribou survey, March 2024. From left to right on photo A: Serge Couturier, Colin Webb, Jazlyn Burrell, and Peter Jefford (March 8-15); on photo B: Serge Couturier, Jazlyn Burrell, Ned Annanack, and Peter Jefford (March 16-20).

2.1 Study area and survey design

The rationale of the 2024 survey area delineation was similar to that of previous surveys (see Couturier et al. 2015, 2018, and 2024 for details). The goal was again to cover as much of the population's historical range as possible, based on the findings of Schaefer and Luttich (1998), but to update this historical range with new information provided by previous surveys, satellite telemetry monitoring (Bélanger 2017a, b; Bélanger et al. 2018) and by Inuit knowledge obtained from direct discussion with Inuit and from the summary compiled by Wilson et al. (2014). The survey area has always been discussed with Inuit Knowledge-holders since 2014, and adjustments were made to cover the new area where Inuit expect that caribou could be seen. Hence, the westward extension of 266 km^2 near Qurlutuarjuq base camp added in the 2021 survey area was kept in 2024 (western sections of transects 18 to 23, Figure 2). As in 2021, survey transects extended further out the shoreline to include nearshore islands and peninsulas. During the 2024 survey, the historical range located south of Hebron Fjord was not covered due to budget limitations and because no caribou has been located there in previous surveys or in recent satellite radio-tracking (Figure 2). Figure 3 shows survey area changes since 2014.

To compute survey area size, all external transects were used to calculate a convex hull minimum bounding geometry using a Geographical Information System (GIS) (ArcPro 2.8, www.esri.com). A 1 km buffer was added to this polygon to take the approximate distance of the line of sight during the survey into consideration.

Since the first Torngat caribou survey, systematic samples of large numbers of transects with a random start were used to provide better spatial coverage than simple random sampling (Buckland et al. 2001; Schmidt et al. 2022). In the 2014 Torngat caribou survey, east-west parallel transects were systematically distributed every 4 km. During the 2017 survey, the northern high-density stratum of the study area was flown using transects 3 km apart to increase sampling effort, while the southern low-density stratum was covered with transects 4 km apart. To increase the sampling effort again in 2021, a 2.5-km spacing design was used (Couturier et al. 2024). In 2024 transect spacing was increased to 4 km (Figure 2) based on the prediction that the Torngat caribou population had continued to increase since 2021, which could provide an adequate group sample size with fewer transects.

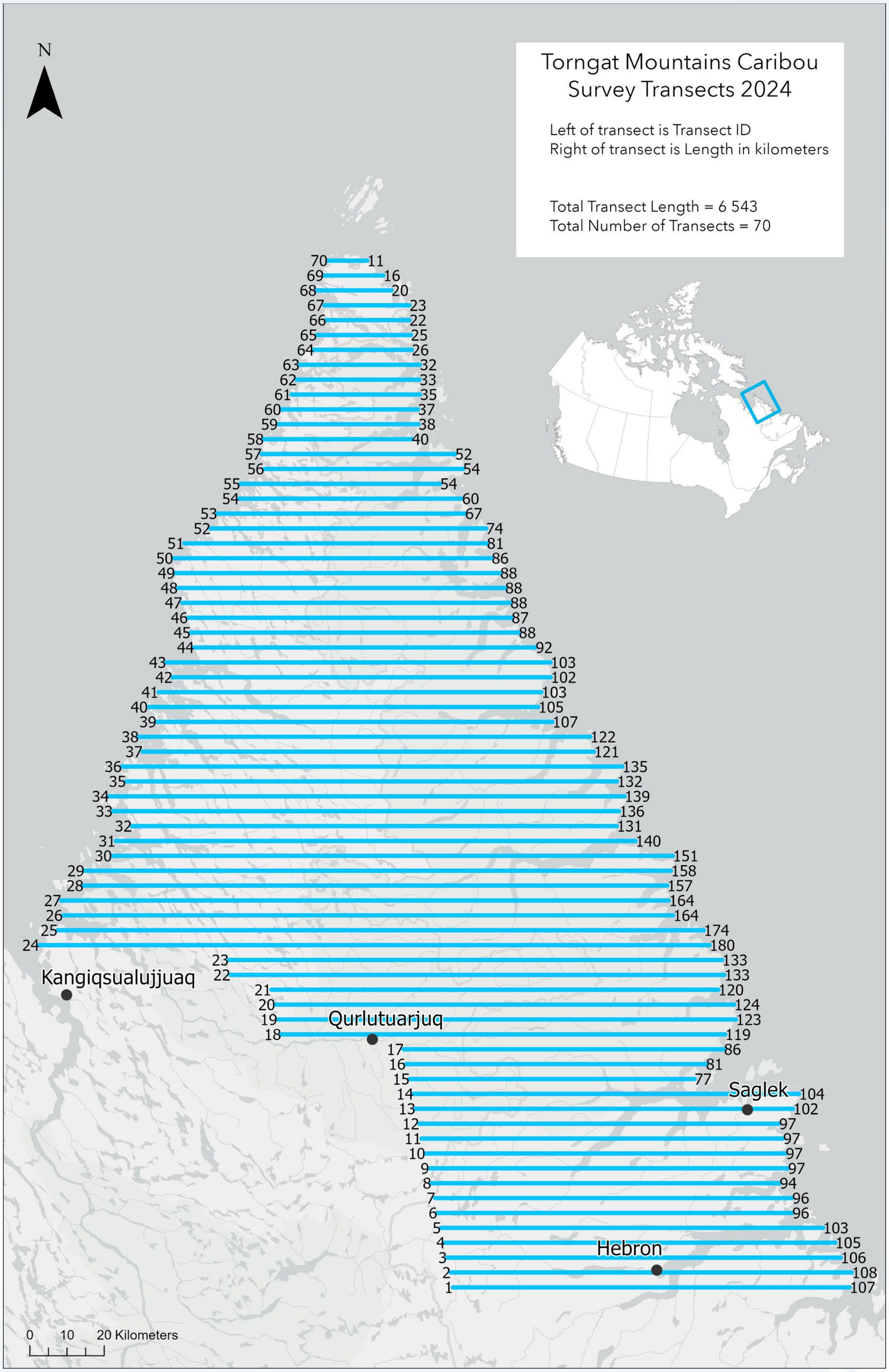

Figure 2. Study area and transects planned for the March 2024 survey of the Torngat Mountains caribou herd.

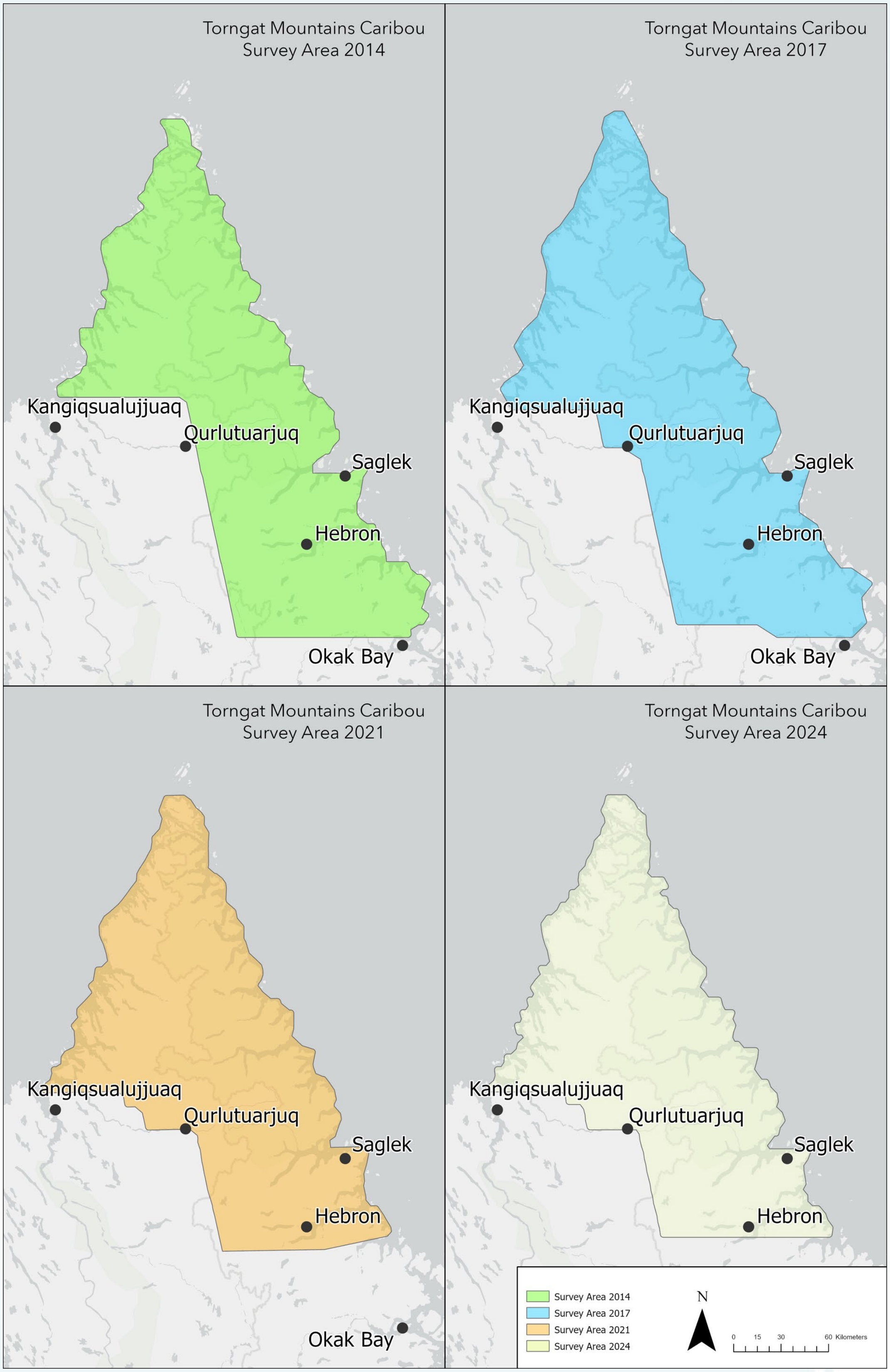

Figure 3. Study area comparison between Torngat Mountains caribou herd surveys since 2014.

2.2 Distance sampling

The Torngat caribou herd range is comprised of open tundra and alpine habitats, offering excellent visibility during aerial surveys. As in previous surveys, the 2024 survey method was distance sampling, which presents some benefits over fixed-width strip survey (see Couturier et al. 2015 for discussion). Distance sampling is a calculation method that estimates population density from a sample of observed animals in the field. It uses the distance of observed animals from the survey transect to estimate how many animals were missed during the flight (Buckland et al. 2001). The strip survey width is not fixed but theoretically infinite in distance sampling. Readers are invited to consult previous Torngat caribou survey reports to learn more about the distance sampling method applied to the Torngat region in winter (see Couturier et al. 2015, 2018 and 2024).

Throughout the world, distance sampling is widely used to estimate wildlife population size. This method was selected to monitor populations of caribou in Newfoundland (Fifield et al. 2013) and in Nunavut (Jenkins et al. 2013; Campbell et al. 2015), ungulates in Alberta (Alberta 2016), reindeer in Svalbard using walking transects (Le Moullec et al. 2017), muskox (*Ovibos moschatus*) in Nunavut (Jenkins et al. 2011), moose (*Alces alces*) in British Columbia (Thiessen 2010; McNay 2013), polar bear (*Ursus maritimus*) in the Barents Sea (Aars et al. 2009) and in Greenland (Laidre et al. 2026), Dall's sheep (*Ovis dalli*) (Schmidt and Rattenburry 2017) and bears during fixed-wing aerial surveys in Alaska (Becker and Christ 2015; Schmidt et al. 2017, 2022), white-tailed deer (*Odocoileus virginianus*) during spotlight road surveys in Minnesota (Larue et al. 2007), wild boar (*Sus scrofa)* during nocturnal sampling carried out using thermal cameras in Italy (Focardi et al. 2020), northern bobwhite (*Colinus virginianus*) during helicopter surveys in Texas (Montalvo et al. 2022), rock ptarmigan (*Lagopus muta*) in Iceland (Ferrarini and Nielsen 2025), and eastern grey kangaroos (*Macropus giganteus*) in Australia using walking transects (Glass et al. 2015). Distance sampling generates a density estimate in a study area from the number of groups detected on transect, the perpendicular distance from the transect line, and the mean size of the groups that were detected. Distance sampling models estimate how detectability decreases with distance. The estimated detection function is then used to estimate the proportion of the caribou that were likely present but not detected by the observers. In distance sampling, there is no need to estimate a sightability correction factor to correct for missed animals as in fixed width transect survey methods. The estimated caribou density is later converted to a herd size estimate based on the area surveyed.

Buckland et al. (2001) recommend that distance sampling fulfill these basic statistical assumptions:

1. Many transects are randomly allocated in the study area independently of the animal distribution of interest.
2. All animals directly on the center line of the transect are detected.
3. Animals do not move in response to the observer before they can be detected, or animal movement is slow relative to the observer's movement.
4. Distances are measured accurately.

As in previous surveys, transects were systematically allocated from a random starting latitude in the south of the study area. As suggested by Marques et al. (2006), perpendicular distances were measured during post-survey analysis with GIS. The perpendicular distance of each group of caribou from the actual flight track was measured. This was based on actual flight tracks monitored every second by hand-held GPS and overhead GPS positions of caribou groups.

All statistical analysis related to distance sampling was done using the software Distance 7.5 (Thomas et al. 2010; Anonymous 2023) (http://distancesampling.org/). Detection functions were modelled with Conventional Distance Sampling (CDS) and Multiple Covariate Distance Sampling (MCDS) engines. Snow and slope covariates (see next section) evaluated at the local scale (i.e. about 100 m) were tested individually and in concert during MCDS model fitting.

In Distance 7.5, CDS and MCDS engines were run to test detection function models recommended by Buckland et al. (2001), Marques et al. (2007), and Thomas et al. (2010). These models and their abbreviations are described by their key functions and adjustment terms in Table 1. Both MCDS models were run with two covariates alone and together. Six models were fit with the CDS, while nine models were fit using the MCDS. In CDS, the maximum number of adjustment terms was set to five, while it was limited to two in MCDS (Marques et al. 2007).

Visual assessment of model fit was performed by examining quantile-quantile (Q-Q) plots. Model fit was also checked with Kolmogorov-Smirnov (K-S) and Cramér-von Mises with cosine weighting function (CvM) goodness of fit (GOF) tests. The K-S and CvM tests determine model fit based on the difference between the estimated cumulative distribution and the empirical distribution function: If the fit is perfect, this difference is zero, and it will be indicated by P= 1.00 (Buckland et al. 2015).

The best models were selected on their Akaike's Information Criteria (AIC) values. For systematic parallel line placement design like in our study, it is recommended to use the density variance estimation method O2 (Thomas, L., pers. comm.). Instead of using the default setting method R2, the variance estimation method O2 was therefore selected during all analyses (Fewster et al. 2009). For all distance sampling parameters, the notation presented in Distance 7.5 was applied in this report:

n: Number of caribou groups detected during the survey
k: Number of transects
W: Longest distance from transects in metres (or truncation distance)
L: Total length in km of survey transects
ESW: Effective strip width in metres (ESW= W*p)
p: Probability of detecting a caribou group during the survey
(with a lowercase p to differentiate from P-value for statistical significance)
E(S): Caribou group size estimated by Distance software using regression
ER: Encounter rate (ER= n/L)
D: Estimated density of caribou per km^2
CV: Coefficient of variation

Table 1. Distance sampling detection function models used in data analysis of the 2024 Torngat Mountains caribou herd aerial survey. Fifteen models are described by their key functions and adjustment terms.

Model description in CDS and MCDS (key + adjustment terms, see Methods)	Covariates	Abbreviations
CDS Uniform key with cosine		CDS Unif Cos
CDS Half-normal key with cosine		CDS HN Cos
CDS Half-normal key with simple polynomial		CDS HN Poly
CDS Half-normal key with Hermite polynomial		CDS HN Herm
CDS Hazard-rate key with simple polynomial		CDS HR Poly
CDS Hazard-rate key with Hermite polynomial		CDS HR Herm
MCDS Hazard-rate key with simple polynomial	snow	MCDS HR Poly snow
MCDS Hazard-rate key with simple polynomial	slope	MCDS HR Poly slope
MCDS Hazard-rate key with simple polynomial	snow slope	MCDS HR Poly snow slope
MCDS Half-normal key with cosine	snow	MCDS HN Cos snow
MCDS Half-normal key with cosine	slope	MCDS HN Cos slope
MCDS Half-normal key with cosine	snow slope	MCDS HN Cos snow slope
MCDS Half-normal key with simple polynomial	snow	MCDS HN Poly snow
MCDS Half-normal key with simple polynomial	slope	MCDS HN Poly slope
MCDS Half-normal key with simple polynomial	snow slope	MCDS HN Poly snow slope

2.3 Survey implementation

Prior to the actual survey, observers were trained during a discussion on distance sampling theory and survey procedure. During the first helicopter flight, observers practiced using the survey equipment. After having collected GPS points over some landmarks on the ground (i.e. rocks, snow free patches, etc.), observers were trained to estimate a normal detection distance from the helicopter. In a snow-covered, tundra landscape that is lacking scale landmarks like trees, it can become difficult for observers to visually guess distance on the ground. Our experience with the Torngat caribou surveys has shown that this normal detection distance is up to about 1,000 m. Caribou groups could be detected at greater distance as shown in previous surveys, but observers were asked not to try to get the farthest distance recorded for the day and instead to systematically scan the entire area on their side of the aircraft. Observers were also prompted to focus search effort to detect all potential groups near zero distance close to the center line of the transect.

The helicopter acted as a single sampling platform (see Buckland et al. 2001), with four observers, including the pilot, searching for caribou. As in previous surveys, the helicopter flew at 150 km/h (about 80 knots) and 150 m of altitude. High-resolution photos and GPS locations were taken of each group of caribou observed. Upon detection, the helicopter flew toward the caribou to record their location with a hand-held GPS. If the caribou moved during the approach, the location where the animals were first seen was recorded based on tracks in the snow. Caribou that were more than 300 metres apart were considered as separate groups.

Bélanger et al. (2018) reported that at a fine scale, Torngat caribou selected habitat with south and southwest aspects, stronger prevailing winds, and higher solar radiation along steeper slopes. They also suggested that caribou selected areas with less snow accumulation. Low snow cover (dark background) and steep slopes could influence the probability of detecting caribou groups, so in previous surveys, snow and slope were included as covariates in the MCDS models. Slope and snow cover were again recorded at the local scale, representing the area within about 100 m of the observation. The habitat slope score was coded as 1 for flat terrain, 2 for moderately sloped or rolling habitat, and 3 for mountainous or steep terrain. The snow cover was visually estimated as a percentage of the ground (in ten increments).

Visibility, temperature, and percent cloud cover were estimated periodically on each transect. During the survey, observations of polar bears, wolves (*Canis lupus*), and arctic foxes (*Vulpes lagopus*) were also recorded.

2.4 Sex and age photo classification

When a group of caribou was detected near transect, the helicopter went directly to the caribou group to slowly herd the group up toward a safe location. The short helicopter chase was aborted if the ground conditions could be dangerous for caribou; for example, if it was rocky, icy, steep terrain, or nearby cliffs. The chase was set to a maximum of two minutes, although it was normally done in less than one minute. In most situations, running caribou were a few hundred metres in front of the helicopter on a snow-covered and relatively uphill or flat area. Since the first Torngat caribou survey in 2014, a photo classification method was used to compensate for sometimes challenging live classification conditions in mountainous terrain. All caribou groups were photographed using a full-frame sensor format Nikon D600 with a 70-300 mm Nikkor zoom (6X magnification) for accurate counting and classification by sex and age. Using the zoom, it was possible to classify the caribou at greater distance than during live classification. Photo classification can decrease pursuit time and provides permanent records of the results compared to live classification. All photo files were GPS-coded, time-stamped and taken as a raw format. The duration of the photo classification process was later estimated by using time stamps of the first and the last photos taken on the same group.

Caribou were classified using the digital photos into one of six categories based on the presence of vulva or penis, head and body size, and antler condition (i.e. present or not, one or two antlers, velvet on calf spike antlers): 1-adult antlered female, 2-adult non-antlered female, 3-adult antlered male (younger males, some may have cast one antler), 4-adult non-antlered male (older males), 5-calf, and 6-unknown sex and age. From a compilation of all caribou observations (on and off transect), it was possible to estimate the ratio of calves/100 adult females, the percentage of calves in the population, the adult sex ratio as males/100 adult females and the percentage of adult female carrying antlers.

3. Results

In March 2024, the Torngat Secretariat, with the help of many partners, successfully completed the fourth population estimate and classification survey of the Torngat Mountains caribou herd using the Distance Sampling method. The helicopter survey extended from March 8 to March 21, 2024, including the positioning and the repositioning days from Happy Valley-Goose Bay (Appendix A). The complete survey took 80.6 hours of flying. The survey team stayed in a rented house in Kangiqsualujjuaq during the entire survey period. The actual survey over transects occurred from March 11 to March 21. The survey started in the north and proceeded southwards to follow the expected decreasing caribou density gradient from north to south. Very few days were lost due to weather conditions or other logistical factors. Snowfall and blowing snow occurred on March 9, 10, 15, and 17, which concealed old tracks and provided a contrasted visibility of caribou and fresh tracks. Once the survey began, it was interrupted only for one day on March 15 due to bad weather. This minimized the confounding risk associated with potential caribou movements between transects during survey pauses (Figure 4).

Visibility was excellent during most transect overflights (Appendix B). Of 70 transects, 55 transects (79%) had primarily excellent visibility, while 12 (17%) had good visibility, and only three transects (4%) had poor visibility. Fog and low cloud patches causing poor visibility were encountered mostly on the east side of transects near the Labrador Coast (ex. March 12 and March 19, Figure 4). Only a combined 152 km from small sections of transects was removed from the analysis due to insufficient visibility. A total of 97.7% of the planned transects were completed (Figure 2 and 4).

The sampling effort of 242.1 km flown over transect per 1,000 km^2 of the study area was 29% lower in 2024 than in 2021 (Table 2). Even with a lower sampling effort, more caribou groups were observed in 2024. A total of 121 groups were recorded on transect with an encounter rate (n/L* 100) of 1.9 groups per 100 km, which was the highest encounter rate since 2014 (Table 2). The increasing trend in the encounter rate is representative of the increasing caribou population since 2014 (Table 2). The average observed group size was 8.9 caribou in 2024, similar to the group size recorded in 2021 (Table 3). A record number of 1,075 caribou were detected on transect in 2024 (Table 3). No double counts were suspected during the survey.

In an area with expected lower density, 11 groups were detected south of the Torngat Mountains National Park Base camp latitude in Saglek Fjord, including three groups detected on transects 4, 3 and 2 at the latitude of Hebron Fjord (see Figure 2 for transect number). In the same area south of Saglek Fjord, three, one, and ten groups were detected in 2014, 2017 and 2021 respectively.

The other species recorded during the 2024 survey were one wolf, 27 polar bears and 17 arctic foxes (Table 4).

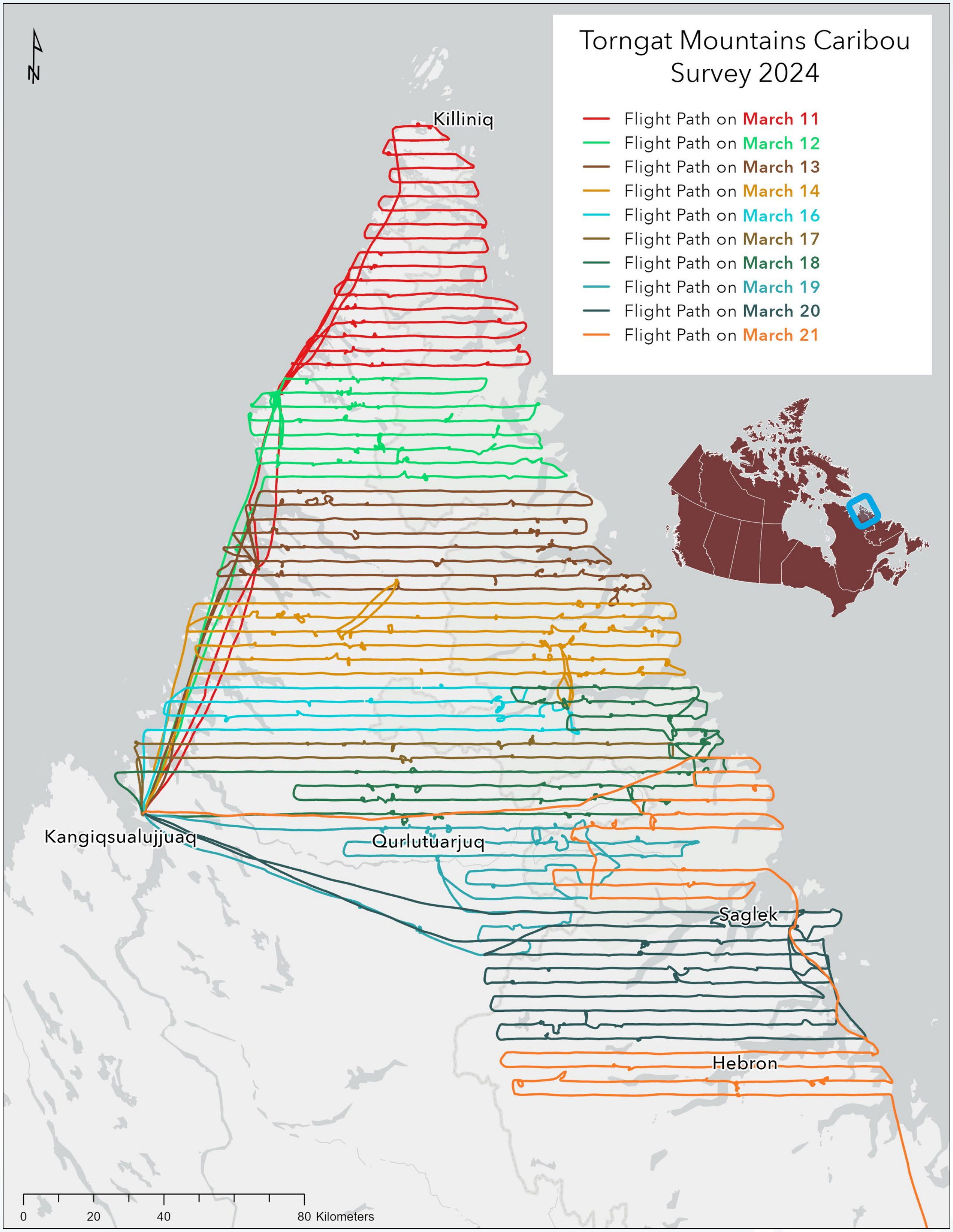

Figure 4. Daily helicopter tracking during the Torngat Mountains caribou herd survey in March 2024. Some small areas in the east were not surveyed due to weather problems.

Table 2. Results of the 2024 aerial survey and from previous surveys of the Torngat Mountains caribou herd done in 2014, 2017 and 2021 (Couturier et al. 2015, 2018 and 2024).

	2014 [a]	2017	2021 [b]	2024
Survey area (km^2)	29,390	30,625	26,668	26,399
Line transects flown (L, km)	7,057	7,722	9,142	6,392
Percentage of line transects flown	100%	88.7%	84.8%	97.7%
Number of transects (k)	81	91	102	70
Sampling effort (L/1,000 km^2)	240.1	252.1	342.8	242.1
Number of caribou groups (n)	50	58	115	121
Encounter rate (n/L) * 100	0.7	0.8	1.3	1.9
Transect spacing (km)	4	3 and 4	2.5	4
Days in the field (incl. pos./repos.)	19	26	35	14
Dates of flying over transects	Mar. 13-29	Mar. 27- Apr. 14	Mar. 15-Apr. 13	Mar. 11-21
Total helicopter flying time (h)	91	85	140	81

[a] In 2014, total survey area was estimated at 30,689.4 km^2 using a different method.
[b] In 2021, some planned transects in the south were not surveyed due to logistical issues.

Table 3. Demographic information obtained from the aerial survey of the Torngat Mountains caribou herd in March 2024 and from previous surveys since 2014 (see Couturier et al. 2015, 2018, and 2024).

	2014	2017	2021	2024
• ***Transect only data***				
Number of caribou	269	610	1,000	1,075
Number of groups detected (n)	50	58	115	121
Observed group size				
Mean	5.4	10.5	8.7	8.9
Standard error (SE)	0.5	1.1	0.7	0.8
Range (min – max)	1 – 18	1 – 38	1 – 49	1 – 50
• ***From on and off transect data*** [a]				
Total classified by sex and age	291	579	977	1,094
Calves %	17.2%	23.1%	22.8%	23.5%
Calves/ 100 adult females	28.4	43.6	47.2	52.6
Males/100 adult females	36.9	45.0	59.7	71.2
Non-antlered adult female %	3.4%	1.6%	3.0%	2.5%

[a] Three, four, five and three caribou groups were recorded off-transect in 2014, 2017, 2021, and 2024, respectively.

Table 4. Other species recorded during four Torngat caribou herd spring surveys.

	2014	2017 [a]	2021	2024
Polar bears	11	14	18	27
Wolves	3 (1 pack)	8 (3 packs)	3	1
Foxes	>50	1	2	17

[a] One moose was seen on the southernmost transect near Okak Bay in 2017.

3.1 Exploratory data analysis

Exploratory data analysis was done to verify that the 2024 dataset fulfilled the four basic statistical assumptions recommended by Buckland et al. (2001). The number of transects was large at 70, and the systematic allocation of transects was independent of caribou locations which supports the first assumption. The second assumption requires that all observations directly on the center line of the transect (i.e. at distance= 0) are detected. At lower altitude and slow speed, the A-Star AS350B3 helicopter provided excellent visibility conditions for the two front observers who were scanning their side of the line from distance zero. Moreover, all caribou groups moved slowly in response to a directly approaching helicopter at low altitude (150 m), which also increased the group detection likelihood at distance zero. The frequency distributions for four binning classes (50 m, 100 m, 150 m and 200 m) showed distributions typical of distance sampling datasets with more detections closer to distance zero (Figure 5). There is no reason to believe that observations at distance zero were missed, which supports the second assumption. When the helicopter approached, most caribou groups moved away, but it was possible to spot the location where they were first detected based on snow tracks and landmarks. The third assumption about slow animal movement relative to the observer's movement was then fulfilled. The perpendicular distance was measured accurately in a GIS after mapping observations in relation to the flight line (as recommended by Marques et al. 2006), which supported the fourth assumption.

A potential bias in distance sampling is that group size may positively influence the probability of detection, such that larger groups are more likely to be detected at greater distances from the transect line than smaller groups, when detection probability should ideally be a function of distance alone (Buckland et al. 2001). Regression of group size (y) as a function of perpendicular distance (x) in the 2024 dataset indicated a weak positive relationship (slope= 0.006; r^2= 0.069; p= 0.004; Figure 6). Potential group size-biased detection can be addressed in several ways, including truncation of distant detections (Buckland et al. 2001, p. 72; Anonymous 2023; see Section 3.5). Removal of the three groups detected at < 1,500 m reduced the relationship further (r^2 = 0.046; p= 0.020), suggesting the regression was influenced in part by these observations. Previous surveys reported non-significant weak positive relationships ($r^2 \leq 0.046$; Table 5).

In the present analysis, the final density estimation in Distance software used the expected group size estimated from the regression E(S) rather than the observed mean group size. Experience has shown that the intercept of this regression (E(S)) is not much, if any, less precise than the straight mean group size (Thomas, L., pers. comm.). This approach is intended to correct for potential size-bias in detection probability that may occur when larger groups are more detectable at greater distances from the transect line (Thomas et al. 2010). Based on the weak relationship between group size and perpendicular distance, and the use of E(S) in the final density estimation procedure, we concluded that any group size detection bias was limited and that inclusion of group size as a covariate in the MCDS modelling was not warranted.

3.2 Covariates descriptive analysis

Like in previous surveys, snow cover was visually estimated at caribou group locations within the 100 m radius scale for each group. Snow cover data in 2024 ranged from 40% to 100% with a mean of 69.9% (n= 121, SE= 1.4%). This is lower than recorded in previous surveys (Table 6). For the slope covariate in 2024, 16 groups (13%) were recorded in flat habitat, 85 in rolling terrain (70%), and 20 (17%) in mountainous or steep terrain (Table 6).

3.3 Photo classification process

A total of 1,505 photos taken of the 121 groups recorded on transects were analyzed. On average, there were 12.4 photos taken for each group (range: 3 to 39 photos). As computed from the difference between the time recorded on the last and the first digital photos, it took on average 28 seconds to photograph a group (range: 3 to 123 seconds).

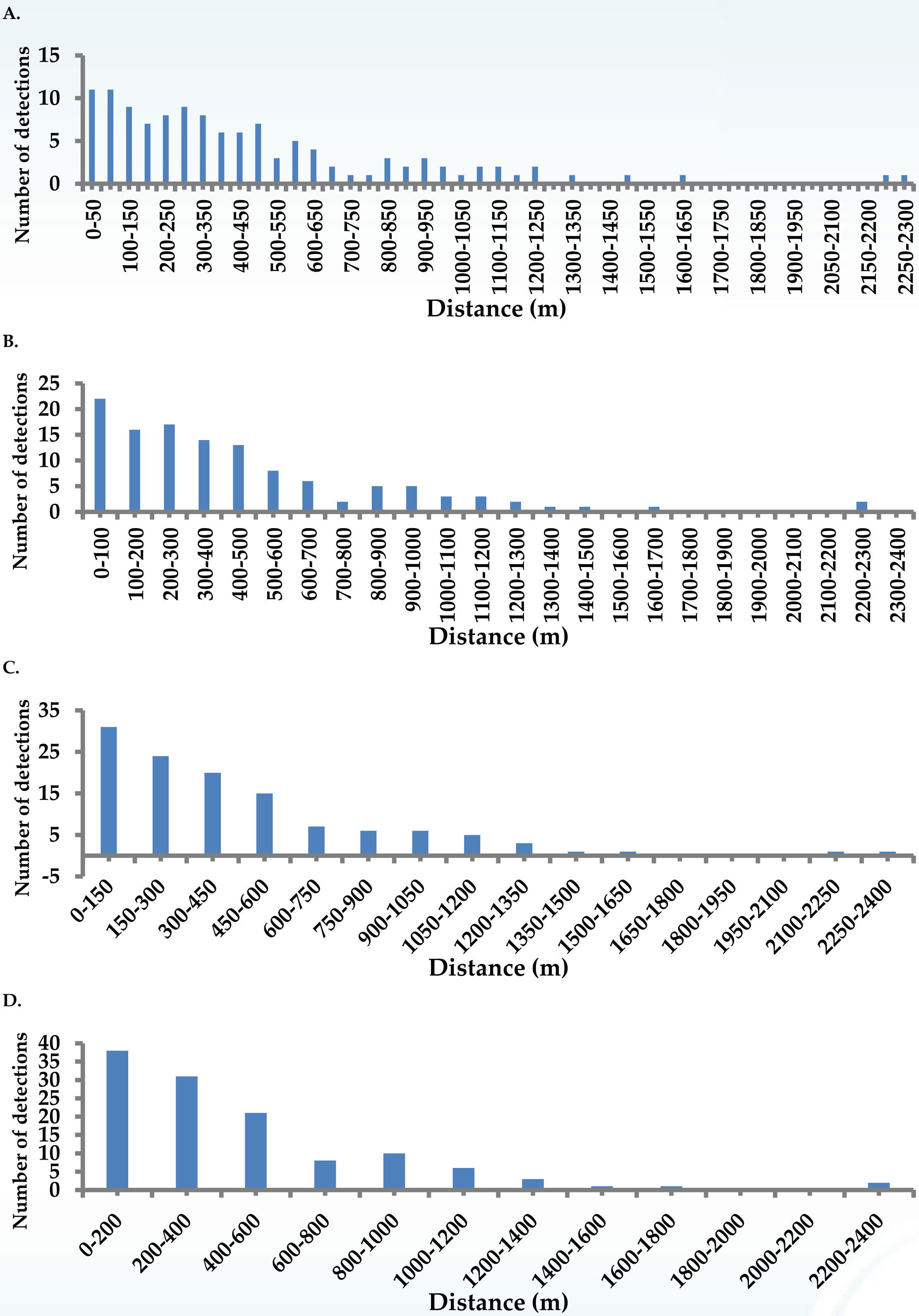

Figure 5. Frequency distribution of perpendicular distances from transects of caribou groups (n= 121) detected during the Torngat Mountains caribou herd survey in March 2024 using four bin sizes: A. 50 m, B. 100 m, C. 150 m, and D. 200 m.

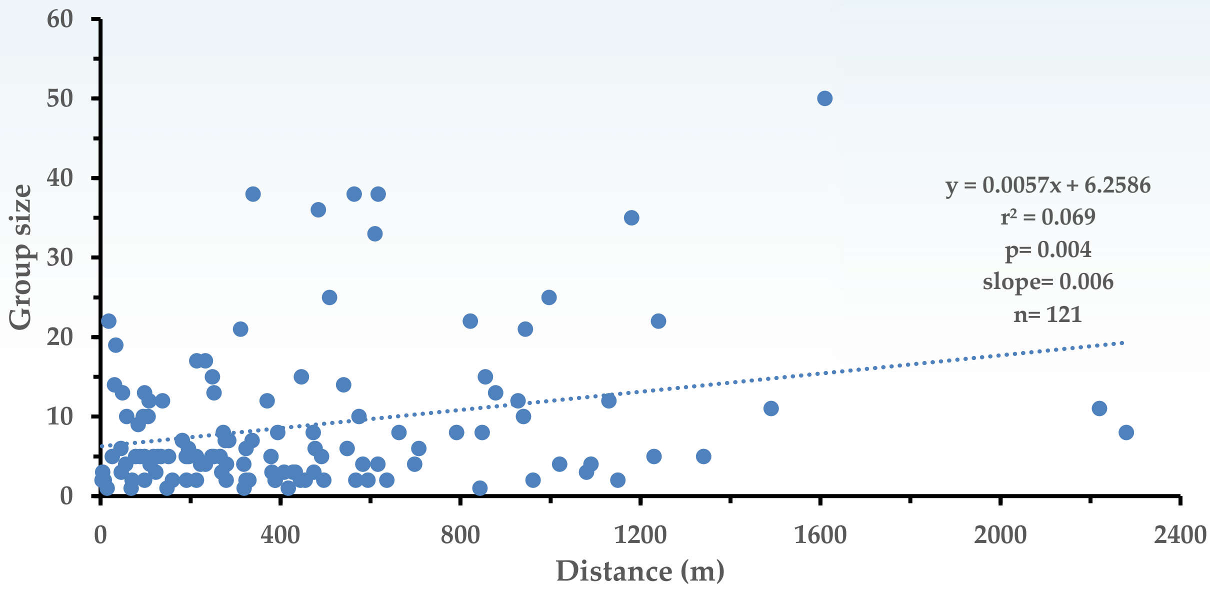

Figure 6. Group size (y) and perpendicular distance in metres (x) for 121 groups of caribou detected on transects during the Torngat Mountains caribou herd survey in March 2024.

Table 5. Relationship between caribou observed group size (Obs. Gr. Size) and perpendicular distance (Dist.) of detection from the center line of the transects, average observed caribou group size for all groups and for groups detected close to the line (< 300 m; as suggested by Banfield et al. 2001, p. 75), and mean group size estimated from regression (E(S)) during four Torngat Mountains caribou surveys since 2014.

Year	Dist. vs Obs. Gr. Size	Obs. Gr. Size: All Groups			Obs. Gr. Size: Only Distance < 300 m		Gr. Size from regression (E(S))	
	r^2	Mean	SE	n	Mean	n	Mean	SE
2014	0.043	5.4	0.5	50	4.67	21	4.63	0.50
2017	0.046	10.5	1.1	58	8.57	28	8.63	1.29
2021	0.001	8.7	0.7	115	8.00	61	7.91	0.66
2024	0.069 [a]	8.9	0.8	121	6.69	55	7.04	0.70

[a] Statistically significant at $P < 0.05$.

Table 6. Snow cover and slope visually estimated at 100 m radius surrounding caribou group locations during the Torngat Mountains caribou herd survey in March 2024 and in previous surveys since 2014 (see Couturier et al. 2015, 2018 and 2024).

Year	**Snow cover (%)**				**Slope**			
	Mean	Range	SE	n	Flat	Rolling	Mountainous	Total
2014	82.4%	50%–100%	1.9%	50	19 (38%)	28 (56%)	3 (6%)	50
2017	74.0%	10%–100%	2.4%	58	33 (57%)	20 (34%)	5 (9%)	58
2021	83.0%	0%–100%	1.5%	115	35 (30%)	62 (54%	18 (16%)	115
2024	69.9%	40%–100%	1.4%	121	16 (13%)	85 (70%)	20 (17%)	121

3.4 Possible overlap with George River herd

In the 1980s and early 1990, the GRH was at its population maximum at more than 800,000 caribou (Couturier et al. 1996; Russell et al. 1996). During this period, part of the GRH seasonal ranges, including its calving grounds, overlapped with the Torngat Mountains caribou herd range (Couturier et al. 1990; Schaefer and Luttich 1998). Although these two herds exhibited some overlapping space use in the 1980s and early 1990s, they maintained mutually exclusive seasonal ranges during most of their annual cycle. Bélanger et al. (2018) reported that the range overlap decreased as the population of the GRH declined from its peak in the 1990s. The GRH reached a population low estimated at 5,500 caribou in July 2018 (Brodeur et al. 2022) and has since increased to 8,600 caribou in July 2024 (NL Govt. press release). As shown on Figure 7, the range overlap between their recent ranges (2023-2024) is minimal as this suggests that the two populations are distinct. The only other migratory caribou population in the Quebec-Labrador Peninsula, the Leaf River Herd (LRH), migrates in a north-south axis, west of the 67°W, far from the Torngat caribou herd (Figure 7).

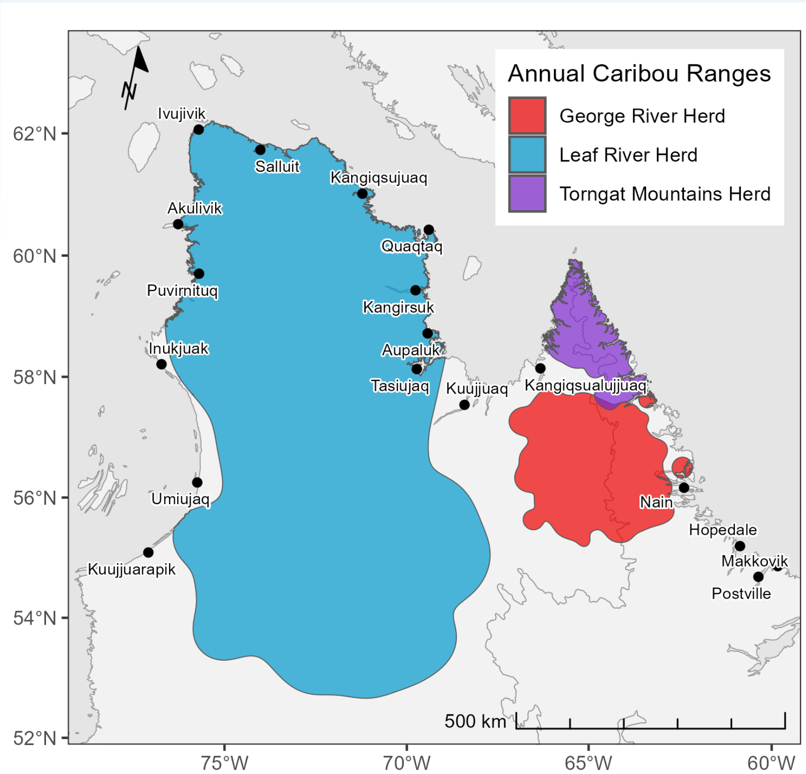

Figure 7. Annual ranges (2023-2024) of the Leaf River herd and the George River herd in the year of the 2024 Torngat survey, and the Torngat Mountains caribou herd range estimated from the 2011-2018 satellite-collar data.

During an aerial survey, it would be impossible to visually distinguish Torngat caribou from the GRH caribou. Movements and distribution of GRH caribou are monitored primarily from caribou equipped with satellite transmission collars (Govt. of Québec and Govt. of Newfoundland and Labrador, unpubl. data). During the 2024 Torngat survey, a total of 71 caribou of both sexes from the GRH were monitored with GPS collars by the two provinces. No collared GRH caribou were located within the Torngat survey area. The three closest GRH radio-collared caribou were located at about 20 km from the southern limit of the survey area while other collared caribou were located farther south of Okak Bay (Figure 8). During the 2024 Torngat visual survey, the caribou groups were not moving in an oriented, linear pattern as shown for example in GRH movements (Figure 8). Based on both the movements of GRH collared caribou (Figure 8) and visual observations of caribou behaviour and tracks, it is presumed that no significant number of George River caribou was present in the study area during the 2024 Torngat caribou survey.

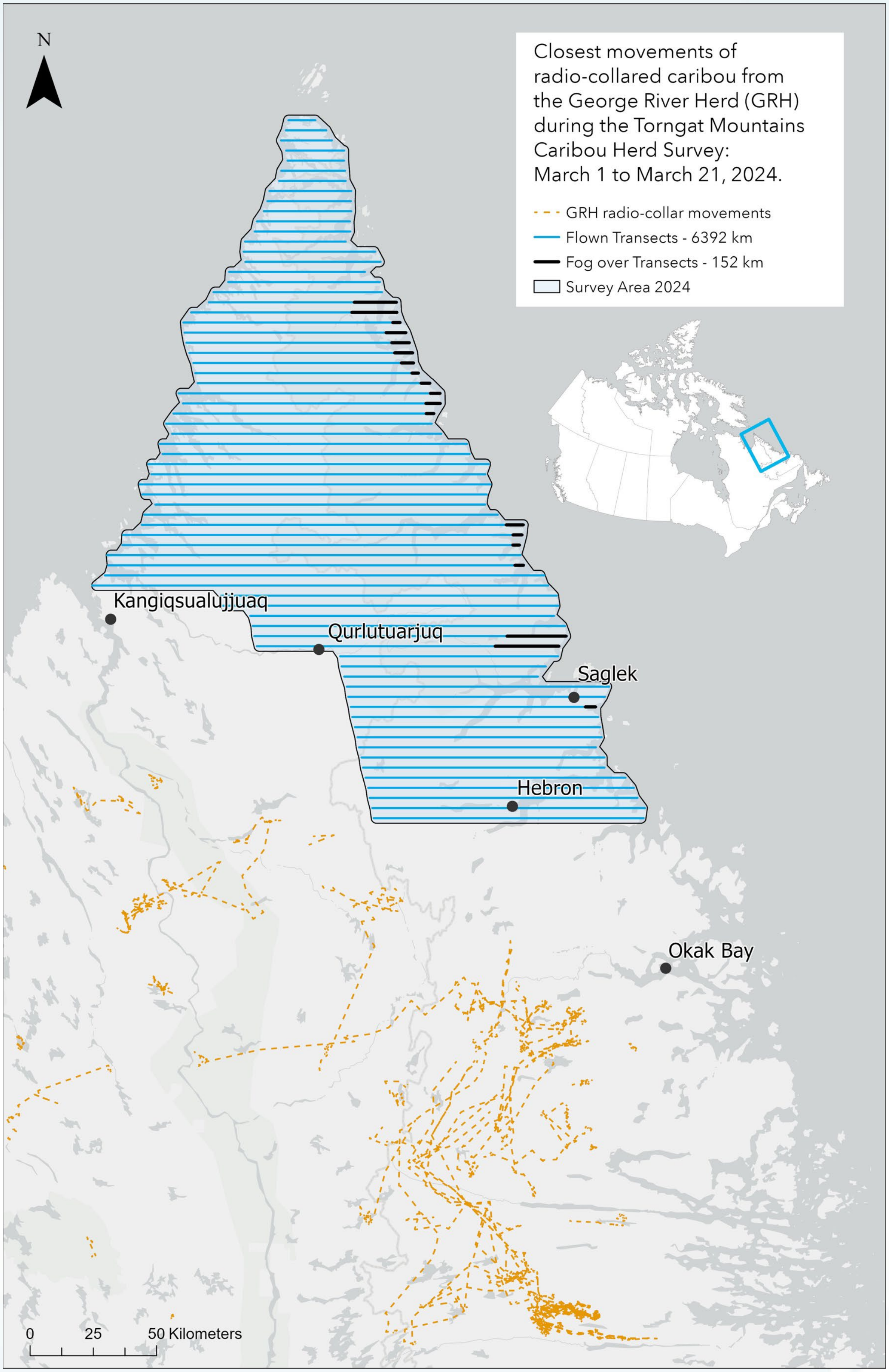

Figure 8. Torngat Mountains caribou herd survey area in relation to the closest George River Herd collared caribou during the March 2024 survey period.

3.5 Density and herd size estimation in distance sampling

A visual examination of Figure 5 shows an expected distance sampling dataset for the frequency distributions of perpendicular distances as detections decrease monotonically with increasing distance. As usual in distance sampling, these distributions also reveal the need to remove some outliers at long distances on the right side of the distribution. Right-truncation in distance sampling improves the prediction performance of the models. When sample size is large enough, some truncation of the distance data is nearly always suggested, even if no outlier is noticed (Buckland et al. 2001, p. 49). Four right-truncation distances from 1,300 m to 1,600 m were evaluated to test their effect on density estimates and their CV (Table 7). Only the best models with delta AIC < 1 and those with no warnings are presented in Table 7. All the best models show good fit, and density estimates are almost identical from one truncation scenario to another. Using the truncation at 1,500 m as a reference for comparison, the density estimates vary by only -1.0%, -0.6% and +1.7% for the best models of truncation scenarios at 1,300 m, 1,400 m and 1,600 m respectively (Table 7). The good fit of these models and the close similarity between the density estimates is partly due to the probability of detection dropping below 10% past 1,300 m. The truncation at 1,500 m (W) removes only three detections or 2.5% of the dataset, which follows usual recommendations of about 5% in line transect sampling (Buckland et al. 2001; Thomas et al. 2010) and yielded the smallest CV. Buckland et al. (2001, p. 105) reported that the choice of truncation point is not a critical decision when all the assumptions are met and when the detection function is typical of distance sampling dataset like in our 2024 dataset. The truncation distance at 1,500 m was selected for the following analysis.

From the 15 models that were tested at truncation distance of 1,500 m (Table 1), only one model received warnings from Distance 7.5 and was removed. Results from these 14 models are presented in Table 8. Six of the 14 models had similar explanatory power, having delta AIC scores of < 2. Five of these six models showed good fit. As the model MCDS HN Cos(2) Snow had the lowest AIC, it was selected for the density estimation. This best model showed good fit as estimated from the K-S test, the CvM test, and the analysis of Q-Q plots (Table 8). It is worth noting that model MCDS HN Cos(2) Snow was also selected as the best model for the 2021 survey dataset (Couturier et al. 2024).

The detection function created by the best model does not show a wide shoulder as it decreases with distance from the first distance bin (Figure 9). The effective strip width (ESW= W*p) was 572 m in 2024 survey, meaning that as many caribou were detected between 0 and 572 m than were missed between 572 m and 1,500 m (W). The effective strip width and perpendicular distances recorded in 2024 are similar to the data recorded in previous surveys (Table 9). The average probability of detecting caribou in 2024 was 0.382 or 38.2% (p CV= 0.07) and the density was 0.1135 caribou/km^2 (D CV= 0.1493; Table 8).

Contrary to previous surveys, the variance of density estimated from the best model in 2024 (see first model in Table 8) was mostly influenced by the variability in group size, which contributed 44.2% of the density estimate variance, while the variability in the encounter rate (n/L) represented 31.3% and the detection probability (p) 24.5% of the caribou density estimate variance

(Table 10). In previous surveys, it was the encounter rate that caused the largest share of the density variance estimation.

Considering a survey area of 26,399 km^2 and an estimated density of 0.1135 caribou/km^2, the herd size was estimated at 2,997 caribou, with a coefficient of variation CV= 0.1493 and an asymmetrical 90% confidence interval of 2,359 to 3,851 (Table 11). The lower confidence interval was 21.3% and the upper confidence interval was 28.5%, which is the most precise estimate of the Torngat Mountains caribou herd surveys so far (Table 11). As the survey was done in March, it must be noted that this herd size estimate includes 10-month-old calves. If only 22-month-old and older caribou are considered, the adult population size is estimated at 2,293 caribou based on the evaluation of 23.5% calves in the population.

Table 7. Analysis of the Torngat Mountains caribou herd 2024 survey data to investigate effects of right-truncation distance (m). Analysis was done in Distance 7.5 with Conventional Distance Sampling (CDS) and Multiple Covariate Distance Sampling (MCDS) engines. Only the best models with Delta AIC < 1 are presented. Columns report the number of caribou groups (n), number of parameters (m), Delta AIC, density and its associated coefficient of variation (D and D CV), Kolmogorov-Smirnov (K-S) and Cramér-von Mises with cosine weighting function (CvM) goodness of fit probability tests (P), and model fit estimated from Q-Q plots (decreasing from good, poor to bad).

Right Truncation	Best Models tested [a, b] (Delta AIC < 1)	n	m	Delta AIC	D	D CV	K-S P	CvM P	Model fit Q-Q plot
None	CDS HR Herm	121	2	0.00	0.1020	0.1680	0. 99	> 0.9	Good
1,300	CDS HN Cos(2)	116	2	0.00	0.1147	0.1716	0.99	> 0.9	Good
1,400	CDS HN Cos(2)	117	2	0.00	0.1142	0.1675	0.99	> 0.9	Good
1,400	MCDS HN Cos(2) Snow	117	3	0.75	0.1154	0.1492	0.99	> 0.9	Good
1,400	CDS HR Herm(0) [c]	117	2	0.94	0.1060	0.1765	0.99	> 0.9	Good
1,400	CDS HR Poly(0) [c]	117	2	0.94	0.1060	0.1765	0.99	> 0.9	Good
1,500	MCDS HN Cos(2) Snow	118	3	0.00	0.1135	0.1493	0.99	> 0.9	Good
1,500	CDS HN Cos(2)	118	2	0.34	0.1120	0.1639	0.99	> 0.9	Good
1,600	MCDS HN Cos(2) Snow	118	3	0.00	0.1116	0.1498	0.99	> 0.9	Good
1,600	CDS HN Cos(2)	118	2	0.27	0.1101	0.1618	0.99	> 0.9	Good
1,600	MCDS HN Poly(4) Snow	118	3	0.84	0.1050	0.2766	0.87	> 0.8	Poor

[a] Key functions: Half-normal (HN), Hazard rate (HR)

[b] Series expansions: Cosine of order x (Cos(x)), Simple polynomial of order x (Poly(x)). The notation (0) means that no adjustment parameter was selected following AIC comparisons.

[c] These two models are identical as no adjustment parameter was selected.

Table 8. The Torngat Mountains caribou herd 2024 survey analysis (n= 118 groups) by Conventional Distance Sampling (CDS) and Multiple Covariate Distance Sampling (MCDS) methods in Distance 7.5. The covariates snow cover and slope were tested, while the truncation distance was set at 1,500 m. Columns report the number of parameters (m), number of adjusted parameters (adj par), Delta AIC, effective strip width in metres (ESW), probability of detection (p), coefficient of variation of p (p CV), estimated group size (E(S)) by Distance 7.5, density of caribou per km^2 (D), coefficient of variation of D, (D CV), and Kolmogorov-Smirnov (K-S), Cramér-von Mises cosine (CvM) goodness of fit tests probability (P), and model fit as estimated from Q-Q plots (decreasing from good, poor to bad).

Model [a, b]	m	adj par	Delta AIC	ESW	p	p CV	E(S)	D	D CV	K-S P	CvM P	Fit
MCDS HN Cos(2) Snow [c]	**3**	**1**	**0.00**	**572**	**0.382**	**0.07**	**7.04**	**0.1135**	**0.1493**	**0.997**	**1.000**	**Good**
CDS HN Cos(2)	2	1	0.34	572	0.382	0.10	6.95	0.1120	0.1639	1.000	1.000	Good
CDS HR Herm(0)	2	0	1.22	633	0.422	0.12	7.20	0.1051	0.1742	0.996	1.000	Good
CDS HR Poly(0)	2	0	1.22	633	0.422	0.12	7.20	0.1051	0.1742	0.996	1.000	Good
MCDS HN Poly(4) Snow	3	1	1.68	639	0.426	0.23	7.20	0.1040	0.2644	0.811	0.700	Poor
CDS Unif Cos(1,2,3)	3	3	1.77	564	0.376	0.10	6.94	0.1135	0.1629	0.998	1.000	Good
CDS HN Poly(4,6)	3	2	2.02	572	0.382	0.10	6.96	0.1122	0.1610	1.000	1.000	Good
MCDS HN Cos(2) Slope	4	1	2.86	572	0.382	0.07	6.87	0.1108	0.1493	0.996	1.000	Good
MCDS HN Cos(2) Slope Snow	5	1	2.96	572	0.381	0.07	6.93	0.1120	0.1496	0.827	1.000	Poor
MCDS HR Poly(0) Snow	3	0	3.02	632	0.421	0.07	7.40	0.1080	0.1487	0.970	1.000	Poor
MCDS HN Poly(4) Slope Snow	5	1	4.16	633	0.422	0.23	7.03	0.1025	0.2673	0.886	0.800	Poor
MCDS HN Poly(4) Slope Snow	4	1	4.81	642	0.428	0.23	6.93	0.0996	0.2618	0.866	0.800	Poor
MCDS HR Poly(0) Slope	4	0	5.09	628	0.419	0.07	7.27	0.1068	0.1484	0.999	1.000	Good
MCDS HR Poly(0) Slope Snow	5	0	7.93	660	0.440	0.07	7.29	0.1020	0.1490	0.586	0.700	Bad

[a] Key functions: HN= half-normal; HR= hazard rate. See Buckland et al. (2001), p. 47.

[b] Adjustment terms (Series expansion): Cos(x)= cosine of order x; Poly(x)= simple polynomial of order x. See Buckland et al. (2001), p. 47. The notation (0) means that no adjustment parameter was selected following AIC comparisons. Slope (flat, rolling, steep) and snow (% ground cover) were two covariates in the analysis.

[c] The best model is shown in bold and used later for the population estimation.

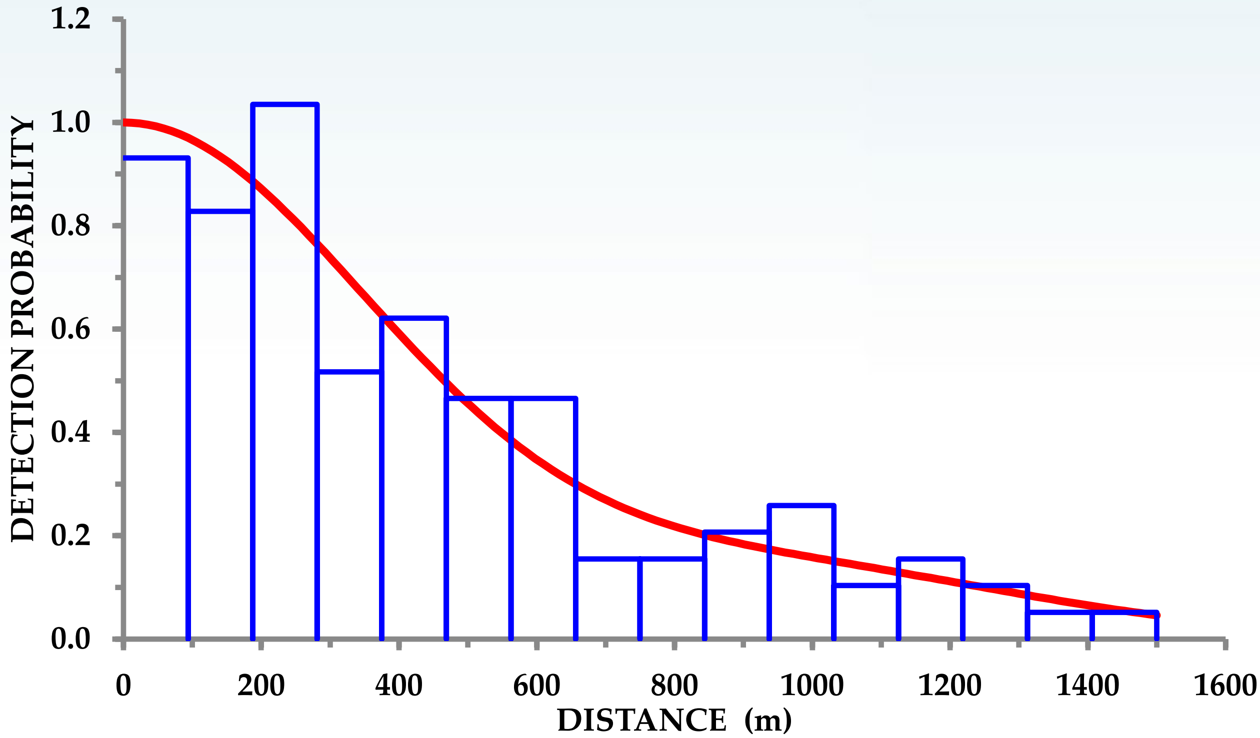

Figure 9. Detection probability function (continuous red line) and histogram of the frequency of observations in 94 m bin size of caribou groups recorded during the Torngat Mountains caribou herd survey in 2024. Computed in Distance 7.5 from the best model in Multiple Covariate Distance Sampling: Half-Normal Cosine with Snow as a covariate following right-truncation at 1,500 m.

Table 9. Perpendicular distances and effective strip width (ESW) in metres recorded in distance sampling survey of the Torngat Mountains caribou herd in March 2024 and comparisons with previous surveys since 2014 (see Couturier et al. 2015, 2018 and 2024).

	2014	2017	2021	2024
Perpendicular distance: Mean (m)	464	423	489	459
Perpendicular distance: Maximum (m)	1,390	1,980	1,780	2,280
Perpendicular distance: Truncation (W; m)	No [a]	1,390	1,300	1,500
Effective strip width (ESW) (m) [b]	541	622	519	572

[a] Due to small sample size, no right-truncation was applied in 2014 survey analysis.
[b] The effective strip width (ESW= W*p) means that as many caribou were detected between 0 to ESW than were missed between ESW and the truncation distance (W).

Table 10. Variance components in the caribou density estimation since 2014 using distance sampling.

Variance components	2014	2017 South stratum	2017 North stratum	2021	2024
Detection probability (p)	25.0%	3.0%	11.2%	23.5%	24.5%
Encounter rate (n/L)	53.5%	87.0%	51.2%	47.5%	31.3%
Group size	21.5%	10.0%	37.6%	29.0%	44.2%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Table 11. Results of the 2024 Torngat Mountains caribou herd survey and comparison with previous surveys done in 2014, 2017 and 2021 (see Couturier et al. 2015, 2018 and 2024).

	2014	2017	2021	2024 [a]
Survey area (km^2)	30,689.4	30,624.8	26,667.9	26,399.0
Density (caribou/km^2)	0.0303	0.0433	0.0908	0.1135
Density CV	0.2329 [b]	0.2390	0.1545	0.1493
Density SE	0.007053	0.010348	0.014034	0.016949
Herd size (including 10-month-old calves)	930	1,326	2,422	2,997
Lower confidence interval (90%)	30.6%	31.2%	21.9%	21.3%
Upper confidence interval (90%)	47.2%	49.7%	29.6%	28.5%
Confidence interval (CI, 90%)	645 to 1,369	912 to 1,986	1,892 to 3,140	2,359 to 3,851
Number of adult caribou estimated	770	1,020	1,870	2,293
Average annual rate of increase:				
- Since previous survey	n.a.	12.5%	16.3%	7.4%
- Since 2014	n.a.	12.5%	14.7%	12.4%

[a] This study.

[b] Using the O2 variance estimation method (Fewster et al. 2009), the 2014 herd size CV has been recalculated by Couturier et al. (2018).

3.6 Recruitment and population dynamics

The raw classification data are presented in Appendix C. The adult sex ratio of 71.2 males/100 adult females in 2024 is higher than reported in previous surveys but still within the normal range for a caribou population (43 to 72, Bergerud 1980). The calf spring recruitment (i.e. percentage of 10-month-old calves in the population) was excellent in 2024 at 23.5%. It was the highest recruitment estimate since 2014 (Table 3). In spring 2024, the 52.6 calves/100 adult female ratio was also the highest value reported since 2014.

Density of 0.1135 caribou/km^2 in 2024 is statistically different from the lower estimated densities of 2014 and 2017 ($P< 0.01$; see method in Buckland et al. 2001), although it is not different from the estimated density of 0.0908 in 2021 ($P> 0.10$). The Torngat caribou herd increased since the previous survey in 2021 (Figure 10). However, the 7.4% annual rate of population growth between 2021 and 2024 is the lowest over the monitoring period (Table 11).

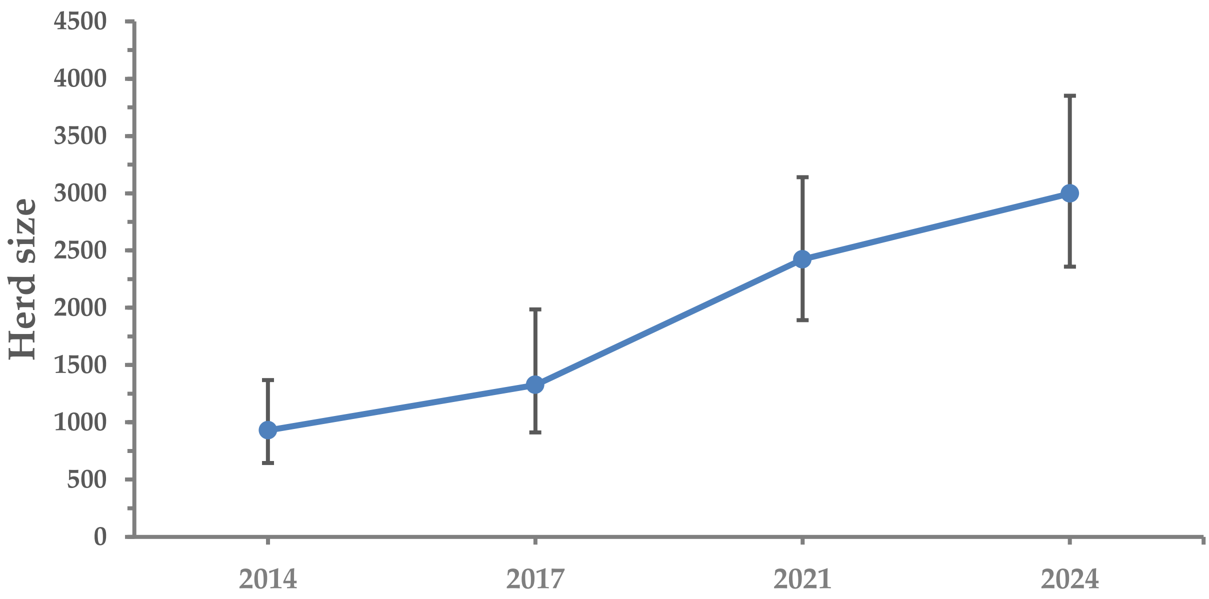

Figure 10. Torngat Mountains caribou herd size estimates since 2014 with their 90% confidence intervals (vertical bars).

4. Discussion

Since the beginning of the Torngat caribou surveys in 2014, the distance sampling method remains unchanged. Although minor additions have been made, the survey area has also remained relatively consistent, except for the inclusion of the historical range south of Hebron Fjord in 2014 and 2017 (Figure 3). Couturier et al. (2018, Table 8) showed that inclusion or exclusion of the southern historical range (where no caribou were recorded) had little effect (-4%) on the herd population estimate in 2017. The timing of the surveys in late March also remained similar among the four surveys. Methodological consistency allows straightforward comparison among survey results and their confidence intervals. Further, we demonstrated that no significant numbers of George River caribou herd were present in the Torngat herd study area during the four surveys. These four extensive surveys have established essential background information to monitor changes in population dynamics of the Torngat Mountains caribou herd.

The Torngat caribou population has been increasing since 2014. It is one of the rare increasing caribou populations in Canada. High recruitment rates in survey years are consistent with the observed population increase. High calf survival is normally associated with a low predation rate. Wolves and black bears are the main predators on caribou calves. Inuit from Kangiqsualujjuaq have also reported observations of polar bears preying on caribou. The mortality of calves or adults by predation or other causes is unknown, but our findings strongly suggest that predation is low (i.e. recruitment is high, and the population is increasing).

4.1 Photo classification process

During the 2024 survey, Inuit in Kangiqsualujjuaq expressed concerns about low altitude helicopter overflights of caribou in winter, particularly regarding the potential stress imposed on pregnant females. For the first time in the Torngat caribou survey series, the duration of the photo classification was computed in 2024. It showed classifications were made very rapidly (28 sec on average) for an observed group size of 8.9 caribou. Furthermore, the magnification lens allowed more remote observations than live classifications that require flying closer to the animals. We believe that photographic classifications reduce the stress on caribou. This benefit for animal care increased with group size as larger groups can be hazardous to classify on the fly in mountainous terrain. We will present these results to the people of both Kangiqsualujjuaq and Nain.

4.2 Other methods to survey caribou population

We have shown that flying time over caribou is very brief and at further distances, which likely causes limited undue stress to caribou, even to pregnant females in winter. However, it is still interesting to explore if other survey techniques could be used for next surveys of the Torngat caribou population.

Methods to estimate the size of a caribou population are tailored to the specific context, landscape, ecology and behaviour of the population of interest. Many of caribou survey techniques do not align with the context of the Torngat Mountains caribou herd. For example, the calving ground or post-calving aggregation methods used in migratory caribou are not possible for mountain caribou as they have been for the GRH or the LRH (Brodeur et al 2017). Fecal DNA identification can be practical for a very small caribou population (Hettinga et al. 2012; Flasko et al. 2017) but would not be suitable to implement in the growing Torngat population because it would depend on an unrealistic and cost prohibitive sample size. Mark-Resight (M-R) surveys would also be too expensive as it would require the maintenance of a large sample size of radio-collars in a medium-sized caribou population like the Torngat (Anderson & Klaczek 2021; Russell et al. 2024). Transect based survey methods done in winter appear to be the best approach to take advantage of the specific context of the Torngat caribou. The alpine and tundra habitat provide good sightability (no trees) and the snow-covered landscape offers opportunity to see tracks from a long distance. Many caribou populations in Canada are monitored using a fixed 500 m strip width transect method (Anderson 2016; Nishi & Buckland 2000; Courtois et al. 2001). However, fixed transects surveys are dependent on the measurement of a sightability correction factor to account for the caribou that are missed by observers. They also generally require intensive coverage with transect spacing from 1 to 2.1 km and are associated with demographic classifications, which also cause some disturbance to animals. The distance sampling method proved to be successful since 2014 for the Torngat caribou and does not require this sightability correction factor for animals missed. The Distance sampling method in the Torngat range offers also the flexibility to increase the spacing between transects if the encounter rate continues to increase, reducing cost, effort and disturbance without compromising scientific rigor.

4.3 Survey area and sampling design

The first two surveys in 2014 and 2017 of the Torngat caribou covered part of the historical range between Hebron Fjord and Okak Bay (Figure 3). However, no caribou or tracks have been recorded there in both surveys. The 2021 and 2024 surveys focused the survey effort from the Hebron Fjord and north. The southwestern section of the survey area has been slightly increased in 2017 and 2021 based on local Inuit knowledge informing recent use of these areas by caribou in winter. In 2024, the survey area was about the same as in 2021 (Figure 3).

There is a growing consensus that Torngat caribou have been absent for several years from the southern region of their historical range, from Hebron Fjord to Okak Bay. This has been reported by Inuit knowledge (Wilson et al. 2014) and telemetry data (Bélanger 2017 a, b; Bélanger et al. 2018), as well as by previous surveys (Couturier et al. 2015, 2018 and 2024). Monitoring space use by the Torngat caribou will be necessary to plan the next survey. Inuit knowledge and satellite radio tracking could detect caribou range contraction or expansion, and it would be useful to re-evaluate periodically if the south of Hebron Fjord should be surveyed or simply monitored occasionally to detect possible changes to the herd's range. It will be particularly important to remain vigilant about a possible southern range expansion if the caribou population continues to increase.

Nunavik Inuit local knowledge suggested that more of the Kuururjuaq Park should be covered during the March caribou surveys. The survey extensions east of Kangiqsualujjuaq added since 2017 (Figure 3) were beneficial, as some caribou groups were recorded there in 2021 and again in

2024. We recommend keeping these extensions in future surveys. Moreover, during flights from and to Kangiqsualujjuaq in 2024, two off-transect groups were detected opportunistically west of the survey area at the latitude of transects 13 and 15 (see Figure 2 for transect ID number). They were located 14 km and 20 km south of the extension previously added in the southwest portion of the survey area (i.e. south of transect 18). The survey area of future surveys must be expanded to include the area used by these two off-transect groups. It is then recommended to further extend this area by moving the west ends of transects 9 to 17 by about 35 km toward the west (see Figure 2). Such an extension would increase the survey area by about 1,000 km^2 and the transect length by about 300 km for the next survey if transect spacing remains at 4 km as in 2024.

In 2014, the spacing between transects was set to 4 km. At the time, there was limited knowledge about the caribou density in the survey area. With only 50 caribou groups recorded in 2014, the spacing between transects were set to 3 km for the 2017 survey, to increase the sampling effort in the northern region (anticipated to be the high-density strata). The southern region was considered the low-density stratum and the transects were spaced every 4 km like in 2014. A reduced distance between transects means the ability to fit more transects in the same survey area, thus increasing sampling effort to increase the sample size of groups detected. As the number of groups recorded was still low at 58 in 2017, the sampling effort was increased again for 2021 by choosing a transect spacing of 2.5 km for the entire survey area. The 2021 survey was plagued with major logistical issues, but it was the largest survey effort ever done on a Torngat caribou survey. However, the closer spacing at 2.5 km meant that the observer detection capacity exceeded the middle point between transects (i.e. 1.25 km) even though the probability of detection was low at such distance in the mountainous terrain. The maximum distance caribou groups have been detected was 1.39 km, 1.98 km, 1.79 km and 2.28 km, respectively during the four successive surveys (Table 9). Due to small sample size, the dataset was not right-truncated in 2014. The dataset was truncated at 1.39 km and 1.3 km during the 2017 and 2021 survey analysis (Table 9). Such a sampling design with spacing at 2.5 km, and subsequent observations past the middle point between transects, could create confusion during the field survey. For these reasons, and because of budget limitations, a transect spacing of 4 km was selected for the 2024 survey. It was one of the lowest sampling efforts since 2014 (Table 2), but it produced one of the most robust survey datasets, due to the increased number of groups and encounter rate that was caused by a decade-long increase of the Torngat caribou herd.

From experience of past surveys, it has been shown that survey effort can be adapted to improve the sample size in consideration of the expected population trend. For the future distance sampling surveys, a 4-km transect spacing would provide a good sample size considering that caribou density has been increasing since 2014, and that the average group size has remained relatively constant since 2017 despite a large increase in population abundance.

4.4 Density and herd size estimation

The frequency distributions shown in Figure 5 confirms the main assumption of distance sampling that numbers of detections decrease monotonically with increasing distance from the transect (Buckland et al. 2001). When compared to detection functions of previous surveys, the

2024 data set is the most rigorous survey data set recorded on the Torngat caribou. It must be acknowledged that the population increase since 2014 has provided more opportunities to increase sample size in the number of caribou groups detected during the survey. In 2024, there was a 5% increase in the number of groups detected compared to the 2021 despite a 29% reduction of survey effort (Table 2). The relatively constant effective strip width (ESW: 519 m – 622 m; Table 9) and comparison of the average group size (Table 5) over the four surveys suggests that the increase in sample size was due to the caribou population growth (i.e. more groups available for detection) rather than varying performance of observers. The narrower confidence intervals of -21.3% and +28.5% are now close to the 20% target that many managers are using to assess wildlife populations.

Due to a larger sample size of 118 caribou groups (after truncation at 1,500 m), the 2024 density CV is 0.1493, which is smaller than those reported during previous surveys (Table 11). This is coherent with the shift in the dominant variance source of the density estimate from encounter rate in previous surveys to group size in 2024 (Table 10). If group sizes become more variable with the increasing population, this overall variance potential increase may be compensated with the naturally increasing encounter rate and therefore sample size.

Buckland et al. (2001) recommend 60-80 detections and 10-20 transects as practical minimum for estimating detection function and encounter rate. However, it has been suggested more recently that 150-200+ detections are required to adequately estimate sampling variance in distance sampling surveys of large gregarious mammals (Schmidt & Rattenbury 2013; Schmidt et al. 2022). The Torngat caribou population has changed so much since 2014 that it is difficult to estimate the sample size goal for the next survey. Since the first survey, the population estimates increased by a magnitude of 3.2X, the encounter rate increased by 2.7X, the number of caribou detected on transects increased by 4.0X despite a reduced sampling effort in 2024, and the group size has changed after 2014. Although our survey methods remained similar, these demographic variations are making the use of power analysis less accurate to determine the sample size goal of next survey. Maintaining a sample size above 120 groups seems a minimal objective to contain the CIs of future herd estimates within a relevant range to assess trend and management recommendations. If possible, the next survey should get a larger sample size (i.e. > 150) to target a population estimate CI < 20% or a CV of < 0.1

One advantage of the MCDS approach is that it reduces the variance in density estimates by modelling the heterogeneity in detection probability functions, which is not incorporated in the CDS methods (Marques et al. 2007). Since 2014, MCDS models have been selected as the best in three out of four previous surveys of the Torngat caribou. When using MCDS, it is important to consider only the covariates that are believed a priori to influence the detection probability (Marques et al. 2007). Since the first caribou survey in the Torngat Mountains winter range in 2014, it was hypothesised that snow cover and slope could influence the detection probability of caribou groups. Although we have demonstrated that snow cover influenced the detection probability during the 2021 and 2024 surveys, our datasets do not allow us to ascertain how this snow effect is unfolding. One possible explanation is that caribou on or near snow-free patches do not provide track networks in the snow that can easily be seen from a distance in this mostly white alpine landscape. The three detection probability functions computed by Distance 7.5 in 2024 for snow cover at 60%, 70% and 80% suggest that the probability of detecting caribou groups is slightly higher where there was more snow. However, these detection probability differences are so small that it is difficult to explain further. For example at mid-distance of 750 m, the detection probability p was 0.22 with 60% snow, 0.25 with 70% snow, and 0.27 with 80% snow coverage The only conclusion we can draw from the AIC selection of the snow covariate model as the best in the 2021 and 2024 surveys (Table 8) is that snow cover significantly affects the detection probability of caribou groups.

4.5 Recruitment and population dynamics

The sex and age classifications in 2014, 2017, 2021, and 2024 indicate that Torngat caribou recruitment was high during survey years (Table 3). The highest recruitment was estimated during the 2024 survey. High recruitment of Torngat caribou is consistent with the increasing population trend, and we could expect that recruitment was high during non-survey years as well. Annual recruitment can, however, be highly variable from one year to another, and regular estimates are required to correctly assess the herd's productivity when the delay between surveys increase.

The high recruitment estimates and the average annual rate of increase of 12.4% show that the Torngat herd was increasing from 2014 to 2024. However, the rate of increase of 7.4% since the last survey was the lowest since 2017. This indicates that the rate of increase has slowed down. Moreover, the lack of data for recruitment between surveys years, for adult survival and for annual hunter harvest information, does not allow annual modelling of the Torngat caribou population dynamics. Continued monitoring of the Torngat herd is required to evaluate demographic trends and to support adaptive management decisions.

5. Conclusion

This fourth survey since 2014 shows that the Torngat caribou herd has continued to increase, although the annual rate of population growth slowed between 2021 and 2024. Partial monitoring of population dynamics suggests that high recruitment was indicative of Torngat herd growth. However, the Torngat herd is still a small caribou population that will require regular monitoring to ensure that conservation and harvest objectives remain sustainable.

The Torngat herd is likely to remain a small population in the near future and must be managed as such. There are several limiting factors on caribou herd demography that are not fully understood or adequately quantified, such as predation, human disturbances, hunting, and current and future environmental conditions. The effects of these limiting factors on the population dynamics of the Torngat caribou are largely unknown, so it is difficult to predict long-term population trends.

If the Torngat caribou continue to increase, it is possible that the southern portion of the historical range south of Hebron Fjord could be reoccupied, which highlights the importance of continued vigilance regarding potential range expansion.

Improved monitoring and communication, as well as careful stewardship, are having a positive effect on the respectful management of this important resource for the Inuit people of Nunavik and Nunatsiavut.

References

Aars, J., Marques, T. A., Buckland, S. T., Belikov, S., Boltunov, A., & Wiig, O. (2009). Estimating the Barents Sea polar bear subpopulation size. *Marine Mammal Science, 25(1),* 35–52.

Alberta. (2016). Aerial ungulate surveys using distance sampling techniques – Protocol manual. Alberta Environment and Parks, Environmental Monitoring and Science Division, 30 p.

Anderson, M. (2016). Distribution and abundance of muskoxen (*Ovibos moschatus*) and Peary caribou (*Rangifer tarandus pearyi*) on Prince of Wales, Somerset, and Russell Islands, August 2016. Department of Environment, Wildlife Research Section, Government of Nunavut, Igloolik, NU. Status report 2016-06 27 p.

Anderson, M. & Klaczek, M. (2021). Mark-resight survey of caribou in the Chase herd, north-central BC, March 2021. BC Ministry of Forests, Lands and Natural Resource, Omineca region.

Anonymous. (2023). Distance 7.5 Release 2 User's Guide. Research Unit for Wildlife Population Assessment, University of St. Andrews, Scotland. 420 p.

Becker, E. F. & Christ, A. M. (2015). A unimodal model for double observer distance sampling surveys. *PLOS ONE* 10(8): e0136403.

Bélanger, É. (2017a). Habitat use of Torngat Mountains caribou – Results update of the Torngat Mountains caribou research. Report submitted to the Torngat Secretariat. Université Laval, Québec, QC.

Bélanger, É. (2017b). Sélection de l'habitat, dynamique de population et utilisation de l'espace du caribou des Monts Torngat. M. Sc. Thesis, Université Laval, Québec, QC. 64 p + 9 Appendix.

Bélanger, É., Leblond, M., & Côté, S. D. (2018). Habitat selection and population trends of the Torngat Mountains caribou herd. *The Journal of Wildlife Management. 83(2)*, 379–392.

Bergerud, A. T. (1980). A review of the population dynamics of caribou and wild reindeer in North America. *Proc. 2nd Int. Reindeer/Caribou Symposium,* 556–581, Roros, Norway.

Buckland, S. T., Anderson, D. R., Burnham K. P., Laake, J. L., Borchers, D. L., & Thomas, L. (2001). Introduction to distance sampling. Oxford University Press, London, 432 pp.

Buckland, S. T., Rexstad, E. A., Marques, T. A., & Oedekoven, C. S. (2015). Distance sampling: Methods and applications. Springer. 292 pp.

Brodeur, V., S. Rivard, C. Dussault, L. Harvey & Taillon, J. (2017). The use of satellite telemetry to estimate the abundance of a migratory caribou population. Ministère des Forêts, de la Faune et des Parcs, Québec. 25 p.

Brodeur, V., Pisapio, J., McCarthy, S., Rivard, S., & Taillon, J. (2022). Aerial survey of the migratory George River Caribou Herd in July 2020. Ministère des Forêts, de la Faune et des Parcs, Québec, & Department of Fisheries, Forestry and Agriculture, Newfoundland and Labrador, 21 p.

Campbell, M., Goorts, J., Lee, D. S., Boulanger, J., & Pretzlaw, T. (2015). Aerial abundance estimates, seasonal range use, and spatial affiliations of the barren-ground caribou (*Rangifer* *tarandus groenlandicus*) on Baffin Island – March 2014. Government of Nunavut, Department of Environment. Technical Report Series - No: 01–2015.

Courtois, R., A. Gingras, C. Dussault, L. Breton & Ouellet, J-P (2001). Développement d'une technique d'inventaire adaptée au caribou forestier. Société de la faune et des parcs du Québec, Direction de la recherche sur la faune et Direction de l'aménagement de la faune. Société de la faune et des parcs du Québec et Université du Québec à Rimouski, 23 p.

COSEWIC. (2011). Designatable units for caribou (*Rangifer tarandus*) in Canada. Ottawa, Committee on the status of Endangered Wildlife in Canada (COSEWIC).

COSEWIC. (2017). COSEWIC assessment and status report on the Caribou *Rangifer tarandus*, Eastern Migratory population and Torngat Mountains population, in Canada. Committee on the Status of Endangered Wildlife in Canada (COSEWIC), Ottawa. xvii + 68 pp.

Couturier, S., Brunelle, J., Vandal, D., & St-Martin, G. (1990). Changes in the population dynamics of the George River caribou herd, 1976-87. *Arctic, 43,* 9–20.

Couturier, S., Courtois, R., Crépeau, H., Rivest, L. P., & Luttich, S. (1996). Calving photocensus of the Rivière George Caribou Herd and comparison with an independent census. In Proc. Sixth North American Caribou Workshop, Prince George, British Columbia. *Rangifer,* Special Issue 9, 283–296.

Couturier, S., Dale, A., Mitchell Foley, J., Snook, J., & Wood, B. (2015). First scientific data on herd size and population dynamics of the Torngat Mountains caribou herd. Torngat Wildlife, Plants and Fisheries Secretariat. Happy Valley-Goose Bay, NL. Ser. 2015/43 + 9 p.

Couturier, S., Dale, A., Wood, B., & Snook, J. (2018). Results of a spring 2017 aerial survey of the Torngat Mountains caribou herd. Torngat Wildlife, Plants and Fisheries Secretariat. Happy Valley-Goose Bay, NL. Ser. 2018/40 + 10 p.

Couturier, S., Purcell, M., Rivoire, S., Dale, A., Brodeur, V., McCarthy, S., & Snook, J. (2024). Aerial survey of the Torngat Mountains caribou herd in March-April 2021. Torngat Wildlife, Plants and Fisheries Secretariat. Happy Valley-Goose Bay, NL. Ser. 2024/32 + 9 p.

Ferrarini, M. & Nielsen, O. (2025). Distance sampling: comparing walked transects and road transects for rock ptarmigan densities and population trends. *Wildlife Biology*: e01350.

Fewster, R. M., Buckland, S. T., Burnham, K. P., Borchers, D. L., Jupp, P. E., Laake, J. L., & Thomas, L. (2009). Estimating the encounter rate variance in Distance Sampling. *Biometrics, 65*, 225–236.

Fifield, D. A., Lewis, K. P., & Gullage, S. E. (2013). Application of distance sampling to determine calving ground abundance and aggregation of parturient females in the Middle Ridge herd, June 2012. Dept. of Env. and Conserv., Sustainable Development and Strategic Science. St. John's, NL. Technical Bulletin No. 005: 17 p.

Flasko, A., Manseau, M., Mastromonaco, G., Bradley, M., Neufeld, L. & Wilson, P. (2017). Fecal DNA, hormones, and pellet morphometrics as a noninvasive method to estimate age class: an application to wild populations of Central Mountain and Boreal woodland caribou (*Rangifer tarandus caribou*). *Canadian Journal of Zoology* 95(5): 311-321.

Focardi, S., La Morgia, V., Montanaro, P., Riga, F., Calabrese, A. & et al. (2020). Reliable estimates of wild boar populations by nocturnal distance sampling. *Wildlife Biology* 4: wlb.00694.

Glass, R., Forsyth, D. M., Coulson, G., & Festa-Bianchet, M. (2015). Precision, accuracy and bias of walked line-transect distance sampling to estimate eastern grey kangaroo population size. *Wildlife Research, 42*, 633–641.

Hettinga, P.N., Arnason, A.N., Manseau, M., Cross, D., Whaley, K. & Wilson, P.J. (2012), Estimating size and trend of the North Interlake woodland caribou population using fecal-DNA and capture–recapture models. *The Journal of Wildlife Management* 76: 1153-1164. https://doi.org/10.1002/jwmg.380

Jenkins, D. A., Campbell, M., Hope, G., Goorts, J., & McLoughlin, P. (2011). Recent trends in abundance of Peary caribou (*Rangifer tarandus pearyi*) and muskoxen (*Ovibos moschatus*) in the Canadian Arctic Archipelago, Nunavut. Department of Environment, Government of Nunavut, Pond Inlet, NU. 184 p.

Jenkins, D. A., Goorts, J., & Lecomte, N. (2013). Estimating the Abundance of South Baffin Caribou - Summary Report 2012. Pond Inlet, Nunavut, Department of Environment, Government of Nunavut.

Laidre, K. L., Marques, T. A., Cohen, B., Hansen, R. G., Regehr, E. V., Zahn, M. J., Aars, J., Ware, J., Stern, H. L. & Ugarte, F. (2026). First abundance estimate for the East Greenland polar bear subpopulation. *Endangered Species Research* 59:esr01479.

Larue, M. A., Nielsen, C. K. & Grund, M. D. (2007). Using distance sampling to estimate densities of white-tailed deer in South-Central Minnesota. *The Prairie Naturalist* 32(2): 57-68.

Le Moullec, M., Pedersen, A. O., Yoccoz, N. G., R, Tufto, J., & Hansen, B. B. (2017). Ungulate population monitoring in an open tundra landscape: distance sampling versus total counts. *Wildlife Biology,* DOI: 10.2981/wlb.00299.

Marques, T. A., Andersen, M., Christensen-Dalsgaard, S., Belikov, S., Boltunov, A., Wiig, O., Buckland, S. T., & Aars, J. (2006). The use of Global Positioning Systems to record distances in a helicopter line-transect survey. *Wildlife Society Bulletin, 34*, 759–763.

Marques, T. A., Thomas, L., Fancy, S. G., & Buckland, S. T. (2007). Improving estimates of bird density using multiple- covariate distance sampling. *The Auk, 124*, 1229–1243.

McNay, S., Webster, D., & Sutherland, G. (2013). BC Boreal Caribou Implementation Plan – Aerial Moose Survey in Northeast BC 2013. Science and Community Environmental Knowledge, 25 p + appendices.

Montalvo, A., Brennan, L. A., Morrison, M. L., Grahmann, E. D. & Tri, A. N. (2022). Distance sampling survey effort to improve density estimates of northern bobwhite. *Wildlife Society Bulletin* 46: e1303.

Nishi, J. & Buckland, L. (2000). An aerial survey of caribou on western Victoria Island (5-17 June 1994). Department of Resources, Wildlife, and Economic Development, Government of the Northwest Territories, Volume 128. 88 p.

Russell, J. H., Couturier, S., Sopuck, L. G. & Ovaska, K. (1996). Post-calving photo-census of the Rivière-George caribou herd in July 1993. In Proc. Sixth North American Caribou Workshop, Prince George, British Columbia. *Rangifer* Special Issue 9: 319-330.

Russell, K. L., Beckmann, K. & Beatty, A. (2024). Coal River Caribou Herd 2022 population estimate. Government of Yukon, Whitehorse, Yukon. 14 p. + Appendix.

Schaefer, J. A., & Luttich, S. N. (1998). Movements and activity of caribou, *Rangifer tarandus caribou*, of the Torngat Mountains, northern Labrador and Québec. *Can. Field Nat.*, *112*, 486–490.

Schmidt, J. H. & Rattenbury, K. L. (2013). Reducing effort while improving inference: Estimating Dall's sheep abundance and composition in small areas. *The Journal of Wildlife Management* 77(5): 1048-1058.

Schmidt, J. H. & Rattenburry, K. L. (2017). An open-population distance sampling framework for assessing population dynamics in group-dwelling species. *Methods Ecol. Evol.*: 1-10.

Schmidt, J. H., Wilson, T. L., Thomson, W. L. & Reynolds, J. H. (2017). Improving inference for aerial surveys of bears: The importance of assumptions and the cost of unnecessary complexity. *Ecology and Evolution* 7: 4812-4821.

Schmidt, J. H., Thompson, W. L., Wilson, T. L. & Reynolds, J. H. (2022). Distance sampling surveys: using components of detection and total error to select among approaches. *Wildlife Monographs* 210(1): e1070.

Thiessen, C. (2010). Horn River Basin moose inventory January/February 2010. Ministry of Environment, Fort St-John, BC. 26 p + appendices.

Thomas, L., Buckland, S. T., Rexstad, E. A., Laake, J. L., Strindberg, S., Hedley, S. L., Bishop, J. R. B., Marques, T. A., & Burhham, K. P. (2010). Distance software: design and analysis of distance sampling surveys for estimating population size. *Journal of Applied Ecology*, *47*, 5–14.

Wilson, K. S., Basterfield, M. W., Furgal, C., Sheldon, T., Allen, E., Communities of Nain and Kangiqsualujjuaq & Co-operative Management Board for the Torngat Mountains National Park. (2014). Across borders, for the future: Torngat Mountains caribou herd Inuit knowledge, culture, and values study. Final report to the Nunatsiavut Government, Makivik Corporation, Parks Canada, and the Torngat Wildlife and Plants Co-Management Board, Nain, NL. 72 p. & appendices.

Appendix A – Timeline

Timeline of the Torngat Mountains caribou herd survey in March 2024.

Date	Daily flying (h)	Transects done	Group #	Notes
March 8, 2024	4.8			Positioning to Kangiqsualujjuaq from Goose Bay.
March 9, 2024	3.8			Visibility too bad for surveying but fuel drums have been moved
March 10, 2024				Weather day. Snow.
March 11, 2024	8.8	70 to 53	1 to 22	
March 12, 2024	8.3	52 to 45	23 to 53	
March 13, 2024	8.8	44 to 37	54 to 71	
March 14, 2024	8.5	36 to 31	72 to 86	
March 15, 2024	2.1			Light snow. Pilot flying Colin Webb to Nain.
March 16, 2024	5.8	30 to 27	87 to 90	Pilot back to Kangiqsualujjuaq (2.1 h), and then in the afternoon survey flying resumed.
March 17, 2024	2.8	26 to 25	91 to 93	Partly weather day (snow in the morning).
March 18, 2024	7.5	24 to 21	94 to 105	
March 19, 2024	6.2	20 to 11W	106 to 108 (201 & 202)	Helicopter Medivac for an Inuit elderly woman (1.0 h) + survey.
March 20, 2024	8.5	12 to 5	109 to 116	Flew sections not covered before
March 21, 2024	9.9	25 to 1	117 to 121	Survey + repositioning to Goose Bay.
Grand Total	85.8			
Minus other flying	5.2			(Medivac, flying to Nain and back to Kangiqsualujjuaq)
TOTAL for survey	**80.6**			

Appendix B – Transect information

Transect related information during the spring 2024 population survey of the Torngat Mountains caribou herd: transect number, start and end time, time on transect (h), visibility class (3: excellent, 2: good, 1: poor), temperature, cloud coverage, precipitation, wind (knots, direction) and comments.

Trans.	Start Date/Time	End Date/Time	Time (h)	Vis. class	T. (°C)	Clouds (%)	Precip.	Wind		Comments
								Kt	Dir.	
70	2021-03-11 08:47	2021-03-11 08:57	0.167	3	-14	60%	none	20	45	
69	2021-03-11 08:59	2021-03-11 09:05	0.100	3	-14	30%	none	14	45	
68	2021-03-11 09:07	2021-03-11 09:17	0.167	3	-14	20%	none	22	65	
67	2021-03-11 09:19	2021-03-11 09:27	0.133	3	-14	60%	none	13	68	
66	2021-03-11 09:29	2021-03-11 09:39	0.167	3	-12	60%	none	15	72	
65	2021-03-11 09:40	2021-03-11 09:50	0.167	3	-14	60%	none	14	68	
64	2021-03-11 09:52	2021-03-11 10:04	0.200	3	-13	60%	none	18	73	
63	2021-03-11 10:08	2021-03-11 10:20	0.200	3	-14	50%	none	8	80	
62	2021-03-11 10:22	2021-03-11 10:37	0.250	3	-13	80%	none	17	70	
61	2021-03-11 10:39	2021-03-11 10:55	0.267	3	-13	70%	none	9	85	Then go to fuel.
60	2021-03-11 12:09	2021-03-11 12:29	0.333	3	-11	50%	none	13	101	
59	2021-03-11 12:31	2021-03-11 12:48	0.283	3	-12	60%	none	7	75	
58	2021-03-11 12:49	2021-03-11 13:15	0.433	3	-10	40%	none	17	58	
57	2021-03-11 13:19	2021-03-11 13:43	0.400	3	-12	60%	none	6	50	Then go to fuel.
56	2021-03-11 14:30	2021-03-11 15:09	0.650	3	-10	30%	none	15	55	
55	2021-03-11 15:11	2021-03-11 15:36	0.417	3	-11	80%	none	8	20	
54	2021-03-11 15:38	2021-03-11 16:16	0.633	3	-10	80%	none	22	76	High altitude clouds.
53	2021-03-11 16:17	2021-03-11 16:49	0.533	2	-12	90%	none	8	75	
52	2021-03-12 08:43	2021-03-12 09:22	0.650	3	-9	70%	none	12	100	Fog in the east.
51	2021-03-12 09:26	2021-03-12 10:02	0.600	3	-6	70%	none	3	90	Fog in the east.
50	2021-03-12 10:36	2021-03-12 11:20	0.733	2	-8	90%	none	13	17	Go to fuel, fog in the east.
49_E	2021-03-12 11:23	2021-03-12 11:59	0.600	2	-11	90%	none	0		Fog in the east.
49_W	2021-03-12 12:29	2021-03-12 12:32	0.050	3	-8	30%	none	0		
48	2021-03-12 12:34	2021-03-12 13:20	0.767	3	-8	30%	none	0		Fog in the east.
47_E	2021-03-12 13:21	2021-03-12 14:11	0.833	3	-11	30%	none	4	50	Break to fuel, fog in the east.
47_W	2021-03-12 14:53	2021-03-12 14:55	0.033	3	-6	20%	none	4	230	
46	2021-03-12 14:57	2021-03-12 15:56	0.983	3	-6	20%	none	4	230	Fog in the east.
45	2021-03-12 15:58	2021-03-12 16:41	0.717	3	-10	60%	none	8	15	Fog in the east.
44	2021-03-13 07:56	2021-03-13 08:30	0.567	3	-6	10%	none	5	175	Fog in the east.
43	2021-03-13 08:42	2021-03-13 09:28	0.767	3	-7	0%	none	7	25	Fog in the east.

42	2021-03-13 10:07	2021-03-13 10:52	0.750	3	-8	20%	none	7	170	Fog in the east.
41	2021-03-13 10:54	2021-03-13 11:50	0.933	3	-7	10%	none	10	0	Fog in the east, go to fuel.
40	2021-03-13 12:29	2021-03-13 13:24	0.917	3	-7	30%	none	6	45	
39_E	2021-03-13 13:26	2021-03-13 14:19	0.883	3	-9	10%	none	6	20	Break for fuel.
39_W	2021-03-13 14:46	2021-03-13 14:49	0.050	3	-7	30%	none	4	315	
38	2021-03-13 14:51	2021-03-13 16:03	1.200	3	-7	30%	none	4	315	
37	2021-03-13 16:04	2021-03-13 17:05	1.017	3	-10	20%	none	0		
36	2021-03-14 07:49	2021-03-14 08:51	1.033	2	-3	90%	none	14	187	Sun through high clouds.
35	2021-03-14 08:53	2021-03-14 10:02	1.150	3	-6	60%	none	10	130	
34_W	2021-03-14 10:05	2021-03-14 10:29	0.400	3	-1	60%	none	4	250	Break for fuel.
34_E	2021-03-14 11:17	2021-03-14 12:19	1.033	3	-1	60%	none	4	250	
33_E	2021-03-14 12:21	2021-03-14 12:39	0.300	3	-4	40%	none	4	343	Break for fuel.
33_W	2021-03-14 13:19	2021-03-14 14:12	0.883	3		50%	none			
32	2021-03-14 14:14	2021-03-14 15:22	1.133	2	-1	90%	none	9	215	Sun through high clouds.
31_E	2021-03-14 15:24	2021-03-14 15:47	0.383	3	-6	10%	none	4	330	Break for fuel.
31_W	2021-03-14 16:13	2021-03-14 17:00	0.783	2		90%	none			
30_W	2021-03-16 13:13	2021-03-16 13:53	0.667	3	-15	20%	none	5	355	Was stop because of low clouds.
29_W	2021-03-16 13:55	2021-03-16 14:46	0.850	3	-15	50%	none	4	216	Only the western part.
28_W	2021-03-16 14:48	2021-03-16 15:34	0.767	3		20%	none			Was stop because of low clouds, then go to fuel.
27_W	2021-03-16 16:08	2021-03-16 16:49	0.683	3	-11	20%	none	12	35	Some fog, not possible to fly the east.
26_W	2021-03-17 11:34	2021-03-17 12:53	1.317	3	-5	80%	none	6	180	Was stop because of low clouds.
25_W	2021-03-17 12:54	2021-03-17 14:02	1.133	2	-9	30%	none	5	185	Some fog, not possible to fly the east.
24	2021-03-18 08:49	2021-03-18 10:09	1.333	1	-4	100%	none	10	120	Not possible to reach the east end.
25_E	2021-03-18 10:10	2021-03-18 10:15	0.083	1	-6	100%	none	7	300	Not possible to reach the east end.
26_E_1	2021-03-18 10:16	2021-03-18 10:26	0.167	1	-6	100%	Rain	7	300	Not possible to reach the east end.
27_E_1	2021-03-18 10:27	2021-03-18 10:39	0.200	1	-6	100%	Rain			

28_E	2021-03-18 10:42	2021-03-18 10:48	0.100	1		100%	none			Not possible to reach the east end.
29_E	2021-03-18 10:50	2021-03-18 11:11	0.350	1		100%	none			Not possible to reach the east end, break for fuel.
29_Mid	2021-03-18 11:42	2021-03-18 11:54	0.200	3		70%	none			Short section of #29.
30_E	2021-03-18 11:56	2021-03-18 12:21	0.417	3	-7	70%	none	8	50	Not possible to reach the east end.
28_Mid	2021-03-18 12:25	2021-03-18 12:37	0.200	2		80%	none			
27_E_2	2021-03-18 12:38	2021-03-18 12:59	0.350	2		50%	none			
26_E_2	2021-03-18 13:06	2021-03-18 13:12	0.100	3		90%	none			Short section.
23_Mid	2021-03-18 13:18	2021-03-18 13:26	0.133	2	-5	90%	none	9	37	Short section. Break for fuel.
23_W	2021-03-18 13:56	2021-03-18 14:43	0.783	3	-8	40%	none	12	30	
22_W	2021-03-18 14:45	2021-03-18 15:41	0.933	3	-4	60%	none	7	115	
21_W	2021-03-18 15:45	2021-03-18 16:36	0.850	3	-9	50%	none	8	140	
20_W	2021-03-19 09:16	2021-03-19 09:55	0.650	3	-7	40%	none	4	55	Break because of fog.
19_W	2021-03-19 09:57	2021-03-19 10:28	0.517	3	-10	50%	none	12	20	
18_W	2021-03-19 10:30	2021-03-19 10:40	0.167	3	-8	60%	none	3	130	Break to fuel.
18_Mid	2021-03-19 11:23	2021-03-19 11:54	0.517	3		40%				
19_Mid	2021-03-19 12:00	2021-03-19 12:29	0.483	1		100%	none			
20_Mid	2021-03-19 12:30	2021-03-19 12:40	0.167	2		90%	none			Not possible to reach the east end.
17_W	2021-03-19 12:53	2021-03-19 13:02	0.150	3	-10	40%	none	13	50	Not possible to reach the east end.
16_W	2021-03-19 13:03	2021-03-19 13:15	0.200	3	-9	20%	none	3	325	Not possible to reach the east end.
15_W	2021-03-19 13:19	2021-03-19 13:31	0.200	2	-10	90%	none	9	70	Not possible to reach the east end.
14_W_1	2021-03-19 14:03	2021-03-19 14:14	0.183	2	-10	40%	none	9	90	Not possible to reach the east end.
13_W	2021-03-19 14:16	2021-03-19 14:27	0.183	1		90%	none			Not possible to reach the east end.

12_W	2021-03-19 14:29	2021-03-19 14:35	0.100	2	-9	90%	none	3	95	Not possible to reach the east end.
11_W	2021-03-19 14:37	2021-03-19 14:42	0.083	2		90%	none			Not possible to reach the east end.
12	2021-03-20 08:07	2021-03-20 08:51	0.733	2	-11	90%	none	7	345	98% completed.
13_E	2021-03-20 08:52	2021-03-20 08:55	0.050	2		100%	none			90% completed.
14_E	2021-03-20 08:57	2021-03-20 09:02	0.083	2			none			Break to fuel.
13_Mid	2021-03-20 09:31	2021-03-20 10:05	0.567	2		100%	none			80% completed. Break: going to #11.
11	2021-03-20 10:11	2021-03-20 10:51	0.667	1	-11	80%	none	5	350	100% completed.
10	2021-03-20 10:53	2021-03-20 11:35	0.700	1	-11	100%	none			100% completed.
9	2021-03-20 11:37	2021-03-20 12:14	0.617	3	-11	90%	none	14	290	100% completed, then go to fuel.
8	2021-03-20 12:58	2021-03-20 13:32	0.567	2	-10	100%	none	10	25	
7	2021-03-20 13:34	2021-03-20 14:08	0.567	2	-11	60%	none	9	330	
6	2021-03-20 14:10	2021-03-20 14:59	0.817	2	-11	100%	none	6	30	
5	2021-03-20 15:01	2021-03-20 15:40	0.650	3	-10	80%	none	8	280	Then go to fuel.
14_W_2	2021-03-20 16:22	2021-03-20 16:52	0.500	3	-10	30%	none	10	50	95% completed.
25_E	2021-03-21 07:42	2021-03-21 07:48	0.100	3	-15	30%	none	6	230	
24_E	2021-03-21 07:50	2021-03-21 07:55	0.083	3	-8	30%	none	4	170	
23_E	2021-03-21 07:59	2021-03-21 08:07	0.133	3	-8	30%	none	6	220	
22_E	2021-03-21 08:09	2021-03-21 08:22	0.217	3	-9	40%	none	9	130	Then go to fuel.
21_E	2021-03-21 08:54	2021-03-21 09:15	0.350	3	-9	60%	none	6	250	
20_E	2021-03-21 09:18	2021-03-21 09:45	0.450	3	-7	50%	none	9	190	
15_E	2021-03-21 09:55	2021-03-21 10:10	0.250	3	-8	50%	none	6	135	
16_E	2021-03-21 10:12	2021-03-21 10:33	0.350	3	-8	70%	none	8	170	
17_E	2021-03-21 10:34	2021-03-21 10:56	0.367	3	-8	50%	none	15	160	Not enough fuel to do #18E and #19E.
4	2021-03-21 11:46	2021-03-21 12:23	0.617	3	-10	80%	none	2	15	
3	2021-03-21 12:25	2021-03-21 13:04	0.650	3	-9	80%	none	10	120	
2_E	2021-03-21 13:07	2021-03-21 13:36	0.483	3	-7	40%	none	3	225	Break to fuel.
2_W	2021-03-21 13:53	2021-03-21 14:15	0.367	3		20%	none			
1	2021-03-21 14:16	2021-03-21 14:49	0.550	3	-5	50%	none	11	190	Survey done!
Mean				**2.60**	**-8.9**	**58%**		**8.3**		
SE					**3.2**	**28%**				
Sum			**52.4**							

Appendix C – Classification

Sex and age classification of the caribou groups recorded on (121 groups) and off (3 groups) transects during the March 2024 aerial survey of the Torngat Mountains caribou herd. Distance (Dist.) is the perpendicular distance in metres from the flight line (OFF refers to group recorded off-transect) and Unknown (Unkn.) is to refer to caribou not classified for sex and age.

Date	Group ID	Dist. (m)	Female antlered	Female unantlered	Calves	Male antlered	Male unantlered	Unkn.	Group size
2024-03-11	1	381	1	1		1			3
2024-03-11	2	444	1			1			2
2024-03-11	3	269	2		1				3
2024-03-11	4	567	2						2
2024-03-11	5	56	3		1				4
2024-03-11	6	127	2		2	1			5
2024-03-11	7	134				2	3		5
2024-03-11	8	46	1		1	1			3
2024-03-11	9	491	3		1	1			5
2024-03-11	10	408	2			1			3
2024-03-11	11	323	2	1	2	1			6
2024-03-11	12	473	3		3	2			8
2024-03-11	13	279	1			1			2
2024-03-11	14	433	2			1			3
2024-03-11	15	594	2						2
2024-03-11	16	5				1	2		3
2024-03-11	17	474	1			2			3
2024-03-11	18	98	8		3	2			13
2024-03-11	19	15	1						1
2024-03-11	20	195	2		3	1			6
2024-03-11	21	138	5		6	1			12
2024-03-11	22	98	2		3				5
2024-03-12	23	1090				1	3		4
2024-03-12	24	45	2		1	3			6
2024-03-12	25	3	1		1				2
2024-03-12	26	108	6		5			1	12
2024-03-12	27	707	2		3	1			6
2024-03-12	28	88	4		1				5
2024-03-12	29	247	4			1			5
2024-03-12	30	49	7		5	1			13
2024-03-12	31	484	17		11	8			36
2024-03-12	32	330					2		2
2024-03-12	33	233	1		3				4
2024-03-12	34	84	5		1	2	1		9
2024-03-12	35	151	4		1				5
2024-03-12	36	252	5		3	1	3	1	13

2024-03-12	37	388					2		2
2024-03-12	38	182			2	2	3		7
2024-03-12	39	222	2		1	1			4
2024-03-12	40	196	4		1				5
2024-03-12	41	213	1				1		2
2024-03-12	42	190	3		1	1			5
2024-03-12	43	394	6			2			8
2024-03-12	44	370	7	1	1	3			12
2024-03-12	45	843	1						1
2024-03-12	46	95	7		1	1	1		10
2024-03-12	47	791	5		2	1			8
2024-03-12	48	233	8		6	2		1	17
2024-03-12	49	417					1		1
2024-03-12	50	574	3		2	5			10
2024-03-12	51	118	2		1	2			5
2024-03-12	52	848	5		3				8
2024-03-12	53	98	1		1				2
2024-03-13	54	319				1			1
2024-03-13	55	160					2		2
2024-03-13	56	191	1		1				2
2024-03-13	57	123	2				1		3
2024-03-13	58	273				1	7		8
2024-03-13	59	266	3		2				5
2024-03-13	60	636			2				2
2024-03-13	61	477	4		2				6
2024-03-13	62	446	7	1	6		1		15
2024-03-13	63	70					2		2
2024-03-13	64	548	1		2	3			6
2024-03-13	65	1490				3	8		11
2024-03-13	66	1340				1	4		5
2024-03-13	67	148	1						1
2024-03-13	68	110				1	3		4
2024-03-13	69	388	1			1			2
2024-03-13	70	277	3	1	2	1			7
2024-03-13	71	1150			1		1		2
2024-03-14	72	8			2				2
2024-03-14	73	428	3						3
2024-03-14	74	18	17	1	2	2			22
2024-03-14	75	323					2		2
2024-03-14	76	944	11		3	5	1	1	21
2024-03-14	77	997	13		8	3		1	25
2024-03-14	78	31	8		6				14
2024-03-14	79	2280	2			4	2		8
2024-03-14	80	1080					3		3
2024-03-14	81	339	16	2	7	11		2	38
2024-03-14	82	280					4		4

2024-03-14	83	540				1	13		14
2024-03-14	84	1020	2		1		1		4
2024-03-14	85	285	5		2				7
2024-03-14	86	26				1	4		5
2024-03-16	87	2220	6			5			11
2024-03-16	88	1240	14		4	4			22
2024-03-16	89	337	4		1	2			7
2024-03-16	90	214						17	17
2024-03-17	91	213					5		5
2024-03-17	92	1130	7		4	1			12
2024-03-17	93	106	8			2			10
2024-03-18	94	252					5		5
2024-03-18	95	509	13		8	3		1	25
2024-03-18	96	583	1	1	2				4
2024-03-18	97	928	5		5		2		12
2024-03-18	98	455				1	1		2
2024-03-18	99	34	13		2	4			19
2024-03-18	100	663					8		8
2024-03-18	101	940	5		4	1			10
2024-03-18	102	78					5		5
2024-03-18	103	616					4		4
2024-03-18	104	318					4		4
2024-03-18	105	822	10		2	8	2		22
2024-03-19	106	379	1				4		5
2024-03-19	107	58	4			6			10
2024-03-19	108	1230					5		5
2024-03-20	109	855	7		6	2			15
2024-03-20	110	1610	17	2	16	4	7	4	50
2024-03-20	111	961	1		1				2
2024-03-20	112	617	12		11	6	7	2	38
2024-03-20	113	311	12		7	1	1		21
2024-03-20	114	249	3	1	5	6			15
2024-03-20	115	564	21		12	3	2		38
2024-03-20	116	610	13		6	5	9		33
2024-03-21	117	1180	16		13	4	2		35
2024-03-21	118	878	7		4	2			13
2024-03-21	119	68	1						1
2024-03-21	120	496					2		2
2024-03-21	121	698	1				3		4
2024-03-19	201	OFF	3		3	1	1		8
2024-03-19	202	OFF	11		6	2			19
2024-03-21	203	OFF	2		3	2	16		23
TOTAL			477	12	257	172	176	31	1125