Understanding Drivers of Barren-ground Caribou Decline in the Northwest Territories

Collaborative Barren-ground Caribou Initiative Synthesis Report

July 2026

Comprendre les facteurs à l'origine du déclin du caribou de la toundra aux Territoires du Nord-Ouest

Rapport de synthèse de l'*Initiative conjointe sur le caribou de la toundra*

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SUMMARY

Barren-ground caribou are an iconic species in the Northwest Territories (NWT) and integral to the culture of many of the people who call the NWT home. However, many NWT barren-ground caribou herds have experienced declines over the last 20 to 30 years and in at least one herd, these declines have been both dramatic and well outside normal cyclical patterns. The causes of these declines are uncertain, but both widespread environmental and herd-specific drivers are likely contributing, with their influence on barren-ground caribou likely to continue into the future.

To better understand the drivers of these barren-ground caribou declines, in 2022, the NWT Cumulative Impact Monitoring Program (NWT CIMP) and Polar Knowledge Canada (POLAR) collaborated to offer a special one-time funding opportunity for barren-ground caribou monitoring and research called the Collaborative Barren-ground Caribou Initiative (CBGCI). The key question behind the CBGCI was 'what drives barren-ground caribou herd numbers up and down?' The funded projects focused on animals from the Porcupine, Tuktoyaktuk Peninsula, Cape Bathurst, Bluenose-West, Bluenose-East, Bathurst, Beverly, Ahiak, and Qamanirjuaq barren-ground caribou herds.

A total of seven projects were funded through the CBGCI, the results of which are summarized within this synthesis report. These projects employed methods from both traditional and scientific knowledge systems and spanned various topics, including the direct and indirect impacts of climate and weather, human development and disturbance, predation, pathogens, and pollutants and contaminants. Several projects reported herein are the result of long-term relationships developed among communities, academia, and governments and reflect community priorities and leadership autonomy. Other projects are new, bringing outside expertise to address critical questions for barren-ground caribou and develop relationships.

CBGCI project results showed that climate and weather, health, and roads have been overarching drivers of change in barren-ground caribou populations. Summer temperature, snow depth, and insect harassment emerged as particularly important drivers (Table 1), impacting survival both in the short and medium term. Other climate variables, parasites and pathogens, changes in forage quality and availability, and the cumulative impacts of roads are also having an effect, albeit with less certainty regarding their influence at the population level (Table 1).

Each of these drivers directly and indirectly affect barren-ground caribou populations and can act together to affect herds through impacts to health, fitness, movements, behaviour, and even survival. We note that many of these drivers are tied to increased stress in caribou; although stress responses to unfamiliar or potential dangerous stimuli are normal, sustained stress caused by exposure to these drivers of change can become visible in population indicators of health, including cow and calf weight loss, reduced birth rates, and increased calf mortality. The impact of increased stress should therefore not be discounted.

It is also important to note the link between several of these drivers and climate change. Climate change is already happening, with signs already clearly visible within the NWT. These changes will continue into the future. While caribou are capable of adapting to changing environmental conditions, it is unclear how the magnitude of projected change may strain their capacity for adaptation. In this context, there is real concern about whether barren-ground caribou will be able to adequately respond to threats.

Climate change mitigation is difficult to pursue at a local level; it requires effective national and global action. As such, management actions should prioritize removing or substantially reducing all non-climate threats to barren-ground caribou, while also pursuing conservation actions that provide caribou with a

greater chance of successfully adapting to climate change (e.g., maintaining or restoring habitat connectivity). Considering the results of the CBGCI funded studies presented here, the CBGCI project leads therefore strongly urge decision makers to, first and foremost, address the multiple threats posed by roads, focusing on the Tibbitt-to-Contwoyto winter road, Misery access road, and proposed Arctic Economic and Security Corridor. This includes employing the least impactful routing option with road construction standards that reduce movement barriers, protecting key insect relief habitats (e.g., Contwoyto Lake), implementing seasonal road closures for migratory caribou movements, establishing no-shooting corridors on either side of these roads to reduce harvester access, mandating the collection and reporting of traffic data, and continuing and enhancing support for guardian and enforcement presence along these roads.

Additionally, the CBGCI results highlight the importance of long-term monitoring and surveillance of wildlife populations, with the full integration of experts across knowledge systems, including western science, traditional knowledge, and community-based monitoring. Enhanced interagency communication, respectful harvesting practices and harvester education programs, mandatory harvest reporting, meat sale prohibitions, improved data access across agencies, and continued research efforts should also be encouraged.

While conservation efforts to date have been significant and valuable, it is also clear that further action is required to provide barren-ground caribou with the best chances of recovery in the NWT.

Table 1. Summary of key CBGCI project results across drivers of barren-ground caribou population change.

Specific drivers	Results	Hypothesized mechanism
Weather and climate (including temperature, precipitation, habitat, and interactions with other species influenced by weather and climate)		
Winter temperature	• Survival is lower in extremely cold winters	• Affects health and fitness (thermal stress)
Winter snow	• Survival is greatest at snow depths of 40-55 cm	• Affects access to forage and predator avoidance
Spring snow	• Survival decreases with high volumes of spring snow	• Affects movements and forage access
Summer temperature	• Survival is greatest between 11-14°C	• Affects health and fitness (thermal stress), insect harassment levels, and parasites and pathogens
June greenness index (spring green-up)	• Survival is greatest at moderate levels of greenness	• Affects availability of forage
Flying insect harassment	• Survival is greatest when flying insect harassment is moderate (i.e., manageable), which is associated with cooler and windier summers	• Affects health and body condition (e.g., stress, energy reserves, reduced foraging, less nursing by calves) and likelihood of pathogen transmission (i.e., if insect vector activity increases)
Insect relief habitat	• Declining availability (e.g., relict summer snow patches)	• Affects health and fitness (ability to avoid insect harassment)
Tundra shrub growth (shrubification)	• 44% increase in extent of shrubland projected over next 40 years, primarily affecting Bathurst herd range	• Affects migratory movements and availability of lichen forage
Wildfire	• Projected increases in wildfire that will reduce available habitat, particularly in southern Bluenose-West and Bluenose-East range (35% and 25% declines in	• Affects movements, habitat availability, and forage availability

	forest over 50 years old in next 40 years, respectively)	
Health		
Parasites and pathogens	• Higher infection rates are expected/occurring for some kinds of pathogens with warming temperatures • Range expansion of other parasites and pathogens expected as climate shifts	• Affects range of health metrics, including body condition, birth rate, and survival
Contaminants	• No contaminants from fire suppressants and retardants recorded in either caribou or lichen forage • New rubber-derived additive recorded in both caribou and lichen forage	• Sublethal contaminant exposure may affect a range of health metrics
Genetic diversity	• Relatively healthy genetic diversity, with notable exception of Bluenose-East herd, which may be below the minimum threshold for maintaining long-term diversity • Beverly herd is also considered vulnerable if it was to experience sustained decline or increased inbreeding	• Affects adaptability, and capacity to rebound from declines
Roads		
Development footprint	• Developments (current and proposed) constitute only a small portion of total caribou range in the NWT, but secondary impacts can be important (e.g., increased energy use, increased harvester and predator access, barriers to movement)	• Affects energy use (avoidance behaviour, stress), movements, habitat accessibility and availability, and, indirectly, survival
Harvesting	• New harvest estimates for Tibbitt-to-Contwoyto winter road and Gahcho Kue spur road are a minimum of 2,814 and may be closer to 5,000 • Meat wastage occurred at about 10% of gut piles[1] • If harvest was from the Beverly herd, this represents a harvest of 1.85-3.29% of the total herd	• Affects survival
Predation	• Harvesting near the road attracts wolves to the area (scavenging, taking advantage of caribou congregated near roads)	• Affects survival
Barriers to movement	• Tibbitt-to-Contwoyto winter road and Misery access road almost completely impermeable to caribou when operational	• Affects energy use (avoidance behaviour, stress), movements, behaviour, and, indirectly, survival

[1] We note that this wastage figure is representative of the actions of only a small fraction of harvesters. The large majority of harvesters are experienced and respectful.

SOMMAIRE

Le caribou de la toundra est une espèce emblématique des Territoires du Nord-Ouest (TNO) et fait partie intégrante de la culture de maints habitants et habitantes de ce territoire. Cependant, la population de nombreuses hardes de caribous des TNO diminue depuis les 20 à 30 dernières années et, pour au moins l'une de ces hardes, ce déclin est à la fois frappant et bien en dehors des schémas cycliques habituels. Les causes de ces déclins restent incertaines, mais les facteurs environnementaux généraux et certains éléments propres à chaque harde en sont probablement en partie responsables et risquent de continuer d'avoir une influence sur cette espèce.

Afin de mieux comprendre les facteurs à l'origine du déclin des populations de caribous de la toundra, le Programme de surveillance des effets cumulatifs des TNO (PSECTNO) et Savoir polaire Canada (POLAIRE) ont collaboré en 2022 pour proposer une occasion spéciale de financement ponctuel destinée à la surveillance du caribou de la toundra et à la recherche sur l'espèce : l'*Initiative conjointe sur le caribou de la toundra* (ICCT). La question centrale à l'origine du lancement de cette initiative était : « Quels facteurs contribuent aux fluctuations des effectifs des hardes de caribous de la toundra? » Les projets financés portaient sur la population des hardes de caribous de la toundra de Porcupine, de la péninsule de Tuktoyaktuk, de Cap Bathurst, de Bluenose-Ouest, de Bluenose-Est, de Bathurst, de Beverly et de Qamanirjuaq.

Au total, sept projets ont été financés dans le cadre de l'ICCT, dont les résultats sont résumés dans le présent rapport de synthèse. Ces projets ont fait appel à des méthodes issues à la fois des systèmes de connaissances traditionnels et scientifiques, et ont porté sur divers thèmes, notamment les répercussions directes et indirectes du climat et des conditions météorologiques, du développement humain et des perturbations anthropiques, des prédateurs, des agents pathogènes, ainsi que des polluants et des contaminants. Plusieurs projets présentés dans ce rapport sont le fruit de relations de longue date établies entre les collectivités locales, le monde universitaire et les pouvoirs publics, et reflètent les priorités des collectivités ainsi que leur autonomie pour la conduite des activités. D'autres projets, quant à eux, sont récents et visent à faire appel à une expertise extérieure pour aborder des questions cruciales concernant le caribou de la toundra et nouer des relations.

Les résultats de l'ICCT montrent que le climat, les conditions météorologiques, la santé et les routes sont les principaux facteurs de changement au sein des populations de caribous de la toundra. La température estivale, l'épaisseur de la neige et le harcèlement des insectes se révèlent être des facteurs particulièrement importants (tableau 1), influençant la survie tant à court terme qu'à moyen terme. D'autres variables climatiques, les parasites et les agents pathogènes, les changements dans la qualité et la disponibilité du fourrage, ainsi que les effets cumulés des routes ont également une incidence, même si leur influence au niveau de la population est moins certaine (tableau 1).

Chacun de ces facteurs a une incidence directe ou indirecte sur les populations de caribous de la toundra et peut, combiné à d'autres, affecter les hardes en ayant des répercussions sur leur santé, leur condition physique, leurs déplacements, leur comportement, voire leur survie. Nous constatons que bon nombre de ces facteurs sont liés à une augmentation du stress chez les caribous. Bien que les réactions de stress face à des stimuli inconnus ou potentiellement dangereux soient normales, un stress prolongé causé par l'exposition à ces facteurs de changement peut se refléter dans les indicateurs de santé de la population, notamment une perte de poids chez les femelles et leurs petits, une baisse des taux de natalité et une augmentation de la mortalité des petits. Il ne faut donc pas négliger l'incidence d'un stress accru.

Il est également important de souligner le lien qui existe entre plusieurs de ces facteurs et le changement climatique. Le changement climatique est déjà une réalité, et ses signes sont déjà bien visibles aux TNO. Ces transformations vont se poursuivre. Si les caribous sont capables de s'adapter à l'évolution des conditions environnementales, on ignore dans quelle mesure l'ampleur des changements prévus pourrait mettre à rude épreuve leur capacité d'adaptation. Dans ce contexte, on peut légitimement se demander si le caribou de la toundra sera vraiment capable de faire face aux menaces qui pèsent sur son espèce.

Il est difficile de lutter contre le changement climatique au niveau local : il faut prendre des mesures efficaces à l'échelle nationale et mondiale. À ce titre, les mesures de gestion devraient viser en priorité à éliminer ou à réduire considérablement toutes les menaces non climatiques pesant sur le caribou de la toundra, tout en menant des initiatives de conservation qui offrent à cette espèce de meilleures chances de réussir à s'adapter au changement climatique (p. ex. en préservant ou en rétablissant la connectivité écologique). Au vu des résultats des études financées par l'ICCT présentés ici, les responsables de l'initiative exhortent donc vivement les décideurs à s'attaquer en priorité aux multiples menaces que représentent les routes, en mettant l'accent sur la route d'hiver reliant Tibbitt à Contwoyto, sur la route d'accès à Misery et sur le projet de corridor économique et de sécurité de l'Arctique. Cela implique notamment de choisir le tracé ayant le moins de répercussions, en respectant des normes de construction routière qui réduisent les obstacles aux déplacements des animaux, de protéger les habitats clés servant de refuge aux insectes (p. ex. le lac Contwoyto), de mettre en place des fermetures saisonnières des routes pour faciliter les déplacements migratoires des caribous, d'établir des couloirs d'interdiction de chasse de part et d'autre de ces routes afin de limiter l'accès des chasseurs, d'imposer la collecte et la communication des données sur la circulation, ainsi que de maintenir et de renforcer le soutien apporté aux agents de sécurité et aux forces de l'ordre le long de ces routes.

Les résultats de l'Initiative soulignent aussi l'importance d'un suivi et d'une surveillance à long terme des populations d'animaux sauvages, en impliquant pleinement des experts de tous les systèmes de connaissances, notamment la science occidentale, les connaissances traditionnelles et le suivi communautaire. Il convient également d'encourager une meilleure communication entre les différents organismes, des pratiques de chasse respectueuses et des programmes de formation destinés aux chasseurs, l'obligation de déclarer les prises, l'interdiction de vendre la viande, un meilleur partage des données entre organismes, ainsi que la poursuite des travaux de recherche.

Même si les efforts de conservation déployés jusqu'à présent ont été importants et utiles, il est également évident que des mesures supplémentaires s'imposent pour optimiser les chances de rétablissement du caribou de la toundra aux TNO.

Tableau 1. Synthèse des principaux résultats de l'ICCT sur les facteurs influant sur l'évolution des populations de caribous de la toundra.

Facteurs spécifiques	Résultats	Mécanisme hypothétique
Météo et climat (notamment la température, les précipitations, l'habitat et les interactions avec d'autres espèces, influencées par les conditions météorologiques et le climat)		
Température hivernale	• Taux de survie plus faible lors des hivers extrêmement rigoureux	• Répercussions sur la santé et la condition physique (stress thermique)
Neige hivernale	• Taux de survie le plus élevé lorsque l'épaisseur de neige est comprise entre 40 et 55 cm	• Répercussions sur l'accès au fourrage et la capacité à échapper aux prédateurs

Neige printanière	• Baisse du taux de survie lorsque les volumes de neige printanière sont importants	• Répercussions sur les déplacements et l'accès au fourrage
Température estivale	• Taux de survie le plus élevé entre 11 et 14 °C	• Impact sur la santé et la condition physique (stress thermique), sur l'intensité du harcèlement des insectes, ainsi que sur les parasites et les agents pathogènes
Indice de verdure en juin (reverdissement printanier)	• Taux de survie le plus élevé lorsque le niveau de verdure est modéré	• Incidence sur la disponibilité du fourrage
Nuisances causées par les insectes volants	• Taux de survie le plus élevé lorsque le harcèlement des insectes volants est modéré (c'est-à-dire maîtrisable), ce qui correspond à des étés plus frais et plus venteux	• Répercussions sur la santé et l'état physique (p. ex. le stress, les réserves d'énergie, une diminution de la recherche de nourriture, une réduction de l'allaitement des faons) ainsi que sur le risque de transmission d'agents pathogènes (lorsque l'activité des insectes vecteurs augmente)
Habitat de refuge contre les insectes	• Diminution de la disponibilité des habitats de refuge (p. ex. restes de plaques de neige l'été)	• Incidence sur la santé et la forme physique (capacité à échapper au harcèlement des insectes)
Croissance des arbustes dans la toundra (arbustation)	• Prévision d'une augmentation de 44 % de la superficie des zones arbustives au cours des 40 prochaines années, ce qui affectera principalement le territoire de la harde de Bathurst	• Influence les mouvements migratoires et la disponibilité du lichen comme source de nourriture
Feux de forêt	• Prévision de l'augmentation des feux de forêt, ce qui entraînera une réduction de l'habitat disponible, en particulier dans le sud des aires de répartition de Bluenose-Ouest et de Bluenose-Est (baisse de 35 % et 25 % respectivement des forêts âgées de plus de 50 ans au cours des 40 prochaines années)	• Incidence sur les déplacements, la disponibilité des habitats et la disponibilité de la nourriture
	Santé	
Parasites et agents pathogènes	• Augmentation à venir/actuelle des taux d'infection liée à certains types d'agents pathogènes à mesure que les températures montent • Prévision de l'élargissement de l'aire de répartition d'autres parasites et agents pathogènes à mesure que le climat évolue	• Répercussions sur divers indicateurs de santé, notamment l'état physique, le taux de natalité et la survie
Contaminants	• Aucun contaminant provenant d'agents extincteurs ou de retardateurs de feu n'a été détecté, que ce soit chez les caribous ou dans les lichens dont ils se nourrissent • Détection d'un nouvel additif dérivé du caoutchouc à la fois chez le caribou et dans le lichen lui servant de nourriture	• Possibles répercussions de l'exposition à des contaminants à des doses sublétales sur divers indicateurs de santé

Diversité génétique	• Diversité génétique relativement bonne, à l'exception notable de la harde de Bluenose-Est, qui pourrait se situer en dessous du seuil minimal nécessaire au maintien de la diversité à long terme • La harde de Beverly est également considérée comme vulnérable si elle venait à subir un déclin prolongé ou une consanguinité accrue	• Répercussions sur la capacité d'adaptation et la capacité à rebondir après des baisses
Routes		
Empreinte du développement	• Les projets (en cours et proposés) ne concernent qu'une petite partie de l'aire de répartition totale du caribou aux TNO, mais leurs répercussions indirectes peuvent être importantes (p. ex. augmentation de la consommation d'énergie, accès accru des chasseurs et des prédateurs, obstacles aux déplacements)	• Répercussions sur la consommation d'énergie (comportements d'évitement, stress), les déplacements, l'accessibilité et la disponibilité des habitats, ainsi que, de manière indirecte, sur la survie
Récolte	• Nouvelles estimations des caribous abattus pour la route d'hiver reliant Tibbitt à Contwoyto, et la voie d'accès Gahcho Kue : au moins 2 814 et possiblement plus près de 5 000 • Gaspillage de viande dans environ 10 % des tas d'entrailles[2] • Si les prises viennent de la harde de Beverly, cela représente entre 1,85 % et 3,29 % de l'effectif total du troupeau	• Incidence sur la survie
Prédation	• La chasse près des routes attire les loups dans la région (ils se nourrissent de charognes et profitent de la présence de caribous rassemblés près des routes)	• Incidence sur la survie
Obstacles aux déplacements	• La route d'hiver reliant Tibbitt à Contwoyto et la route d'accès à Misery sont pratiquement impraticables pour les caribous lorsqu'elles sont ouvertes à la circulation	• Incidence sur la consommation d'énergie (comportements d'évitement, stress), les déplacements, le comportement et, indirectement, la survie

[2] Nous précisons que ce pourcentage de gaspillage reflète les pratiques de seulement une petite fraction des chasseurs. La grande majorité des chasseurs sont expérimentés et respectueux.

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PART 1: Where we started

Barren-ground caribou are integral to many of the people who call the Northwest Territories (NWT) home. They are both an ecological and cultural keystone species, acting as the primary grazer in their range, supporting predator populations, moving nutrients across northern ecosystems, enhancing forage access for smaller mammals (e.g., ptarmigan), providing a reliable and valued food source for people across the territory, and providing a foundation for cultural identity and spirituality in NWT communities. Their role in the environment, culture, and economy of the territory cannot be overstated.

Although both traditional and scientific knowledge systems have documented barren-ground caribou populations alternating between high and low numbers in 40-70-year cycles (Beaulieu 2012, Ferguson et al. 1998, Gunn 2003), in at least a few NWT herds, recent declines have been dramatic. For example, the most recent survey results show an almost 50% decline in the Bathurst herd over a three-year period from 2022 to 2025 (Government of the Northwest Territories 2025). This is in addition to the existing 96% decline reported for this herd as of 2018 (Species at Risk Committee 2017). The causes of these declines are uncertain, but both widespread environmental and herd-specific drivers are likely, as evidenced by synchronized declines across herds in western and central Canada after the mid- to late 1990s and then divergence in herd trends after those initial declines. Movements of individuals between herds (i.e., immigration and emigration) may also be contributing. Some herds have continued to decline (Bathurst, Qamanirjuaq, Ahiak, Porcupine), others have stabilized at lower numbers (Bluenose-West), and others are beginning to show signs of recovery (Tuktoyaktuk Peninsula, Cape Bathurst, Bluenose-East, and Beverly) (Figure 1; Environment and Climate Change unpubl. data 2025, Advisory Committee for Cooperation on Wildlife Management 2026, Government of the Northwest Territories 2025, Campbell et al. 2024, 2025).

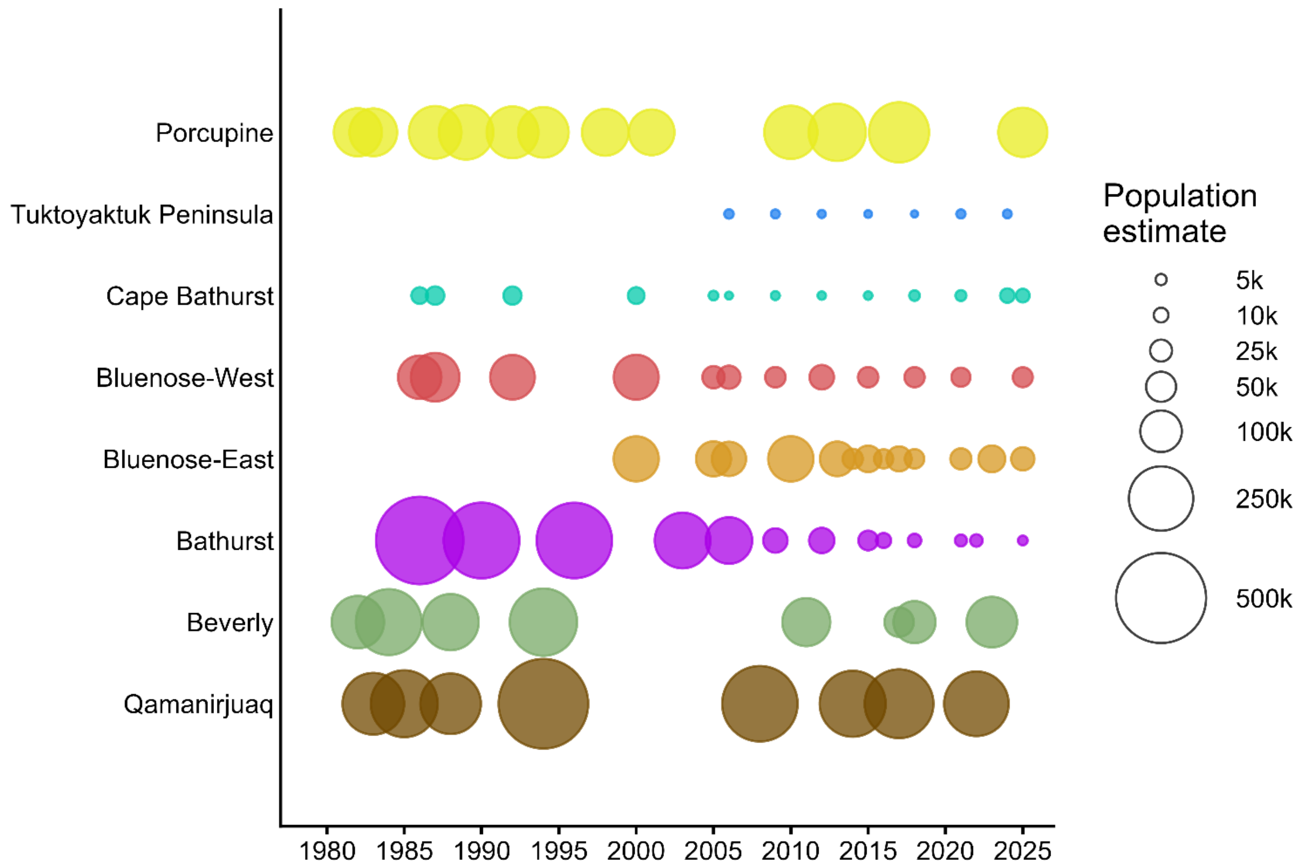


Figure 1. Population estimates of barren-ground caribou herds from 1980-2025. Note that barren-ground caribou repopulated the Tuktoyaktuk Peninsula after reindeer herding stopped in the area, with the first abundance survey in 2005. Prior to 2000, the Cape Bathurst, Bluenose-West and Bluenose-East were surveyed as one "Bluenose Herd". Radio collar data showed that there were three separate herds in the Bluenose range, and estimates for the herds were reconstructed from survey data.

In this context, most of the barren-ground caribou herds in the NWT have been designated as species at risk under the *Species at Risk (NWT) Act*. The Tuktoyaktuk Peninsula, Cape Bathurst, Bathurst, Bluenose-West, Bluenose-East, Beverly, Ahiak, and Qamanirjuaq herds were assessed together in 2017 (Species at Risk Committee 2017) and were legally listed as Threatened in 2018 (NWT Species at Risk 2026). This decision reflected cumulative and interacting threats to barren-ground caribou that were considered unprecedented. The Porcupine caribou herd, although intentionally not considered under the NWT species at risk process, also recorded a significant population decline between 2017 and 2025 (Porcupine Caribou Technical Committee 2026). Dolphin and Union caribou, considered an intergrade between barren-ground caribou and Peary caribou, were assessed as Threatened in 2013, re-assessed as Endangered in 2023 (Species at Risk Committee 2023), and have been listed as Endangered since 2024 (NWT Species at Risk 2026) (Figure 1 and 2).

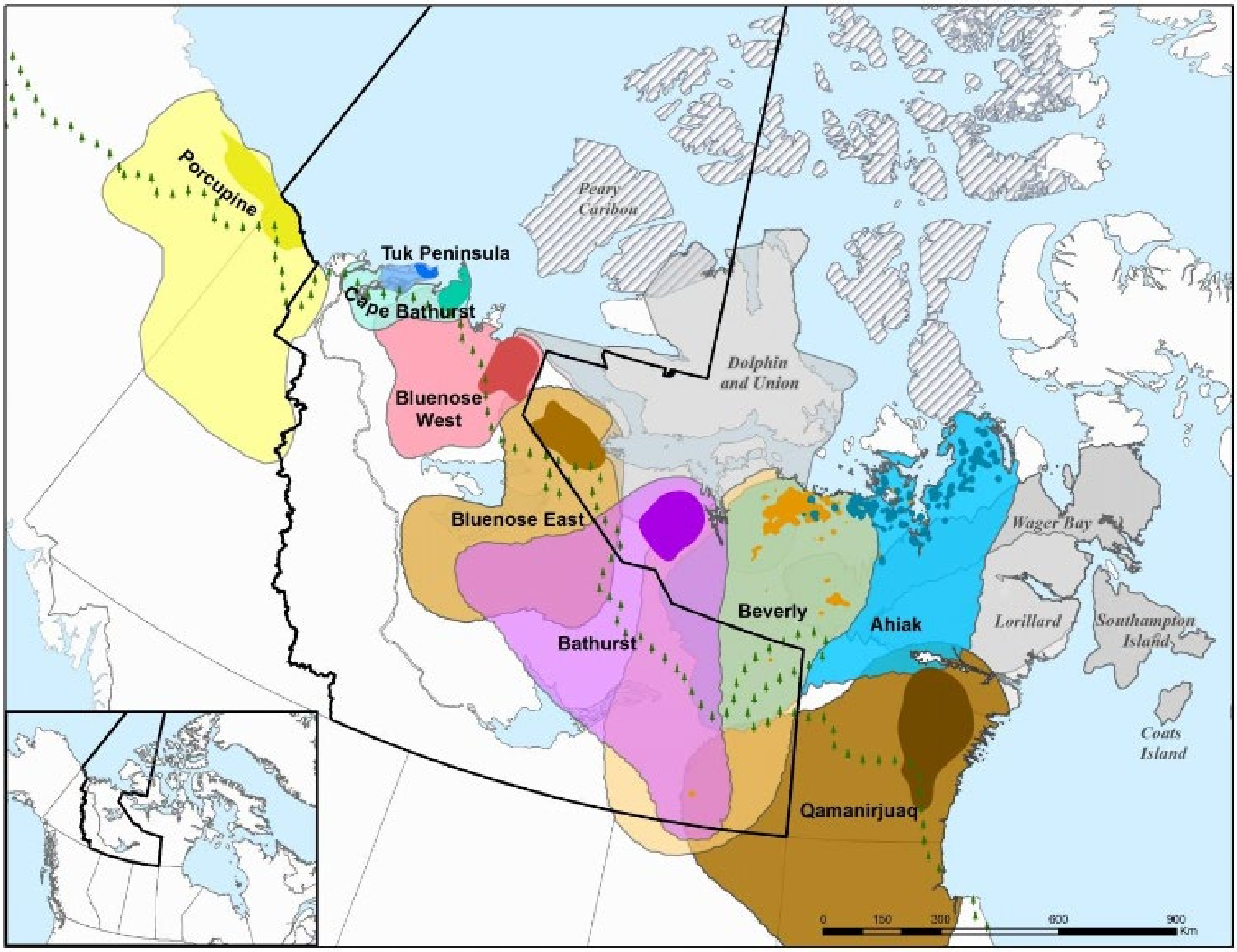


Figure 2. Distribution of barren-ground caribou range (pale colours) and calving grounds (dark colours) in the NWT (black border) from 1996-2009. Treeline displayed in green tree symbols (reproduced from Species at Risk Committee 2017). Nunavut barren-ground caribou herds (Wager Bay, Lorillard, Southampton Island, Coats Island), Peary caribou, and Dolphin and Union caribou are displayed in grey scale for completeness.

Management actions are guided by a recovery strategy (Conference of Management Authorities 2020) and herd-specific management plans such as the Beverly and Qamanirjuaq Caribou Management Plan 2023-2032 (Beverly and Qamanirjuaq Caribou Management Board 2023), Yúnethé Xá ʔetthën Hádı (Łutsël K'é Dene First Nation's Caribou Stewardship Plan) (Łutsël K'é Dene First Nation 2020), Bathurst Caribou Management Plan (Bathurst Caribou Advisory Committee 2021), Bathurst Caribou Range Plan (Government of the Northwest Territories 2019), Taking Care of Caribou (Advisory Committee for Cooperation on Wildlife Management 2021), Belarewı́le Gots'ę́ ʔekwę́ (Caribou for All Time): a Délı̨nę Got'ı̨ne Plan of Action (Neyelle et al. 2016), and Dehlá Got'ı ̨ne ʔədə Plan (Colville Lake Caribou Stewardship Plan) (Colville Lake Renewable Resources Council 2019). Many of these documents were developed collaboratively among agencies that share responsibility for caribou management in the NWT, including Indigenous governments and Indigenous organizations, renewable resources boards, and the Government of the Northwest Territories.

In 2022, the NWT Cumulative Impact Monitoring Program (NWT CIMP) and Polar Knowledge Canada (POLAR) entered into a collaboration to offer a special one-time funding opportunity for barren-ground caribou monitoring and research through the Collaborative Barren-ground Caribou Initiative (CBGCI), the results of which are presented in this synthesis report.

NWT Cumulative Impact Monitoring Program (NWT CIMP) and Polar Knowledge Canada (POLAR)

Since 1999, NWT CIMP has coordinated, conducted, and funded the collection, analysis, and reporting of information related to cumulative effects on the environment in the NWT. Its main purpose is to better support resource management decision-making and the wise use of resources by furthering understanding of cumulative impacts and environmental trends. NWT CIMP supports monitoring and research projects throughout the NWT that address key cumulative impact monitoring priorities of land, water, and wildlife decision-makers, including co-management boards, federal, territorial, and Indigenous governments, and Indigenous organizations.

POLAR is a federal organization responsible for advancing Canada's knowledge of the Arctic and strengthening Canadian leadership in polar science, research, and technology. Based at the Canadian High Arctic Research Station (CHARS) in Cambridge Bay, Nunavut, POLAR seeks to build a knowledge base of the polar environments by mobilizing current knowledge produced by others and research co-developed with northern communities, in a meaningful and accessible way, to address the gaps and concerns of these communities.

The key question behind the CBGCI was 'what drives barren-ground caribou herd numbers up and down?' This question is tied to many of the knowledge gaps and uncertainties articulated in the Recovery Strategy for Barren-ground Caribou in the NWT (Conference of Management Authorities 2020) and elsewhere, including questions about the impacts of climate change, disease, natural disturbances, and human-caused disturbances; predator-prey dynamics; the extent of harvest and wastage; habitat use; and the capacity of barren-ground caribou to adapt to rapid change in their environment. Trends and patterns in the NWT's barren-ground caribou vary across herds, so it is likely that the relative importance of these impacts are at least somewhat range-specific. Thus, addressing drivers of declines must also separate effects across herds. Answering this large question demands insight from all sources of knowledge, including traditional knowledge, western science, and community-based monitoring.

The results presented in the pages that follow synthesize information across knowledge systems, disciplines, and research questions, within the scope of the CBGCI collaboration. Over the three-year funding agreement, the leads of the funded research projects met to provide input to this synthesis report and share project updates with the goal of advancing understanding of the drivers of population changes in NWT barren-ground caribou. The enhanced funding provided through this joint NWT CIMP-POLAR initiative allowed project teams to work together to share results and succinctly summarize their collective results in this report, including at two meetings in December 2025 and January 2026 that were set aside to allow teams to begin building the framework for this synthesis report (Figure 3). This reflects requests from decision-makers in the NWT, who asked that increased effort be put into presenting results from multiple research and monitoring efforts together, to better show linkages and findings.

This synthesis report is intended for decision-makers across co-management, advisory, and regulatory agencies working in the NWT and represents a unique opportunity to bring together and hear the voices of community, government, and academic researchers engaged in barren-ground caribou monitoring and research in the territory.

Figure 3. CBGCI team and research leads in Calgary, Alberta, January 2026. Back row, left to right: Amish Dua, Caylee Falvo, Eliezer Gurarie, Petter Jacobsen, Thom Stubbs, Frank van der Meer, Chloe Beaupré, Amelia Cox, Stephanie Behrens, Lorraine Brekke, Megan Perra, Orna Phelan, Benjamin Padilla, Wayne Mercredi. Front row, left to right: Susan Kutz, Mary Gamberg, Shirley Coumont, Allicia Kelly, Andrew Leung, Claire Singer. Photo by Roxane Poulin (facilitator).

PART 2: What we did

A total of seven projects were funded through the CBGCI initiative. These projects employed methods from both traditional and scientific knowledge systems, and spanned topics that addressed several drivers of barren-ground caribou populations, including direct and indirect impacts of climate and weather, human development and disturbance, predation, pathogens, nutrition, and pollution and contaminants. Projects focused on different barren-ground caribou herds in the NWT, with some projects capturing many herds and others focusing their efforts on just two or three herds (Figure 4). The time period during which data were collected reflected the goals of the project but variably included data from all seasons of the caribou life cycle (i.e., spring, summer, fall, and winter, including calving). Summaries of each project follow below.

As the impetus for this research was largely focused on attempting to understand the causes of recent herd declines, most of the studies focused on the collection of data post-decline, particularly within the last 5-10 years, although several projects were strongly informed by local traditional knowledge and others by data collected in earlier years from various herds. Understanding the causes of a population decline demands understanding of the conditions that led to the initial decline. This therefore limits the degree to which the studies described within this synthesis report are able to speak to the drivers of the initial declines in caribou herds. Those projects employing traditional knowledge and longer-term datasets are likely better placed in this respect, although those projects relying on shorter term datasets still provide valuable information about current stressors of caribou populations, which may be limiting their capacity for recovery. The need to understand pre-decline conditions underscores the importance of long-term, ongoing monitoring of wildlife populations in general, as well as the full consideration of traditional knowledge systems, which can offer understanding at large spatial scales and over long time periods.

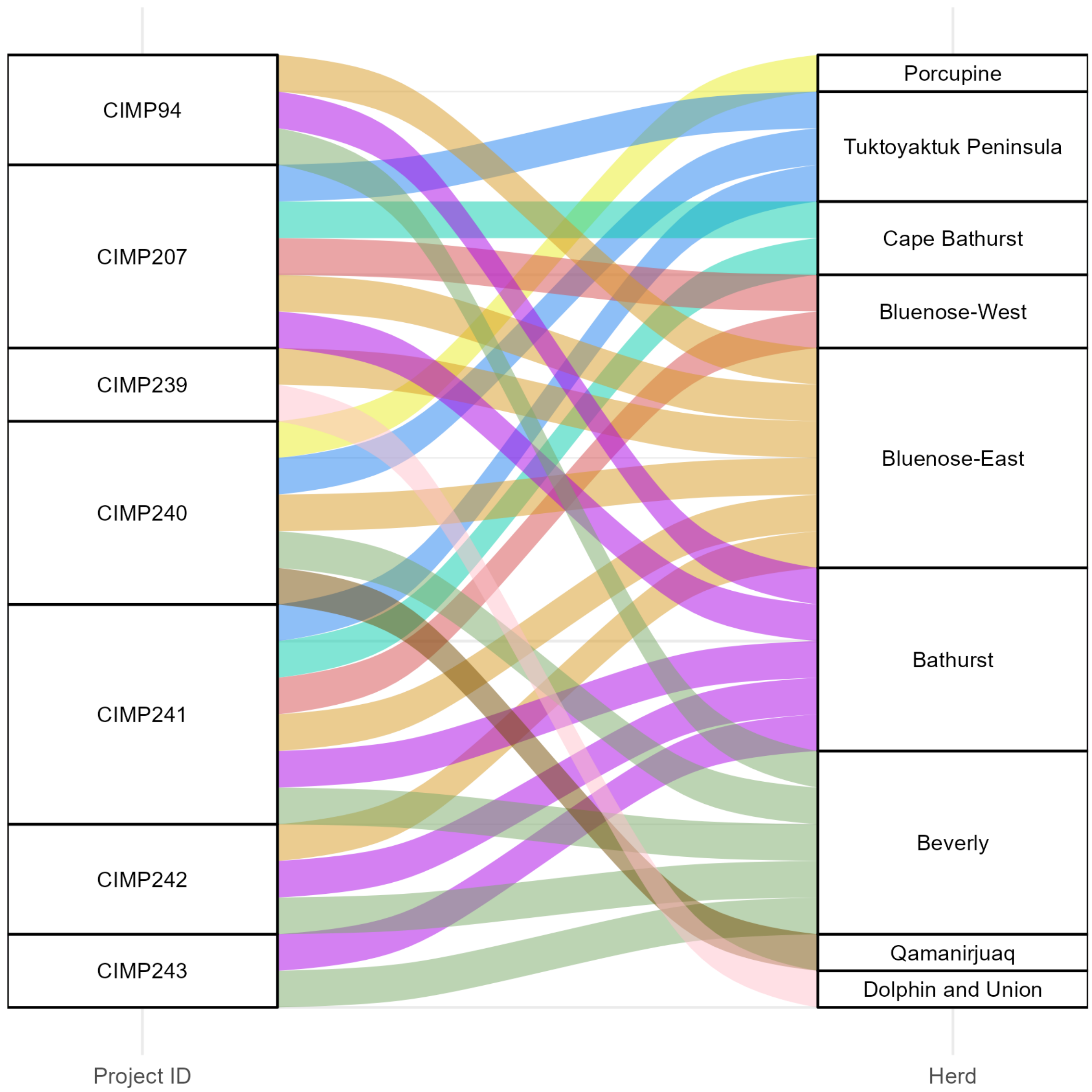


Figure 4. Connections of each CBGCI project to barren-ground caribou herds in the NWT. Figure provided by NWT CIMP. Descriptions of each NWT CIMP project follow below.

CIMP94 - Ekwǫ̀ Nàxoèhdee K'e – Watching Caribou with our 'Boots on the Ground' – Tłįchǫ Government

"Our relationship with ekwǫ̀ [caribou] defines who we are. It's a foundation for our nàowo – a Tłįchǫ concept that encompasses our language, culture, way of life, as well as our knowledge and laws. So, it wasn't surprising that people would get emotionally involved when they learned of declining ekwǫ̀ populations and wanted to know what was happening. When there was talk of reduced harvest, it became a very difficult issue" (Zoe 2012).

Given the importance of ekwǫ̀ (caribou) to Tłįchǫ and in the context of declining herds and co-management actions to restrict harvesting and reduce wolves on caribou winter range (Wek'èezhìı Renewable Resources Board 2016a, b, c, d, 2019a and b, 2021, and 2025), the Tłįchǫ Government began a monitoring program to understand the current situation of the Kokètì ekwǫ̀ (Bathurst ekwǫ̀ herd), Sahtì ekwǫ̀ (Bluenose-East ekwǫ̀ herd), and Beverly caribou herd by applying traditional methods and knowledge to inform co-management decisions. Since 2016, Ekwǫ̀ Nàxoèhdee K'è (Boots on the Ground) has actively monitored ekwǫ̀ through the traditional methods of Tłı̨chǫ Elders and harvesters. The program immerses Elders and harvesters in monitoring efforts, applying their knowledge and methods to observe ekwǫ̀ and their habitat. This project tracks environmental indicators and is reconnecting Tłı̨chǫ monitors with ekwǫ̀ at their ancestral harvesting locations, which strengthens relationships with the land and animals (Tłı̨chǫ Government 2017[3]).

Using a holistic methodology, field teams monitor ekwǫ̀ from July to October each year on their summer and fall range. Teams set up camps on Kǫ̀kètì (Contwoyto Lake), Deèzàatì (Point Lake), and, more recently, Ek'atì (Lac de Gras), and monitors travel by boat and foot daily to find caribou. They record observations about indicators, such as habitat conditions, ekwǫ̀ health, calf abundance, predator observations, and behaviour and movement changes due to industrial development. From February to April, monitors also track ekwǫ̀ by travelling along the Tibbitt-to-Contwoyto winter road by truck and snowmachine. These efforts improve hunter awareness and compliance with the Mobile Core Bathurst Caribou Management Zone and help assess the annual harvest levels of the Beverly ekwǫ̀ herd, which the Tłı̨chǫ depend on to practice our culture, language, and way of life.

Traditional knowledge has guided every phase of this project. A group of Tłı̨chǫ Elders and harvesters planned and designed the program, and the team based the program methodology on "We Watch Everything", a framework that Tłı̨chǫ Elder Michel Louis Rabesca created during the first years of monitoring ekwǫ. Their knowledge guides better understanding of the cumulative impacts on the Kǫ̀kètì ekwǫ̀, Sahtì ekwǫ̀, and Beverly ekwǫ̀ herds.

CIMP207 - Decision-support Tools for Understanding Cumulative Impacts on Barren-ground Caribou – Government of the Northwest Territories, Integral Ecology Group, Headwater Strategy Group, EcoBorealis Consulting Inc., TK and Ecological Consulting, Alberta Biodiversity Monitoring Institute

With support from the Wek'èezhìı, Gwich'in, and Sahtú renewable resources boards and the Wildlife Management Advisory Council (NWT), researchers developed decision-support tools that simulated and assessed the cumulative effects for scenarios of environmental and human-driven changes on Cape Bathurst, Tuktoyaktuk Peninsula, Bluenose-West, Bluenose-East, and Bathurst barren-ground caribou herds. The aim was to help decision-makers understand how climate change and related landscape changes (e.g., ecoregion shifts and wildfire), human land uses (e.g., all-season roads and mineral exploration), and management practices (e.g., harvest levels) may affect caribou habitat and population dynamics.

Researchers produced three decision-support tools:

1. A landscape change simulation model that forecasts changes associated with climate projections and human land uses and maps the response of seasonal barren-ground caribou habitat to these forces.
2. A seasonal population dynamics model that simulates the response of caribou populations to changes in climate, land use, and harvest. The population dynamics model is linked to the landscape change model and incorporates impact pathways related to habitat use and vital rates (recruitment and survival).
3. Traditional knowledge summaries compiling publicly available Indigenous perspectives and observations on the trends and factors affecting caribou health, habitat, and populations.

[3] https://research.tlicho.ca/research/bootsontheground

The first two tools were combined into an integrated landscape and population model that is web-based and user-friendly to support use by decision makers in the NWT (CBGC ALCES n.d.[4]). Researchers used both traditional knowledge and western science to gain a better understanding of caribou in the North. They reviewed written sources of traditional knowledge that shared observations and perspectives on caribou habitat, health, and population changes. The renewable resources boards and the Bathurst Caribou Advisory Committee reviewed the summaries to confirm the information was accurate and respectful, and granted permission to share the summaries on the Advisory Committee for Cooperation on Wildlife Management website (Advisory Committee for Cooperation on Wildlife Management n.d.[5])

CIMP239 - Community-defined and Monitored Indicators of Recovery in Barren-ground Caribou - Susan Kutz, Amish Dua, Olivia Hee, and Fabien Mavrot (University of Calgary)

Researchers, harvesters, and Elders brought together traditional knowledge (encompassing both the traditional knowledge of the NWT and Inuit Qaujimajatuqangit of Nunavut), community-based caribou health surveillance, and western science to better understand what makes a caribou herd healthy, threats to health, and how to use harvester and community-derived data to anticipate and track population changes over time. Through this work, researchers explored how community knowledge and patterns of caribou use could be built into monitoring programs, how environmental factors like weather, fire, and food quality affected caribou health, and how community-based surveillance could be used to detect and anticipate changes in herd health and population trajectory.

Traditional knowledge provides insight into historic trends in caribou health, population, and behaviour over time and can also help identify threats to caribou and indicators of change that can be monitored by communities. Community-based sampling, harvester assessment of caribou health, and scientific analyses of collected samples and data track a variety of health indicators including pathogens, body condition, stress, pregnancy, trace elements, and reproductive status, with samples archived for future analyses (e.g., genomics, microbiome). By working together with multiple communities that interact with caribou at different times of the year, the project captures different parts of the caribou annual and seasonal life cycle.

Researchers worked with communities that rely on the Bluenose-East caribou herd, which had previously declined sharply, to identify signs of recovery and long-term health and to compare these to the Dolphin and Union caribou herd. Through the community-based caribou health surveillance program, 77 sample kits from Bluenose-East caribou and 70 from Dolphin and Union caribou were collected from 2023 to 2026 from approximately April/May through November/December each year. This adds to 122 previously collected for the Bluenose-East herd (dating back to 2017), and 233 for Dolphin and Union caribou (dating back to 2015), thus providing a multi-year perspective of the health status of these herds. Sample kits collected from harvested caribou contained forms and various sample types, including blood on filter paper, feces, jaw or incisor bar, hair and hide, lower leg, kidney with fat, and spleen. Additionally, during the course of this project, 22 Bluenose-East and five Dolphin and Union caribou abnormalities were submitted by harvesters for further diagnostics. Where disease was detected, public health information was provided to address food safety concerns, increase confidence in country foods, and reduce meat wastage. Together, the information from traditional knowledge and harvester-based sampling is helping to define benchmarks (i.e., cutoff limits or target values) for caribou health indicators and is supporting the

[4] https://cbgc.alces-flow.com
[5] https://accwm.com/cea

development of a “traffic-light” system to predict whether a herd is declining (red), stable (amber), or recovering (green) based on caribou health indicators.

This work built on a long term, ongoing, community-led caribou health surveillance program designed to monitor and respond to changes in health and put the information generated by the communities into the hands of local co-management organizations, thus ensuring a stronger voice and role in Indigenous co-management of caribou. It established critical baseline information on the traditional knowledge of Bluenose-East caribou and documented the current health status of Bluenose-East and Dolphin and Union caribou. It also forms the foundation for building a tool that combines traditional and scientific knowledge to guide decisions and protect caribou for future generations.

CIMP239 - Diversity and Impacts of Viruses in Barren-ground Caribou – Frank van der Meer and Jessie Olson (University of Calgary)

As part of the previous project, researchers studied how viruses affect the health and recovery of caribou herds. While viruses cause major declines in other wildlife species, which viruses are present in caribou or how they influence herd survival is largely unknown. The only tests for viruses and the caribou immune response following a virus infection that are available were designed for domestic cattle and need to be modified to be used for caribou.

To fill these knowledge gaps, researchers worked with local harvesters to collect tissue samples from the Bluenose-East herd. Researchers used these samples to learn which types of viruses infected the herd, focusing on two virus groups: pestiviruses and paramyxoviruses—members of these virus families are present in caribou herds and exist in Arctic herds. After identifying these viruses, caribou-specific tests to detect viral exposure were developed and optimized, making it easier and more reliable to identify and monitor these viruses in caribou populations going forward.

This research laid the groundwork for understanding the role of viruses in caribou population dynamics, supported community-led monitoring, and will inform future wildlife management decisions.

CIMP240 - Contaminants, Epigenetics, and Genetic Health in Caribou – Rowan Barrett and Eric Johanneseen (McGill University), Mary Gamberg (Gamberg Consulting)

Pollution from contaminants might affect barren-ground caribou health in ways that are not immediately visible but could still have meaningful consequences for population health and viability. Communities across the range of barren-ground caribou have raised concerns about caribou health, including what contaminants are getting into the animals, whether those contaminants are harming individual caribou, and how caribou populations are responding over time. To help answer these questions, researchers studied the Porcupine, Bluenose-East, Beverly, Tuktoyaktuk Peninsula, and Qamanirjuaq herds to compare contaminant levels, identify how contaminants affect caribou at the genetic level, and evaluate which herds may be most at risk going forward.

This work focused on two areas. The first was epigenetics, the study of how environmental factors like contaminants can change the way genes work without changing the underlying DNA itself. Epigenetics can affect an animal’s health and ability to reproduce. The second area was genetic health, which describes the overall condition of a herd’s gene pool. Herds with greater genetic diversity carry a wider range of traits, giving them more options for adapting to new challenges such as disease, climate change, or habitat loss. Herds with less diversity, or with higher levels of inbreeding (mating between closely related individuals), may have fewer options and be more vulnerable when conditions change.

During the planning stage, researchers held meetings and workshops with harvesters and community representatives to shape how caribou samples would be collected, what information should be recorded alongside each sample, and what questions mattered most to the people who depend on caribou. Hunters from Old Crow (Yukon), Wekweètì (NWT), Tuktoyaktuk (NWT), Kugluktuk (Nunavut), and Arviat (Nunavut) collected all tissue samples while harvesting caribou on the land, in partnership with territorial and Indigenous governments and Indigenous organizations.

Samples were taken from a total of 108 caribou across five herds, including muscle, liver, and kidney tissues, along with approximately 25 fecal samples. Contaminant testing covered a broad suite of 35 elements, including mercury, arsenic, and lead, as well as per- and polyfluoroalkyl substances (persistent industrial chemicals found in many consumer products), plastic additives, and exploratory screening for previously undetected contaminants. These contaminants and genetic markers have been linked to health effects that may not kill caribou outright but could still harm them over time. For example, contaminants or genetic factors may reduce an animal's ability to reproduce or make them less resilient to harsh winters, poor forage, or disturbance.

Researchers also examined genetic markers at the population level (such as diversity and inbreeding, which are indicative of long-term herd health) and epigenetic markers at the individual level (which provide a snapshot of how an animal's genes are currently functioning in response to its environment). Researchers examined whether contaminant exposure was changing gene activity in ways that could compound the pressure from contaminants, and whether some herds were already more vulnerable due to past population declines. When a herd's numbers drop sharply (due to overharvest, disease, or habitat change) the survivors carry a smaller portion of the original gene pool. This kind of event, called a genetic bottleneck, leaves signatures in the genome that researchers can detect long afterward, and the lost diversity does not simply return when numbers rebound. Herds that have passed through a bottleneck may carry higher levels of inbreeding and a narrower range of traits, making them less equipped to adapt to new diseases, changing climate, or other pressures.

Throughout the project, researchers maintained ongoing communication with harvesters and community partners, analyzing data collaboratively to identify patterns that drew on both scientific methods and traditional knowledge. The research team is working with communities and co-management bodies to present findings in accessible formats and to discuss what the results mean for the management of specific herds. This includes community presentations, plain-language summaries, and conversations about how the findings can inform harvest planning, habitat protection, and monitoring priorities for each herd.

CIMP241 - Understanding Adult Survival in Barren-ground Caribou – Eliezer Gurarie and Chloe Beaupré (State University of New York)

Survival (and its opposite, death or mortality) is central to understanding caribou population trends and helps explain why herds grow or shrink over time. Researchers set out to understand how survival changed across seasons, years, and caribou herds, and what environmental factors drove mortality.

Research questions were developed both from the researchers' own expertise and collaboratively with North Slave Métis Alliance members (see project CIMP243, below), whose local knowledge and priorities helped shape hypotheses about what factors influence caribou survival. North Slave Métis Alliance members raised several concerns that shaped the research direction: easy road access and hunting along roads, warmer winters, parasite load and caribou health, and survival differences between males and females. Where community concerns, researcher questions, and available data overlapped, analyses were prioritized. The result was a set of survival models to better understand the timing, location, and causes of caribou mortality, including the roles of climate, health, infrastructure, sex, and herd identity.

These analyses drew on tracking data from caribou across six barren-ground herds in the NWT - Beverly, Bathurst, Bluenose-East, Bluenose-West, Cape Bathurst, and Tuktoyaktuk Peninsula - including over 1,400 caribou collared by the Government of the Northwest Territories between 1996 and 2023; data that captured not just when caribou died, but where they were and how they had moved leading up to their death.

This work has produced practical outcomes for caribou management in the NWT. By compiling survival data across multiple herds, the analyses help to build understanding of impacts to caribou across the region in a standardized way and fed directly into the population models that managers use to make conservation decisions and evaluate management outcomes. The factors affecting survival in the Bathurst herd, for example, will be incorporated into a population model evaluating the impacts of predator control programs on caribou recovery.

CIMP242 - Acoustic Monitoring of Disturbance Impacts on Barren-ground Caribou – Eliezer Gurarie and Megan Perra (State University of New York)

Researchers studied how insect harassment and human-made noise affected barren-ground caribou behaviour and calf survival. They aimed to understand how insects and noise affected caribou, whether some herds were more exposed than others, whether insects and noise together had a stronger impact than either alone, and whether soundscape data could help find insect relief habitat or guide industrial noise-management strategies.

A two-part acoustic monitoring approach tracked the real-time responses of caribou to disturbance. Researchers added combined sound recorders and movement sensors (called audiologgers) to 30 caribou collars in 2025 to listen to the caribou's life. Ten audiologgers were set to record from March 15 until their drop off date on April 19, in the hopes of recording baseline spring caribou behaviour and interactions with the Tibbitt-to-Contwoyto winter road. Twenty audiologgers were set to record for one week in spring (March 15- March 22), during calving (May 30-June 15), and during summer (July 1 until battery death), with a scheduled drop off on August 16. Between those recording periods, the devices were not programmed to record in order to extend the life of the battery. Approximately 9,000 hours of caribou audio was recorded across all individuals for that year (2025), deployed predominately on Bluenose-East, with four on caribou from the Beverly herd. Two audiologgers were also deployed on the Bathurst herd, although researchers were not targeting Bathurst caribou that year. In 2026, 20 audiologgers were deployed on Bathurst and Beverly animals; 5/20 were meant for spring monitoring and were retrieved in May, while the remaining 15 will be retrieved in August 2026. Researchers were able to use sound to identify adult and calf behaviours, such as foraging, nursing, and resting, as well as potential calf mortality events, and to quantify the impacts of industrial noise and insect harassment on behaviour. This information provided baseline data about caribou activity in the absence of disturbances. This information was collected at the millisecond level, for continuous periods of time (back-to-back 24-hour days); it is the first time anyone has been able to monitor caribou at this scale.

To understand how climate conditions influenced insect activity and to measure industrial noise, researchers partnered with Indigenous and government collaborators to use existing sources of acoustic data or to place stationary acoustic recording units on the land. To investigate what conditions caused the most intense insect harassment and which landscape features offered caribou relief from insects, they processed and analyzed acoustic data collected from the Bathurst calving grounds in 2021 from May through August. Stationary acoustic monitoring data was collected by the Kugluktuk Hunters and Trappers Association, the Government of Nunavut, and the Government of the Northwest Territories, and shared with the researchers in 2023. This provided region-specific information about the wind speeds and temperatures around which insects – primarily mosquitoes – are most active. The Ekwǫ̀ Nàxoèhdee K'è program (see CIMP94 project, above) informed acoustic monitoring efforts near Kǫ̀kètì (Contwoyto Lake) and nearby mine sites, where Elders had observed caribou seeking refuge from insects. This information helped inform the researchers' maps of annual insect activity, which they developed from their insect activity index. This culminated in the development of a new insect activity index that can be used by other researchers to hindcast and forecast insect activity in the region.

Researchers also identified the timing and volume of traffic noise along the Tibbitt-to-Contwoyto Winter Road using data collected by North Slave Métis Alliance members (see CIMP243 project, below). This data was collected from acoustic recording units from approximately February 15 to March 15 in 2024 and 2025, and from approximately February 16 to 28 in 2026. Following receipt of the final 2026 data from North Slave Métis Alliance, the research will be extended to determine if caribou appear to be responding to traffic noise in a noticeable way.

CIMP243 - North Slave Métis Alliance Guardianship Program: Monitoring Road Impacts on Barren-ground Caribou – Orna Phelan (North Slave Métis Alliance)

The North Slave Métis Alliance (NSMA) represents a community that is deeply connected to the land, and the caribou have been a critical part of this relationship for generations. The health and abundance of caribou directly impact the well-being of the Métis people. In response to the growing concerns over declining caribou populations in the North Slave region, the NSMA has taken proactive steps to monitor and protect this keystone species by establishing a guardianship program focused on caribou monitoring. This initiative ensures that the Métis community is at the forefront of conservation efforts while fostering a deeper understanding of the health of caribou herds, their migration patterns, and the broader environmental factors influencing their population.

Roads can disturb caribou by making it easier for vehicles, hunters, and predators to access their habitat, and by creating physical barriers that affect how caribou move across the land. Since 2020, the NSMA winter road monitoring program has drawn on traditional knowledge, land-based observations, and western science approaches to investigate and monitor the cumulative impacts of the Tibbitt-to-Contwoyto winter road on barren-ground caribou.

Each year, NSMA guardians patrol the road during the February-March operating season to document caribou numbers, health, harvest (including, but not limited to, disrespectful or illegal harvesting), predators, and disturbances. In 2024, the NSMA expanded the program and constructed a semi-permanent camp along the winter road, so guardians could spend more time on the land observing caribou, other wildlife, environmental conditions, and human activity. Detailed guardian observation forms were developed in collaboration with NSMA biologists and land-users. The NSMA developed a harvest model to estimate total barren-ground caribou harvest along the ice road based on gut pile observations for the 2025 season.

During the 2024, 2025, and 2026 seasons, the NSMA deployed game cameras along and off the road to document barren-ground caribou interactions with the road and to measure traffic levels. They also deployed autonomous recording units (ARUs) along with the cameras and worked in collaboration with the State University of New York (see CIMP242 project, above) to use this data to create models of human made sounds, primarily traffic noise (or “disturbance landscapes”) around the road. These data will be used to better understand how road traffic and noise affect caribou movement and behaviour on their winter range.

The project team braided traditional knowledge with western science throughout the project. The NSMA held several community workshops and engagement sessions to guide the research, share concerns, and explore how relationships between people and caribou had changed over time. They shared project results directly with NSMA members and compared findings with traditional and local knowledge during annual workshops.

This research will help inform future land-use decisions, including decisions about the proposed construction of the Arctic Economic and Security Corridor. It also highlights the cultural impacts of caribou decline and supports the development of better strategies to reduce road-related disturbance.

Advice for future collaborative processes

The CBGCI took a new approach to funding research by requiring funded projects to come together regularly and synthesize their results. This collaborative approach was intended to facilitate communication and collaboration across research teams and between researchers and decision-makers. Ultimately, the aim of the CBGCI was to synthesize results in a report that was available to the decision-makers who may use the results to inform recommendations and decisions. This approach to prioritizing collaboration and synthesis in research funding is novel, and both funders and participants saw great value in the approach. To improve future collaborative funding calls, participants were asked to reflect on the process, provide feedback to the funders, and provide advice to future participants. Participants were asked about the strengths of this approach, challenges they encountered, and recommendations for future collaborative initiatives of this nature.

Participants highlighted collaboration, structure, and in-person engagement as strengths of this approach. The territorial and federal government representatives and independent professionals who led this initiative were supportive and responsive. Continuity in staffing among these representatives was welcome. The collaborative nature of the funding meant that research teams did not operate in silos, allowing them to discuss common and emerging themes across their projects and results. This resulted in an outcome that felt more meaningful than in stand-alone research projects. Funding requirements to work directly with Indigenous governments and Indigenous organizations were also welcome and effectively led project leads to dedicate time and money towards working with community partners, which, even with the best of intentions can be lost when not explicitly required. For example, most participants felt that they had been more engaged with community partners than they had been with the other science projects. In this collaborative structure, the insight of experienced northern researchers in building strong relationships among partners was appreciated. In this context, mentorship by experienced project leads or administrators may be helpful for early career researchers or those new to working in the north.

Most challenges were related to the nature of funding requirements (e.g., reporting burden, inability to roll funding across years or direct funding towards work in Nunavut, difficult timelines, and meeting fatigue), rather than specific concerns about the collaborative approach. Requirements to submit final reporting prior to the completion of project data collection and analysis proved particularly challenging for many research teams. Moving forwards, participants suggest that initiatives of this nature proceed in 4–5-year funding cycles, aligning more closely with typical project and degree (for academic participants) timelines. Given multi-year project timespans, examining options for fully committed multi-year contribution agreements would be helpful to prevent any delays in subsequent years’ funding. Research projects of this nature, particularly given the emphasis placed on community engagement and participation, are vulnerable to logistical complexities and scheduling conflicts. Funding flexibility would help improve relationships with communities by allowing research teams to respond to community priorities, constraints, and schedules. Participants also described the importance of funding ongoing monitoring. Requirements for novel research constrain the capacity to pursue longer-term monitoring that will likely prove to be as valuable as novel research studies.

Moving forward, participants recommended working towards a balance between collaboration and project delivery. Inter-team collaboration, while extremely valuable, is costly and time-consuming, so should be conducted strategically and purposefully, with an eye to increasing the effectiveness of the end product, improving relationships, improving cost efficiency, and reducing meeting fatigue. Shifting whole group meetings to year two instead of holding them in year one would be helpful in this respect. Providing opportunities for engagement with management agencies during the research rather than only in a synthesis report such as this one could enhance relevancy of research questions and reporting. More regular, smaller meetings among projects identified as having complementary interests rather than involving all project leads throughout may also help ensure targeted and ongoing collaboration. It was also suggested that project leads hold small, regular meetings focused on project management to facilitate logistical coordination across projects. Community capacity should be carefully considered. Multiple research projects in a single community put pressure on administrators, land users, and knowledge holders who may already be oversubscribed. Government facilitation of multi-project submissions and meetings could possibly help reduce the burden placed on communities at the proposal stage, and better project management could reduce the community burden during project activities.

PART 3: What we learned

Research themes

In this section, we highlight how these projects have, together, advanced the state of knowledge on barren-ground caribou and where questions and uncertainties remain. This section is not intended to be organized project-by-project, or present comprehensive summaries of project methods and results. Detailed project-specific reports, including plain language NWT Environmental Research Bulletins, may be found on the NWT Discovery Portal (see Appendix A).

The perspectives described herein reflect the lived and professional expertise of knowledge holders across both traditional and scientific knowledge disciplines. These researchers come from a variety of backgrounds: they are Indigenous and non-Indigenous; NWT-based and from afar; early and late career; affiliated with governments, Indigenous organizations, academia, and private companies; and hunters, researchers, and decision-makers.

In the context of the project results considered here, climate and weather, health, and roads represent overarching themes. Each of these drivers can directly or indirectly affect barren-ground caribou populations and can act together to affect herd trends.

Weather and climate

"On the barrenland, weather dictates every movement, and the weather has a strong effect on caribou behaviour." (Tłı̨chǫ Research and Training Institute 2018: 68)

Weather and climate are two key forces affecting barren-ground caribou throughout their ranges and life cycles (e.g., Tłı̨chǫ Research and Training Institute 2020). These forces can affect caribou health, fitness, and behaviour directly (e.g., temperature changes, insect avoidance) and indirectly (e.g., pathogen exposure, habitat accessibility, forage availability and quality). For example, in addition to female body condition, the timing of calving is known to be strongly influenced by temperature, wind, and precipitation, with year-to-year differences in the timing of calving strongly associated with these conditions (Couriot et al. 2023, Gurarie et al. 2019). Further, the various ways that weather and climate impact caribou do not act alone; rather, these forces interact with one another.

Over the long term, changes in climate and increasing variability in weather are expected to strongly affect barren-ground caribou populations. Studying the relationships between barren-ground caribou and these key forces affecting them is therefore essential for understanding changes in their populations over time. As weather and climate conditions vary across the landscape, separating these effects by herd, and therefore capturing variations in their ranges and movements, is also important to consider.

Weather versus climate

Weather refers to the short-term conditions experienced by an individual; that is, the conditions outside on a day-to-day basis.

Climate refers to the long-term, average conditions experienced at a particular location (NOAA 2018).

The visible effects of climate change within the ranges of barren-ground caribou in the NWT have been well-described to date, through traditional knowledge, community-based monitoring, and western science (e.g., Species at Risk Committee 2017, 2023, Mallory and Boyce 2017). Among the CBGCI project results presented here, Tłı̨chǫ knowledge holders and monitors have documented loss of persistent summer snow patches, earlier spring snowmelt in some years, collapsing esker habitat, changes in surface water, shifts in the composition of vegetation, changes in forage availability, and changes in insect harassment levels within barren-ground caribou ranges (Tłı̨chǫ Research and Training Institute 2018, 2019, 2020). These changes impact caribou movements, the capacity to thermoregulate and seek relief from insects, alter access to forage, and ultimately, affect caribou health, fitness, and abundance (Tłı̨chǫ Research and Training Institute 2020). As caribou cope with and adapt to these changes, human access to caribou is also affected, with harvesters indicating that caribou are becoming increasingly difficult to find (Tłı̨chǫ Research and Training Institute 2018). However, exactly how weather and climate affect barren-ground caribou populations is a complex topic. Building understanding of causal mechanisms is essential for designing management approaches that can effectively conserve and recover barren-ground caribou. Several of the funded CBGCI projects worked to address this point. Their results highlight the importance of weather and climate to caribou survival, movement, reproduction, and health. Within this, summer temperatures, snow depth, and insect harassment emerge as key considerations.

Temperature

Climate change is a global phenomenon, but how it is experienced varies regionally, reflecting factors such as ocean and atmospheric currents, latitude, and topography. Globally, Arctic regions like the NWT are experiencing a greater magnitude of climate change than other regions as a result of Arctic amplification. In fact, the rate of warming in the NWT is three times greater than globally (Environment and Climate Change 2022). Given the strong link between barren-ground caribou and weather and climate, changes in temperature will undoubtably have an effect on their populations. This link between temperature and health in barren-ground caribou is already well-known among traditional knowledge holders, with caribou understood to be healthier and fatter in cooler and wetter summers, at a population level (Tłı̨chǫ Research and Training Institute 2018, Padilla et al. 2023).

Arctic amplification

Temperatures rising more rapidly in Arctic regions, relative to the rest of the world, are tied to several factors, particularly melting sea ice and snow. The more the reflective ice and snow melts, the more energy the darker ocean and land are able to absorb from the sun. This warms the air more rapidly than in other areas (Environment and Climate Change 2022).

Average annual temperatures in the NWT have increased by up to 2.8°C to date, relative to the 1961-1990 period, with substantial variation across years and seasons. These trends are expected to continue into the future, with further increases in average annual temperature and greater weather variability, including more frequent instances of extreme temperatures (Environment and Climate Change 2022).

CBGCI project CIMP207 (see Part 2) included climate projections in the development of their decision support tools for barren-ground caribou decision-makers (CBGC ALCES n.d.). These inputs, considering the combined extent of five herd ranges (Cape Bathurst, Tuktoyaktuk Peninsula, Bluenose-West, Bluenose-East, and Bathurst), suggest a projected increase in average annual temperature by almost 3°C in barren-ground caribou range over the next 40 years, with substantial interannual variation (CBGC ALCES n.d.). Their projections further indicate that adult barren-ground caribou survival is directly associated with the weather and climate conditions each individual experiences across their annual lifecycle. Across the suite of weather and climate variables captured in this study (see Feature Box 1, below), temperature appears to be particularly important to survival (CBGC ALCES n.d.).

This was corroborated by CBGCI project CIMP241, which considered the effects of several weather and climate variables, including summer and winter temperature on female survival in the same five herds considered by CBGC ALCES (n.d.) as well as the Beverly herd (Table 1). Using models applied to summer survival data (totalling 2,328 caribou-summers from over 1,400 caribou collared between 1996-2023), project CIMP241 showed that survival was highest at the intermediate summer temperatures of 11-14°C; temperatures above or below this range were associated with reduced survival (Figure 5). Likewise, applying these models to winter survival data (totalling 2,769 caribou-winters from the same period as summer survival data), winter temperature also had significant effect on survival, with mortality risk highest during the coldest winters (caribou experiencing ~10 days with maximum temperatures below -30°C and average daily temperatures 5-10°C colder across the December-April period).

These relationships likely reflect competing physiological and ecological pressures. In the summer, extreme heat both increases energy use in caribou that seek ways to cool down and also supports increased insect harassment (see subsection *Looking beyond caribou*, below, for additional information on insect harassment). High average summer temperatures (>14°C) are also associated with increased frequency of daily maximum temperatures above 20°C, which may negatively affect digestive function in caribou (Trondrud et al. 2023). Conversely, unusually cold summers may result in poor plant growth and therefore reduced forage quality. Similar relationships (highest survival at intermediate levels) were also observed for the greenness of June vegetation and mosquito harassment, which further suggest that summer conditions congruent with a 'goldilocks' scenario – moderate temperatures, adequate but not excessive vegetation green-up, and manageable insect pressure – collectively promote the highest survival. In the winter, reduced survival in extremely cold winters is consistent with increased cost of thermoregulation (Griffith et al. 2002, Schmidt et al. 2020, Barboza et al. 2020); a relationship that has also been recorded in barren-ground caribou in Alaska (Gurarie et al. 2024).

The survival response to summer temperature was most pronounced during summer and fall, when animals are directly exposed to these conditions, while the response to extremely cold winter temperatures was most visible in overwinter mortality rates. However, lagged effects were also detected, with a weaker but persistent relationship extending into the following year, suggesting that unfavourable temperatures experienced during summer carry forward into subsequent seasons, likely reflected in body condition entering the following year. The persistence of summer temperature effects across seasons underscores its importance as a driver of annual survival variation and highlights the vulnerability of barren-ground caribou to both warming trends and increased climatic variability.

CBGC ALCES (n.d.) took these results of individual survival further, to consider the population level effects of weather and climate variables on barren-ground caribou herds. Applying the relationships between female caribou survival and summer and winter temperatures (in addition to snow depth, see information on precipitation below) that were derived by CBGCI project CIMP241 with an SSP5-8.5 climate projection, CBGC ALCES (n.d.) simulations showed that herd populations exhibited large (i.e., 39 to 80% depending on the herd) declines during a 20-year forecast period.

SSP5-8.5 Climate projection

SSP5-8.5 is a social and economic development scenario commonly used to project greenhouse gas emissions. SSP5-8.5 is a worst-case scenario for emissions resulting from human activities, assuming continued strong reliance on fossil fuels and lifestyles built on unsustainable consumption globally.

FEATURE BOX 1: Central Barren-ground Caribou Landscape and Population Dynamics Model (ALCES) (CIMP207)

This tool helps researchers and decision-makers explore the consequences of development footprint, harvest, and climate change on barren-ground caribou habitat and population. It was developed using data from the Bathurst, Bluenose-East, Bluenose-West, Cape Bathurst, and Tuktoyaktuk Peninsula herds. ALCES can help users understand the relative importance of risks to barren-ground caribou and the effectiveness of various management options through simulation.

ALCES includes projections about how we expect the environment to change over time. This includes projections of land cover (e.g., shifts in the treeline), human disturbance footprint (which projects are pursued), and climate (temperature, precipitation, solar radiation, potential evaporation), looking 40 years into the future. Models were developed using multiple land inventories (e.g., NWT CIMP Inventory of Landscape Change, Land Cover of Canada). Shifts in taiga and tundra and area affected by wildfire were informed by projections for North American ecoregions under climate scenario RCP 8.5 (a business-as-usual greenhouse gas emissions scenario) (Stralberg 2018, Boulanger et al. 2014). Potential future development projects for inclusion in the model were identified in consultation with a working group composed of Government of the Northwest Territories representatives, but the list can be revised to reflect relevant development scenarios. Government of the Northwest Territories telemetry data from 2005 to 2020 was incorporated into the model. Other variables included in the model were forest age, topography, harvest pressure in proximity to roads, avoidance of development footprints, and changes in energy use in response to these stressors.

The model simulates potential caribou population responses (i.e., births and deaths) to habitat changes over time. Seasonality is a key feature of the annual life cycle of barren-ground caribou, and as such, ALCES includes five linked seasonal submodels for (1) spring migration, (2) calving, (3) summer), (4) fall, and (5) winter. Separate models were developed for each of the five herds.

Overall, ALCES is a tool that allows exploration of the relative risks of stressors and potential effectiveness of management options. It is important to note, however, that the tool does not provide predictions of the future. This reflects limitations in our understanding of caribou, limitations in the scope of the model, and uncertainty associated with stressors such as climate change. Further, models do not address movement or habitat accessibility, so should be used and interpreted with caution.

Table 1. Results of survival models testing the effect of weather and climate variables on winter/spring and summer/fall survival of adult female barren-ground caribou in the NWT (Tuktoyaktuk Peninsula, Cape Bathurst, Bluenose-West, Bluenose-East, Bathurst, and Beverly herds), 1996-2023. Each variable was tested independently. Statistically significant effects ($p < 0.05$) are shown in bold.

	Weather/climate variable	**Type of relationship**
Winter/spring survival	**Winter temperature**	Survival lowest in extremely cold winters
	Winter snow	Survival highest at average snow depths of 40-55 cm, lowest below 40 cm, and decreasing at depths above 55 cm
	Spring precipitation	Higher spring precipitation associated with increased mortality
	Summer temperature	No significant relationship
	June greenness index	No significant relationship
	Winter lichen	No significant relationship
	Mosquito index	No significant relationship
	Freeze/thaw days	Higher number initially increased mortality risk, but the effect lessened over time and the relationship was ultimately not significant
Summer/fall survival	**Summer temperature**	Survival greatest between 11-14 °C
	Prior summer temperature	Both very cool and very hot prior summers associated with lower survival
	Prior winter temperature	No significant relationship
	Prior winter snow	Deeper snow in prior winter associated with higher survival the following summer/fall
	Prior spring precipitation	No significant relationship
	June greenness index	Survival greatest at moderate levels of greenness
	Insect activity index	Survival greatest when mosquito harassment is moderate (i.e., manageable)

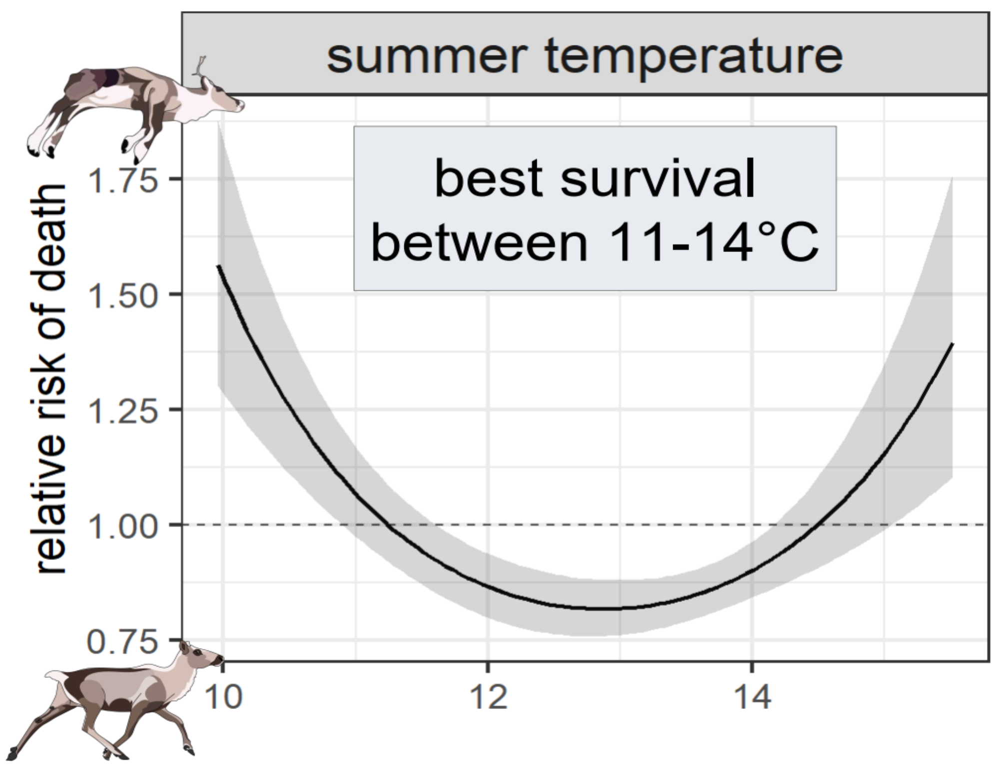


Figure 5. Relative risk of mortality for adult female caribou in the NWT during summer and fall (June 2 - November 30) in relation to mean summer (June 2 - September 6) temperature. The shaded region represents the 95% confidence interval.

The influence of temperature also extends beyond its immediate impact on survival. Complementary research conducted by CBGCI participants outside the context of this initiative shows that the onset of spring migration of barren-ground caribou herds is largely synchronized to specific drivers across North America, including global climatic and oceanic oscillations, spring temperature, and snow conditions (Gurarie et al. 2019). For example, in the Bathurst herd, using collar data from 2007 to 2016, spring migration appears to be related to snowmelt, with migration beginning shortly after snowmelt begins in earnest (Matias et al. 2024). Whether the trigger is strictly related to the timing of snowmelt, or to changing properties of the snow (e.g., packed snow making movement easier), is not yet fully understood (Gurarie et al. 2019). Likewise, in the lake-dense barrenlands (Paltan et al. 2015), frozen lakes and rivers form a highly accessible and often preferred surface for movements, resting, and predator avoidance (Figure 6). At a landscape level, however, interannual variability, coupled with climate change, can result in earlier break-up and delays in freeze-up, potentially forcing alterations to caribou movements and therefore requiring more energy to be used and mortality risk to increase (Liao et al. 2026).

Figure 6. Barren-ground caribou on frozen lake near Wekweètì in April 2024. Photo courtesy E. Gurarie (CIMP242).

Precipitation

Trends in precipitation (snow and rain) are a point of concern among NWT communities. For example, CBGCI project CIMP243, conducted by the North Slave Métis Alliance, brought forward concerns from community members regarding the effect of climate change on snow (e.g., changes in snow depth, more icing events, loss of summer snow/ice patches) and the associated impact to caribou movements, forage access, and vulnerability to predation (Beaupré and Phelan 2023). Project CIMP94, led by the Tłı̨chǫ Government, recorded similar concerns among community members (Tłı̨chǫ Research and Training Institute 2018, 2019, 2020).

Measurement of precipitation is difficult, with measurements often being affected by, for example, wind and drifting of snow (Environment and Climate Change 2022). The data that have been collected to date show no clear long-term trends in precipitation, although extreme drought conditions have been recorded across much of the NWT since 2022 (Environment and Climate Change 2026). Looking forward, projections for the NWT over the course of the next century suggest likely increases in total precipitation, although these projections are subject to high levels of variability across space and are considered highly uncertain (Environment and Climate Change 2022). In spite of this variability and uncertainty, CBGCI project results show a clear connection between precipitation and barren-ground caribou survival and health.

Project CIMP241, focusing on the Tuktoyaktuk Peninsula, Cape Bathurst, Bluenose-East, Bluenose-West, Bathurst, and Beverly herds and examining the relationship between winter survival data (2,768 caribou-winters derived from over 1,400 collared caribou between 1996-2023) and average winter snow depth (December 01 – April 19) showed that snow depth had a largely positive influence on caribou survival over the winter, with survival highest at average snow depths between 40 and 55 cm and lowest at depths below 40 cm. At the deepest snow depths (>55 cm), the positive effect of snow began to reverse and survival decreased, likely associated with impeded cratering access to forage (Laperriere and Lent 1977, Fancy and White 1985, Kinley et al. 2003), which has consequences for survival (Beaupré et al. 2026).

As barren-ground caribou are highly adapted to snowy environments (Telfer and Kelsall 1984), this result is consistent with expectations. Critically, deeper snow (up to an average of 55 cm) may provide a predator refuge; caribou can escape to deep, soft snow that is more difficult for wolves to move through (Telfer and Kelsall 1984). In contrast, shallow snow years may offer caribou fewer of these advantages.

The effects of snow depth were also persistent, with deeper snow (up to 55 cm) associated with better survival the following summer and fall, perhaps reflecting better body condition or enhanced insect relief during summer where snow is able to persist on the land into the spring.

Project CIMP241 also found that spring precipitation, which falls primarily as snow, was associated with increased mortality risk. Higher spring precipitation may reflect late-season icing events or heavy/wet snow that limits forage access or makes movements more costly during a period when body reserves are already depleted and caribou are migrating toward calving grounds. The effect of freeze-thaw events on survival was more difficult to isolate, in part due to the rarity of these events and the challenge of capturing them with coarse-resolution climate data. While some models suggested a positive effect on mortality (i.e., freeze-thaw events increased mortality), the results were not conclusive. However, freeze-thaw events reduce survival in other Arctic ungulates, including Dall's sheep (van de Kerk et al. 2020), and are expected to increase in frequency with climate change. Certainly, as noted previously, NWT communities are concerned about the impact icing events (caused by freeze-thaw cycles or rain-on-snow) are having on barren-ground caribou (Beaupré and Phelan 2023, Tłı̨chǫ Research and Training Institute 2018, 2019, 2020). These events make movements and forage access difficult and there are concerns that increasing frequency of such events may drive starvation in barren-ground caribou. Instances of starvation following icing events have been recorded within the range of the Bluenose-East herd (CIMP239). Further investigation using higher-resolution climate data that capture freeze-thaw events may provide the temporal and spatial precision needed to better characterize this relationship for caribou.

Habitat

Beyond the directly observable influence of weather and climate on temperature and precipitation, these forces are also inextricably linked to the land and influence key habitat components such as structure, composition, and connectivity, disturbance regimes, migration timing, forage availability and quality, the diversity, distribution, abundance of insects and pathogens, and even exposure to contaminants, which all have implications for caribou health and fitness. This also means that climate change is having, and will continue to have, profound impacts to barren-ground caribou habitat.

Locally, traditional knowledge holders and harvesters are observing changes in caribou habitat that may be affecting their behaviour. For example, caribou herds often follow eskers along their migration routes during the summer and fall, preferring sandy eskers for ease of walking. The tops of these eskers also provide insect relief and good vantage for predator detection. The deterioration of these landforms, as warming temperatures affect snowmelt and permafrost, thus impacts caribou movements and migration (Tłı̨chǫ Research and Training Institute 2019). Shifts in the treeline have also been observed by Tłı̨chǫ Elders, with shrub growth sufficient to make the land unrecognizable, with elders saying that "the land looks different from what I remember when I traveled with my dad" and Elder Joe Zoe noting that "the barrenland is becoming smaller (Tłı̨chǫ Research and Training Institute 2025: 37 and 29). The expansion of shrubs (primarily willows and dwarf birch) and contraction in the tundra is expected to change barren-ground caribou migration routes and lessen the volume of lichen growing on the land and available to caribou as forage. This impacts food security for both caribou and people.

Wildfire is also a key source of landscape change that deeply concerns communities, particularly where it affects the winter ranges of barren-ground caribou. Changes in climate are projected to increase occurrence of wildfires within the ranges of several barren-ground caribou herds, with negative consequences for the availability of older forest, which constitutes a key winter habitat for barren-ground caribou. Regrowth of forests that can support adequate lichen populations for winter foraging is a long-term process, requiring 70-230 years post-fire (Species at Risk Committee 2017). Tłı̨chǫ monitors report that caribou are generally staying where food is available; that is, not using areas where there have been fires (CIMP94). The appearance of tundra fires on summer range near Contwoyto Lake also represents a departure from normal (Tłı̨chǫ Research and Training Institute 2024). Alongside fires, severe drought conditions over the last several years have affected vegetation in the barrenlands, with desiccated plants difficult for caribou to feed on (TRTI 2025).

To evaluate the potential consequences of climate-associated shifts in North American ecoregions (Stralberg 2018), CBGCI project CIMP207 incorporated expansion and contraction of boreal and tundra areas into their modeled scenarios, as well as projections for wildfire (CBGC ALCES n.d.). The largest projected change in landscape composition was a 44% increase in the extent of shrubland over the next 40 years, although the location of the shift was such that Bathurst was the only affected herd (considering the Tuktoyaktuk Peninsula, Cape Bathurst, Bluenose-East, Bluenose-West, and Bathurst herds). The habitat model derived for the Bathurst herd identified a positive relationship between shrubland and habitat use by the Bathurst herd, although the modelled increase in habitat did not affect the simulated population trajectory of the Bathurst herd as habitat availability was not a limiting factor. With respect to wildfire, using fire rates established for climate scenario RCP8.5 (a similar 'business as usual' scenario as SSP5-8.5, described in an earlier text box) (Boulanger et al. 2014), CBGC ALCES (n.d.) simulations projected a decline in forest older than 50 years. This decline was greater to the south where forest is more prevalent, with the implication that the fall, winter, and spring migration ranges of the Bluenose-West and Bluenose-East herds were the most affected (35% and 25% decline of forest older than 50 years within fall range over the 40-year simulation period, respectively). However, this change again did not affect the simulated population trajectories of either herd. Narrowing the focus from modelled population level effects to the consequences of landscape change to individual survival, project CIMP241 found no strong evidence associating increased lichen consumption with individual adult female caribou survival, although a near-significant relationship between these two variables was reported for the Bluenose-East herd. These results may lend credence to the modelled results of CBGC ALCES (n.d.), although herd ranges are also known to differ substantially in baseline lichen availability, suggesting that winter forage limitation may be more important for some herds than others.

The absence of an effect on modelled population trajectory despite simulated changes in habitat availability may not reflect the overall importance of habitat to barren-ground caribou; rather, this result may speak to barren-ground caribou populations that are currently well below carrying capacity (i.e., population declines and range contractions). Because current populations are low relative to historical highs, CBGC ALCES (n.d.) simulations reflect an underlying presumption that habitat is not currently a limiting factor. It is also important to note that the model's representation of the consequences of changes in land cover to caribou is incomplete. For example, simulations do not account for the effect of changes in land cover on caribou movement, the ability of herds to access desirable habitat, nor fine-grained effects of quality of available forage – a dynamic nutritional landscape – on caribou reproduction or survival. Caution should therefore be used in application of these results. It is also worth noting that habitat models for some herds, including Bluenose-East, Bluenose-West, and Tuktoyaktuk Peninsula, identify a negative relationship between shrubland and habitat use (CBGC ALCES n.d.), so caution should also be employed in generalizing results across herds.

Looking beyond caribou – interactions with other species

These changes in weather, climate, and habitat do not impact barren-ground caribou alone. Caribou share their ranges and interact with many other species, including insects, pathogens, predators, and other ungulates; all these other species are also affected by such changes. As the environment changes and as animals and plants respond to these changes, relationships between species may change or new relationships may emerge.

Insect, pathogen, parasite, or disease?

We note that overlap exists in common use of these terms. Here, *insect* refers to external insect harassment. *Pathogen* means an infectious agent, such as a bacterium or virus. *Parasite*, whether internal (e.g., gastrointestinal) or external (e.g., tick) refers to an organism that gets its nutrients from its host to the detriment of the host. In this context, insects may harass caribou but may also act as parasites (i.e., where an animal is required for part of their lifecycle) or vectors of pathogens. *Disease* is a strictly internal process, representing the presentation of symptoms following infection by a parasite or pathogen (often referred to as 'disease syndrome' herein).

Insect harassment is a critical source of stress during the summer period of the barren-ground caribou life cycle, affecting energetics, health, and behaviour (e.g., evading insects, reducing ability to forage, causing illness, etc.) (Johnson et al. 2022). During the summer season, caribou energy reserves are at their lowest while energy needs are at their highest, particularly for lactating females and calves trying to nurse (although some level of protection from insect harassment may be available for calves within aggregated groups) (Fauchald et al. 2007, Tłı̨chǫ Research and Training Institute 2019). Population level effects are considered entirely possible if insect harassment is severe enough.

The degree of harassment experienced by caribou on a daily basis during the summer is informed by the combined influence of factors such as wind, temperature, precipitation, and summer season length (Tłı̨chǫ Research and Training Institute 2019). In response to changes in these variables, insects may either increase or decrease their activity levels depending on the species, which may positively or negatively affect caribou. However, broadly speaking, colder and windy summer seasons are associated with fewer insects and healthy, fatter caribou (CIMP94).

Considering specific groups of insects, dry and windy conditions are associated with lower activity levels in insects that depend on water for portions of their lifecycle (e.g., mosquitoes) (CIMP242, CIMP94). In this context, the near NWT-wide drought of the last several years has served to reduce harassment of barren-ground caribou herds by these water-dependent species (CIMP94). Conversely, insects like botflies and warble flies, which do not depend on water for their lifecycles and are therefore largely unaffected by drought conditions, have activity levels defined by temperature (i.e., increased activity when temperatures are elevated). Harassment levels from mosquitoes, botflies, and warble flies are also affected by wind speeds, with higher winds serving to lessen activity levels and thus harassment.

CBGCI project CIMP94, conducted by the Tłı̨chǫ Government and working with the Bluenose-East, Beverly, and Bathurst herds, employed weather monitors within their study area to capture the influence of wind speeds on flying insect activity (and associated levels of harassment). Their results showed a strong correlation between wind speed and insect activity (primarily mosquitoes), with wind speeds around 10 km/hr (2.8 m/s) deterring insects and wind speeds between or above 14-18 km/hr (3.9-5 m/s) preventing insect flight almost entirely (Tłı̨chǫ Research and Training Institute 2019). Below these thresholds, and without rain, insect activity increased immediately. The impact to caribou was clear, with increased avoidance activity (e.g., running in circles) and signs of stress visible (Tłı̨chǫ Research and Training Institute 2019) (Figure 7).

Figure 7. 'Clouds' of mosquitoes and blackflies harass Bathurst caribou on a calm, hot day at Kǫ̀kètì (Contwoyto Lake), July 23, 2018. Petter Jacobsen, Tłı̨chǫ Government (2019).

CBGCI project CIMP242, considering the same herds that were the focus of work by the Tłı̨chǫ Government, recorded similar responses to flying insect harassment using audiologger (recording sounds) and accelerometer (recording the movement rates of caribou) equipment added to caribou collars. Their results showed that caribou significantly increased their activity levels in response to insect harassment, with peak insect activity associated with wind speeds of 10.8 to 21.6 km/hr (3-6 m/s) in combination with temperatures between 18-28 °C. The difference between the facilitative/inhibitory wind speeds described by Tłı̨chǫ monitoring (see paragraph above Figure 7) and project CIMP242 may reflect methodological differences (e.g., Tłı̨chǫ monitors used handheld meters and recorded local windspeed while observing caribou in real time, while project CIMP242 used remote meteorological data which reflects broader daily windspeed patterns). Certainly, despite the differences in wind speeds reported as facilitating/inhibiting flying insect activity, the theme reported by both projects remains the same – higher wind speeds inhibit flying insect activity.

Wind speed and temperature are actually such reliable indicators of flying insect activity that these variables can be used to calculate indices of insect harassment.

CBGCI project CIMP242 estimated a daily harassment index (Russell et al. 2013) derived from temperature and wind speed at each collared caribou's location, within the ranges of the Tuktoyaktuk Peninsula, Cape Bathurst, Bluenose-West, Bluenose-East, Bathurst, and Beverly herds. Using models applied to summer survival data (2,299 caribou-summer from over 1,400 collared caribou between 1996 and 2023), project CIMP241 showed not just that insect harassment affected individual caribou survival, but also that mortality risk was lowest at moderate (i.e., manageable) levels of harassment (Table 1). These results confirm that insect harassment is not just a source of short-term stress but a measurable driver of adult female survival.

CBGCI project CIMP242 developed an insect activity index by analyzing acoustic detections of insects from summer monitoring of Bathurst calving groups (2021) and along MacKay Lake (2016) and matching them with remotely sensed climate variables. When projected broadly across space and time, this index showed high interannual variability in insect activity intensity and distribution (Figure 8), with highest insect activity levels associated with low windspeeds, moderate atmospheric moisture, and temperatures exceeding 6°C. Some of the variability can likely be explained by anomalously high temperatures across this region between 2022-2024 (NOAA 2023, 2024, 2025). This period of high insect activity was recorded alongside a further 50% decline in the Bathurst herd (Government of the Northwest Territories 2025), although causality, in part or in whole, cannot be inferred from this observational study. Kǫ̀kètì (Contwoyto Lake), a core part of the Bathurst summer range (Mennell et al. 2021), showed the most variation in interannual insect activity. This lake typically appears as a large area of insect relief, except in years where insect activity is more widespread and/or intense (Figure 8). This may limit the herd's ability to find insect relief in these years.

An index of warble fly activity (i.e., harassment) also exists in the NWT, although it was not used in any of the funded CBGCI projects described herein. However, significant increases in this index have been documented within Bathurst caribou summer range over time, commensurate with increases in summer temperatures since the 1980s (Species at Risk Committee 2017).

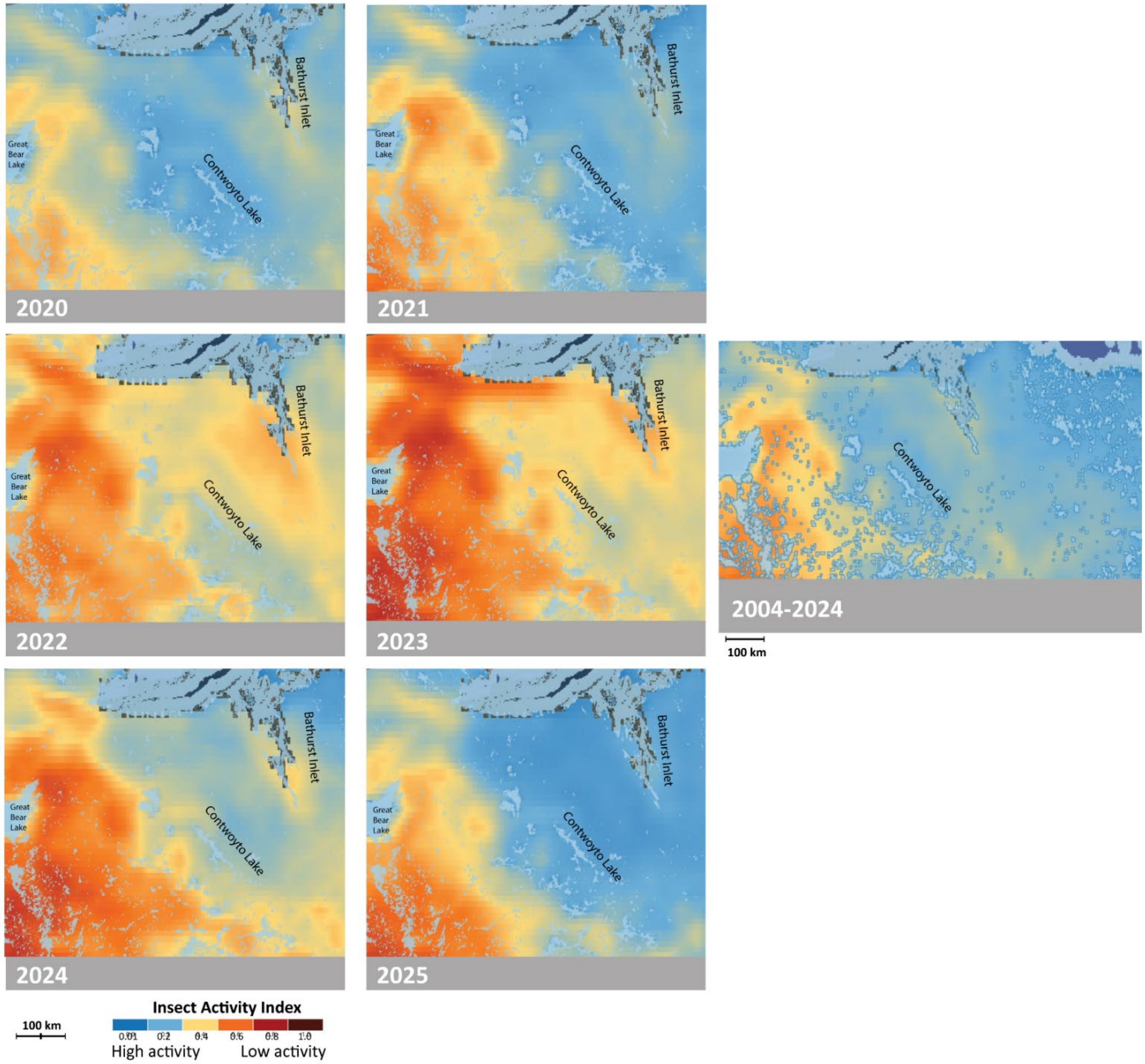


Figure 8. Annual maps of insect activity aggregated from June 25 to July 15. Each pixel on the map represents the maximum insect activity index for a given day averaged across that time period. Activity is graded from 0-1 and scaled by colour. It is based on a composite index of air temperature, wind speed, and vapour pressure deficit (a proxy for atmospheric moisture) that predict whether or not flying insects will be active and audible on recorders. We present it here as a proxy for insect harassment that caribou might encounter. Because we are averaging daily maximum values for each pixel, low activity areas should be true insect relief zones. The rightmost panel shows insect activity across 2004-2024 between June 25 to July 15; note that Kǫ̀kètì (Contwoyto Lake) is a consistent relief area, and that activity around it in more extreme years (2022-2024) is a deviation from the historical average of the past two decades.

As activity levels increase as caribou respond to, and try to avoid, insect harassment, so too does energy expenditure. Additionally, foraging is reduced and effective nursing by calves is prevented (CIMP242). In fact, the previously reported results of summer survival modelling (i.e., lower survival in warm years) may, in part, be explained by the emergence of summer insects.

Undisturbed caribou typically shift between several hours of rest/rumination (digestion) and several hours of active foraging, though the exact length of these periods appears to vary by location, individual, and time of year. This pattern of behaviour is universal among the herds examined by CBGCI project CIMP242, and disturbances appear as clear disruptions to this rest/rumination and foraging cycle, with insect harassment sometimes disrupting caribou behaviour for several hours at a time (Figure 9).

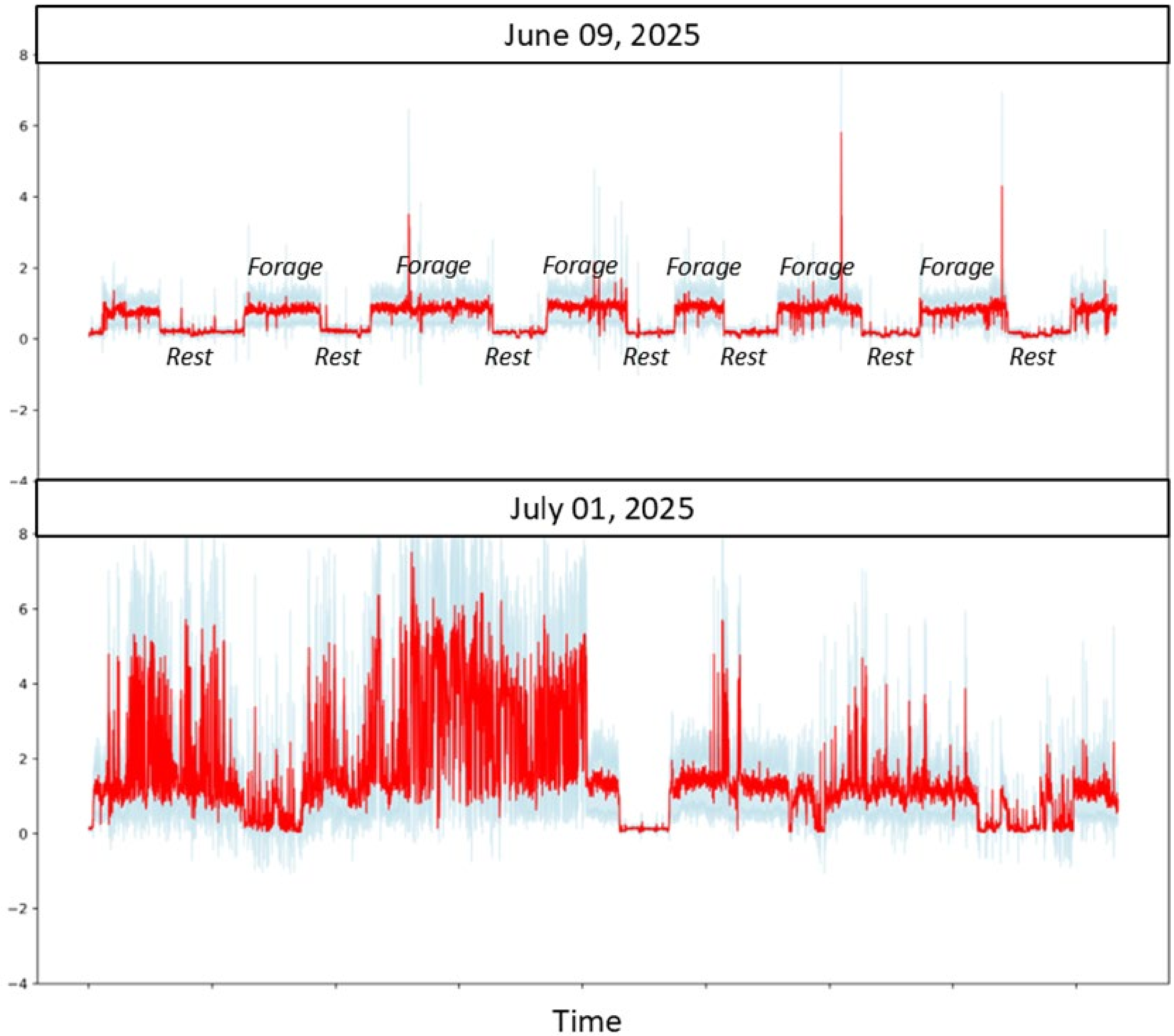


Figure 9. Fine-scale movement recorded by accelerometers over a 24-hour period for a caribou on June 9, 2025 (top) and July 1, 2025 (bottom). In early June, the typical alternating pattern of rest and foraging is clearly visible. By July 1, insect harassment has disrupted this pattern almost entirely.

In conjunction with shifts in insect activity levels, and documented (CIMP94, Species at Risk Committee 2017) and projected (CIMP241, CIMP242) increases in flying insect activity, barren-ground caribou's options to respond to insect harassment are increasingly limited. As the climate has changed over time, there are few areas where caribou can find insect relief, such as snowpack patches, which can reduce survival of cows and calves (CIMP242, Tłįchǫ Research and Training Institute 2018). Barren-ground caribou are now increasingly reliant on lakeshores for finding relief (Tłįchǫ Research and Training Institute 2018). In the Tłįchǫ region, the shores of Kǫ̀kètì (Contwoyto Lake) offer such critical respite from insects (as described previously), but access to this area may be impeded by the proposed Greys Bay Port and Road connection at Jericho Mine (Figure 10).

"The caribou in the past, in the late 1980s and early '90s used to go on the hillsides where the sun wouldn't melt the snow patches. As the summer gets warmer, later on the snow patches would turn into ice and a lot of caribou would be on them. But now we don't see that no more, because of climate change. Now we see them in the shoreline of lakes, ponds and streams, this is how they cool down."
(John Koadloak in Tłı̨chǫ Research and Training Institute 2018: 67)

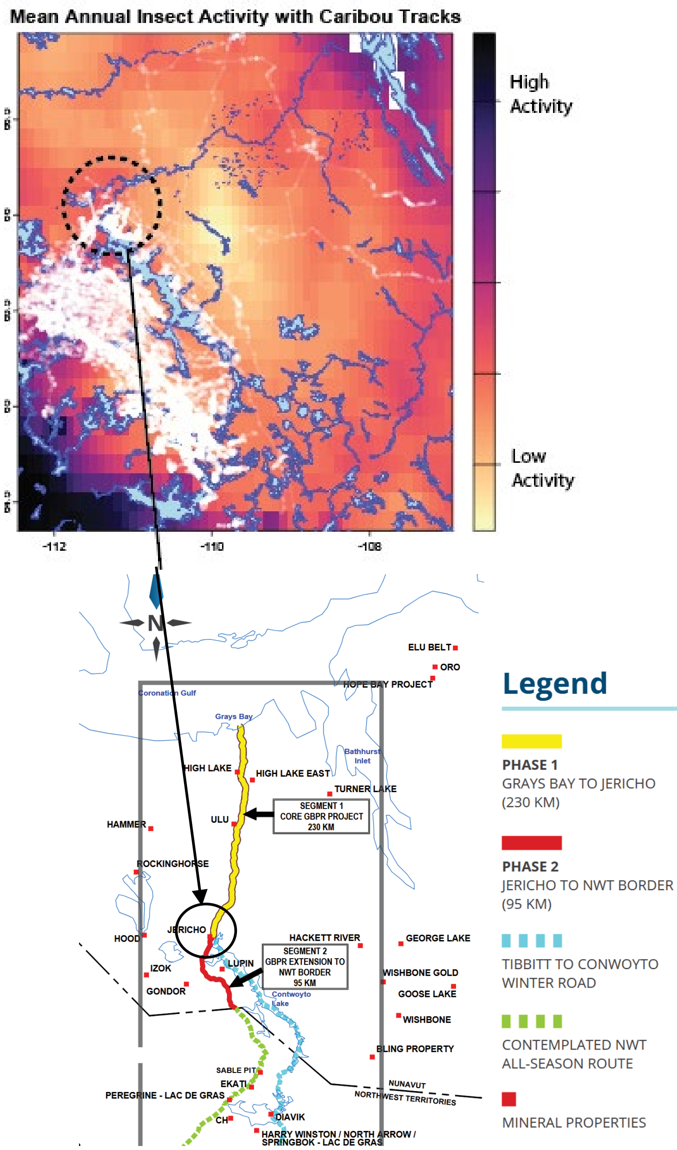


Figure 10. Average insect activity (10 km^2 resolution) using ERA5 weather data (global climate and weather data) from 2016 and 2021-2025. Movements of collared caribou are layered on top in white, capturing the July 15-August 15 period during each year. The circled area shows consistent use of the southern shore of Contwoyto Lake for relief. The lower figure shows how caribou access to this area would be limited by the proposed Greys Bay Port and Road route.

Climate change, and in particular, warming, can also dramatically alter host-parasite/pathogen relationships. Warming temperatures affect the development and infection rates of several pathogens/parasites (Kafle et al. 2020); whether these temperature changes increase infection rates and disease depends on the pathogen and its thermal tolerance, among other factors (e.g., Molnar et al. 2013, Hoar et al. 2012). However, emergence of new climate-driven pathogens and disease syndromes in Arctic caribou is likely, particularly given the shifts in insect vector activity levels described previously (e.g., mosquitoes) as greater activity levels in insect vectors are associated with a higher likelihood of pathogen transmission. For example, filarioids are nematodes (roundworms) that are transmitted by insect vectors, including mosquitoes, black flies, and midges (Figure 11). Their development time is temperature-dependent, but also, if species of flying insects that are particularly effective hosts are favoured in emerging climatic conditions, more filarioid parasites are likely to be transmitted to caribou.

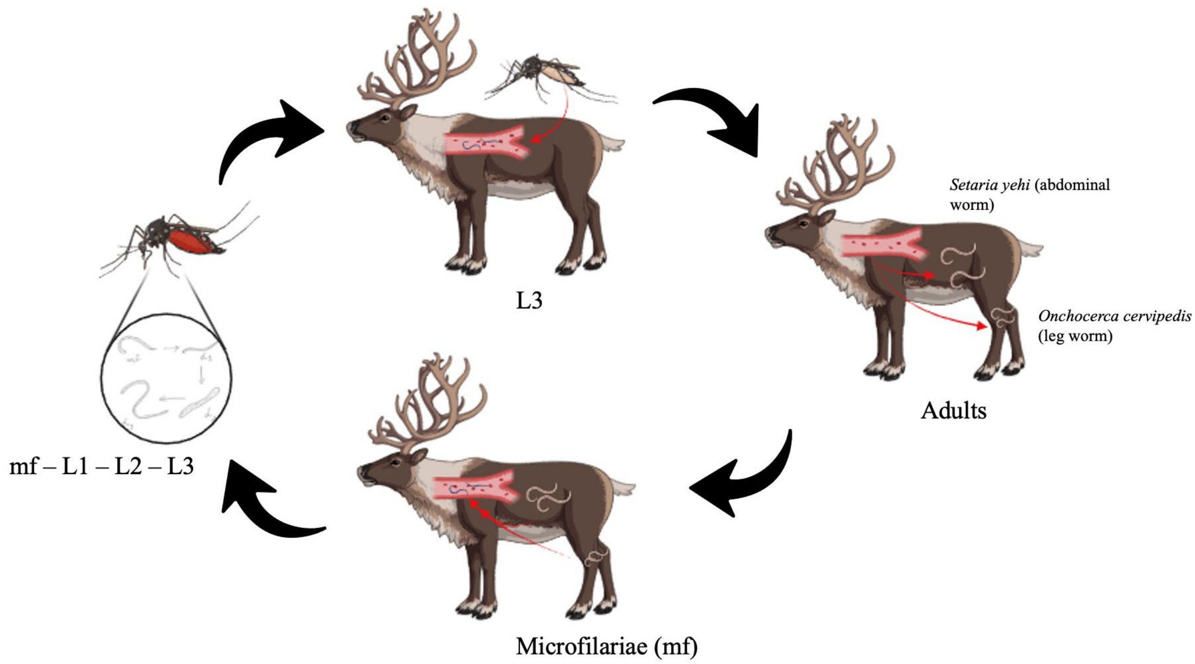


Figure 11. The life cycle of filarioid nematodes. When the insect bites the caribou (beginning of "animal" phase of the parasite life cycle), the larval stage 3 (L3) gets into the blood, and, from there, to the final destination (abdominal cavity for *Setaria yehi* [SY] and under the skin for *Onchocerca cervipedis* [OC]). There, the L3 develops to adult. Adults reproduce and lay the new larvae, called microfilariae, in the blood stream (SY) or surrounding tissues (OC). When an insect feeds on the animal, the microfilariae are also transmitted. Inside the insect ("insect" phase of the life cycle), they develop to the larval stages 1 (L1), 2 (L2) and L3, which is the stage that infects animals. The insects then bite the next animal and pass the parasite on to them. The duration of this cycle is still unknown for those species, but it is most likely that the "insect" phase occurs in summer, and the "animal" phase from one summer to next year's summer. Created on BioRender.

Shifts in when insects are most active may also affect transmission and infection rates. The possibility of mismatch developing between earlier insect emergence dates due to warmer conditions and the migration pattern of insect predators may further increase the populations of host insects (i.e., if a primary predator is absent upon their spring emergence) (Saalfeld et al. 2019, 2021, Tulp and Schekkerman 2008, Culler et al. 2015). The period over which transmission may occur could also increase (Parkinson et al. 2014, Kutz et al. 2005, Caminade et al. 2019). Although not investigated in these CBGCI studies, the groups of parasites and pathogens considered most likely to be affected by climate change include insects, ticks, and vector-borne parasites like muscle worms (Species at Risk Committee 2017).

Pathogens may also be shared among species (e.g., muskoxen, caribou) and through these relationships, show shifts in range over time. Moose are moving into the tundra region gradually (CIMP239) and may potentially bring parasites (e.g., ticks) with them, which may affect barren-ground caribou. There are several parasites and pathogens within the NWT range of barren-ground caribou (e.g., ticks, nematodes) currently showing range expansion (Chenery et al. 2023, Kutz et al. 2013). Shifts in the ranges of muskoxen and bald eagles have also been recorded (CIMP239, Tłįchǫ Research and Training Institute 2019). The effects of muskoxen range expansion on barren-ground caribou remain to be seen, but to date, impacts of bald eagle range expansion are primarily related to predation of caribou calves (Tłı̨chǫ Research and Training Institute 2019).

FEATURE BOX 2: Community-based wildlife health surveillance program detects emerging parasitic disease (CIMP239)

In September 2023, harvesters from Kugluktuk, Nunavut, reported abnormalities in many (28.9%, n = 11/38) of the caribou they harvested from the Bluenose-East herd. They reported seeing yellow-green fluid in the abdominal cavities and around the joints of these animals, as well on the fibers attached to the organs. The harvesters were naturally concerned about the safety of the meat and left these carcasses on the land, but also promptly reported these cases to their local wildlife enforcement personnel, who arranged to collect samples from the carcasses, which were then sent for diagnostic testing. Inflammation, likely associated with the filarioid nematodes *S. yehi* and *O. cervipedis* was diagnosed. These results were returned to the community and harvesters within a month of the initial reports, assuring harvesters of the safety of the meat. These two parasites have been previously recorded in barren-ground caribou (Thomas et al. 2025), but their increasing emergence as a disease-causing agent in Bluenose-East caribou affected harvester confidence in the safety of caribou meat from infected animals.

This rapid intervention, investigation, and communication is a successful example of the potential of passive community-based wildlife health surveillance programs (i.e., opportunistic collections of samples when harvesting) when combined with active agency monitoring programs (i.e., ongoing monitoring and tracking of pathogens and parasites by management agencies). It is based on three pillars: (1) the existence of a robust and rapid network of communication, (2) trust built over years of collaboration, and (3) availability of diagnostic tools. Because this surveillance and response program existed, harvesters were able to report sick animals and have their concerns addressed rapidly. Because reporting of sick animals did not result in their tag being replaced (i.e., no negative consequences of reporting), they were not discouraged from submitting the report. In this case, communication back to the community and harvesters stressed the non-zoonotic nature of the parasites involved (i.e., no risk to humans in consuming meat from infected animals), assuring harvesters of the safety of the meat from these animals.

Health

Weather and climate are not the only drivers or determinants of caribou health. The health of an animal is defined by a combination of factors, including their environment, and is related to an animal or a population's ability to cope with various stressors (Stephen 2014). In the case of caribou, stressors may include pathogens, injury, environmental changes, contaminants, or human-caused disturbances, several of which have been discussed previously. Assessing the health of an individual caribou or a population should include multiple indicators of health that capture the factors that promote or affect health, the animal's response, and the outcomes of these factors, such as population trajectory or reproductive success (Aguilar et al. 2023). Ideally, caribou health is monitored and assessed using a combination of traditional, community-based, and scientific approaches.

CBGCI project CIMP239, focusing on health of barren-ground caribou (reproductive status, stress, body condition, trace elements, parasite or pathogen exposure), drew on the existing community-based wildlife health surveillance program to assess caribou health using new and previously collected samples from harvested caribou (2015-2025). This work connected observations of change in the environment to where caribou are encountered, how they were encountered, and how healthy they were, focusing on Bluenose-East and Dolphin and Union caribou. It ultimately helped build a more complete understanding of the health of barren-ground caribou.

Results showed lower average pregnancy rates in Bluenose-East cows (69%, CI = 50-83%, n = 32) than in Dolphin and Union cows (80%, CI = 68-88%, n = 70), although samples were largely drawn from pre-2020 samples and are, as such, not a true reflection of recent reproductive health. Sample sizes were quite small overall, particularly in recent years, because harvested animals were more likely to be males or harvested in early fall, when pregnancy diagnosis is not accurate. These pregnancy rates are considered low in comparison to pregnancy rates in increasing herds, which is thought to be approximately 90% or higher (Joly et al. 2015). Looking more recently, monitoring work conducted by the Government of the Northwest Territories shows that pregnancy rates across collared NWT barren-ground caribou have been generally high in recent years, with the exception of 2022, across all herds (Kelly pers. comm. 2026). While moderate pregnancy rates could reflect a stable population, and high pregnancy rates could reflect population recovery, more data on current pregnancy rates and calf survival are needed to make conclusions on future herd trajectories.

Stress hormones (e.g., cortisol) sampled in 2017, 2019, 2023, and 2024 differed by year and by herd. In 2017, 2019, and 2023, stress hormones were similar between the two herds or higher in Dolphin and Union caribou than in Bluenose-East caribou, while in 2024, Bluenose-East stress hormone levels were higher than in Dolphin and Union caribou. This may indicate changes in the stressors that Bluenose-East caribou are experiencing, beyond what they have adapted to (Ewacha et al. 2017). Sample sizes were small in recent years (2023 and 2024) due to delays in analysis; further work is required to draw more accurate conclusions on current stress levels.

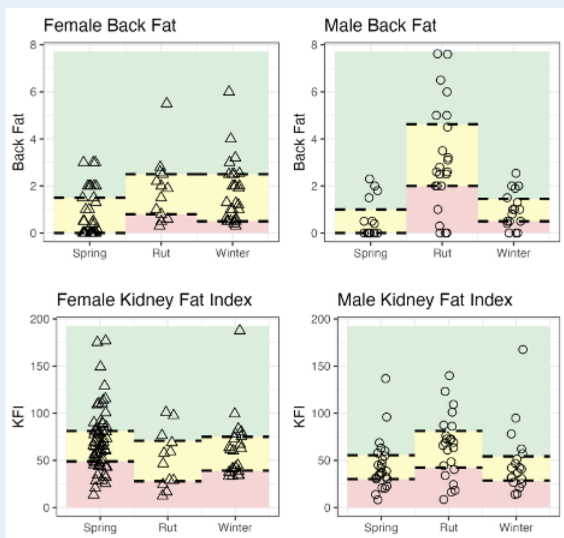
Body condition is a key indicator of individual fitness and reflects an animal’s fat reserves and nutritional state, which both drive survival and reproduction. Body condition can decline due to inadequate nutrition (i.e., lack of quantity or quality) and/or increased energetic demands (e.g., internal or external parasites, illness, pregnancy, lactation). CBGCI project CIMP239 assessed body condition using four metrics from harvester collected samples: hunter condition score, back fat thickness, kidney fat index, and percent bone marrow fat. When an animal loses fat, they will first lose it first from external stores (back fat), then from around the organs (kidney fat), and finally from the bone marrow. The hunter condition score is a composite measure based on the hunter’s impression of the animal. These scores can be considered individually or can be combined into a framework for considering body condition scores collectively (see Feature Box 3, below).

FEATURE BOX 3: Body condition traffic light framework (CIMP239)

Metrics of body condition (hunter condition score, back fat thickness, kidney fat index, and percent bone marrow fat) have been applied to build a traffic light framework that allows the user to estimate how body condition may be affecting the caribou population.

Data from the Dolphin and Union herd (2015-2026) were used to defined expected ranges (benchmarks) for each metric by sex and season (March-May, August-October, and November-February). Scores around the benchmark are considered normal (amber), while scores well below or above the benchmark were considered below (red) or above (green) average. How the benchmarks are defined depends on the sex of the animal and the season. For example, back fat is lowest in spring (March-May) and peaks during mating and rut (August-October), with males showing more pronounced seasonal fluctuation than females.

This traffic light framework will next be applied to the Bluenose-East herd. While benchmark values may need to be adjusted given herd-specific differences in the target metrics, this traffic light framework is expected to be a practical tool for ongoing management.



Feature Box Figure 3.1. Preliminary body condition traffic light framework for Dolphin and Union caribou, derived from data collected between 2015 and 2026.

The nutritional status of caribou must also be assessed as a determinant of health. Both Bluenose-East and Dolphin and Union caribou are low in copper compared to established ranges in cervids (Puls 1994). The copper content of Dolphin and Union caribou hair exhibited a small but biologically significant decline from marginal to deficient from 2018 to 2025, while Bluenose-East caribou have remained marginal from 2015 to 2024. Copper is an essential micronutrient for ungulate reproduction and fetal development, with the capacity to affect population trajectory (Soetan et al. 2010, Dickinson et al. 2025, Oster et al. 2024). Low copper status has also been shown to correlate with reduced body condition and antler size in cervids (Handeland et al. 2017, Rankins et al. 2023). The hair of both Bluenose-East and Dolphin and Union caribou is also low in iron compared to normal ranges in cattle, who use iron for the same function as caribou (Puls 1994). Iron deficiencies are rare, but since copper plays a role in iron utilization, low copper could be responsible for the low levels of iron observed in caribou hair (Van Soest 1994, Soetan et al. 2010). Bluenose-East caribou also had higher levels of selenium than Dolphin and Union caribou, but these levels have declined from adequate (pre-2020) to marginal (post-2020), relative to selenium ranges in other cattle (Puls 1994). Low selenium in ruminants is associated with impaired immunity, reproduction, and growth, and has been found to be limiting for populations (Soetan et al. 2010, Flueck et al. 2012, Dickinson et al. 2025). Trace element imbalances in the Bluenose-East herd could endanger the health and stability of the population or make them more susceptible to other threats. We hope to gain a clearer picture of potential trace element imbalances in the Bluenose-East herd as we continue to process samples from the most recent survey years.

CBGCI project CIMP239 also recorded a diversity of infectious agents in barren-ground caribou, with various bacteria, viruses, protozoa, and parasites present in the population, though with variable infection rates and impacts different across pathogens (Table 3). Of particular concern are *Brucella*, filarioid nematodes, and pestivirus. Bluenose-East caribou had minimal exposure to *Brucella* relative to Dolphin and Union caribou, but the prevalence in the latter herd is concerning, given that *Brucella* infection is known to lower body condition, birth rate, and even survival (Aguilar et al. 2023). Bluenose-East had a higher prevalence of filarioid nematodes (28.9%) and pestivirus (often >10% and 30-75% in recent years) than Dolphin and Union caribou in recent years. Severe inflammation has been associated with filarioid infection in Bluenose-East caribou, and as described previously, increased prevalence of this pathogen is expected as flying insect activity increases (as vectors for transmission). Fennoscandian research suggests that summers with mean temperatures above 14°C result in severe disease in caribou infected with filarioids in the second summer following infection (Laaksonen et al. 2020). This is particularly relevant given the results of CBGCI project CIMP241, which reported decreases in survival of adult female caribou at average summer temperatures exceeding 14°C. The impacts of pestivirus in caribou is not well known, but infection has been associated with fever, diarrhea, coughing, hemorrhage, and death in livestock (Schweizer and Peterhans 2014).

The impact pathogens may be having on barren-ground caribou at the population level is still uncertain (SARC 2017), but it is known that infections affect caribou throughout the year, rather than just during the summer season, and it is possible infections could result in population level effects should their transmission or infection rates increase sufficiently. When barren-ground caribou were assessed as Threatened under the *Species at Risk (NWT) Act* in 2017, infection rates across herds were considered fairly low (SARC 2017). CBGCI project CIMP241's survival analyses included many of the health metrics described above (i.e., pregnancy status, exposure to various pathogens, body condition, and serum biochemical indicators of stress), with health data collected at the time animals were collared and including animals captured from 2012 onwards. Their results, in both the year following capture and over the full collared lifetime of the animal, showed no strong relationships between these metrics and mortality. This is a positive finding – it suggests that animals being collared are in good health, that previous exposure to tested pathogens had not increased their likelihood of death compared to non-exposed caribou, and that the collared sample is reasonably representative of the broader population (i.e., captured animals were not more likely to be ill than the general population). Seroprevalence also reflects survived exposure rather than active infection, so seropositive animals have already mounted an immune response and are not necessarily at greater risk of mortality. That said, survival analysis necessarily misses potentially important sublethal effects. Declining condition likely develops gradually over months and animals can survive in spite of sublethal stressors until those stressors pass critical whole-animal thresholds (either alone or in combination with other stressors). Declining condition in this context may be better captured by continuous behavioural metrics such as daily movement rate than by point-in-time health assessments at capture.

CBGCI project CIMP241's movement analyses offer a complementary approach to identifying animals in poor health. Contrary to the general expectation that increased movement exposes animals to greater risk, reduced movement consistently predicted higher mortality across all herds. Movement rates declined detectably in the weeks prior to death (up to 28 days in females and 49 days in males (Figure 12)) suggesting that low movement functions as a symptom of deteriorating body condition. Isolation also influenced mortality; animals positioned on the periphery of their herd faced higher risk regardless of movement rate, pointing to a safety-in-numbers mechanism where group membership confers survival benefits through collective vigilance and predator dilution. Together, these results suggest that continuous behavioural metrics derived from GPS collars (movement rate and spatial position) may represent good indicators of individual condition and mortality risk that are not able to be captured in point-in-time health assessments.

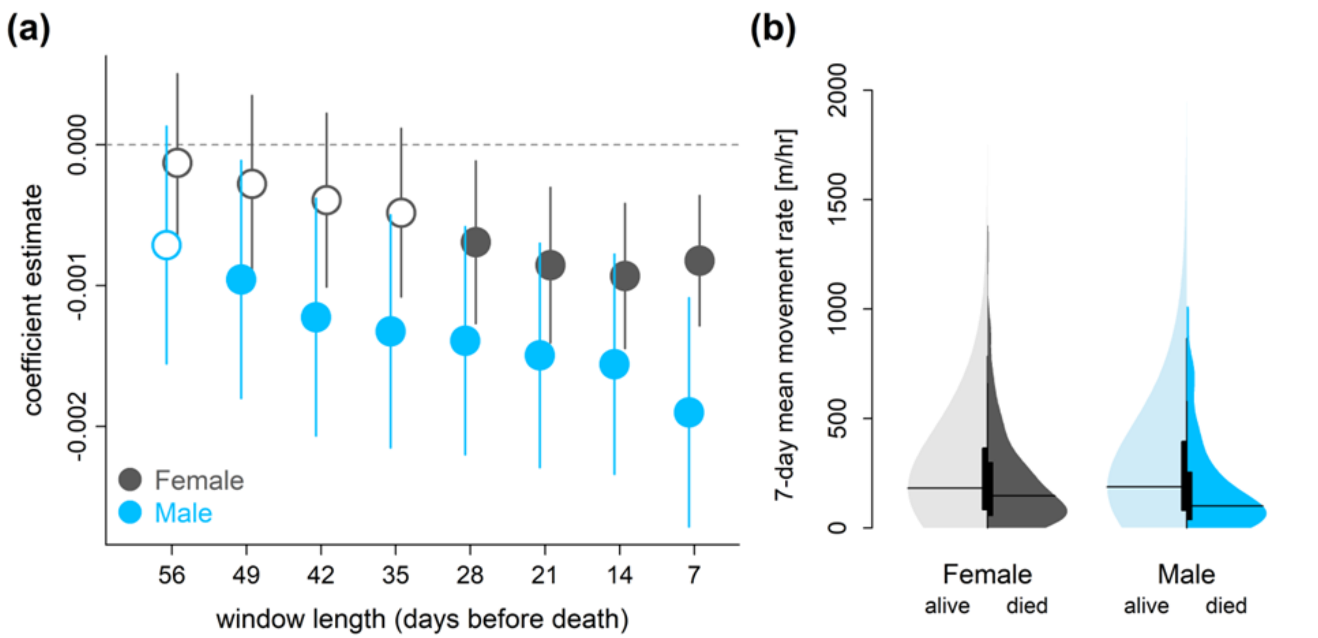


Figure 12. Movement rates prior to death for female (grey) and male (blue) barren-ground caribou across the Tuktoyaktuk Peninsula, Cape Bathurst, Bluenose-West, Bluenose-East, Bathurst, and Beverly herds. (a) The relationship between movement rate and probability of death across different time windows (7 to 56 days before death), where negative values indicate that animals that died were moving less than those that survived. Filled points indicate statistically significant relationships, with 95% confidence intervals; the dashed line indicates no difference. (b) Comparison of average movement rate (m/hr) over the seven days surrounding a death event for individuals that survived (light) versus died (dark) on that date.

Overall, the information on health indicators gathered by CBGCI projects helps improve our understanding of the body condition stressors that barren-ground caribou sustain. Several gaps in understanding remain, including the causal relationships between the different health indicators and defining indicator benchmarks to predict population trajectories (i.e., the traffic-light system). One example currently being explored is the causal relationship between pathogens and individual fitness or population growth rate. Ultimately, health indicators should continue to be monitored as this work provides early warning signs of population-level effects and helps communities understand what pressures caribou may be facing. However, caution should be employed in the interpretation of the results. We stress that observed levels of past and current infection can be found in healthy populations of caribou and that all animals normally and routinely host a variety of parasites and pathogens, which only become potentially impactful to their health when combined with other stressors, a weakened immune system, etc.

Table 3. CBGCI project-related updates to pathogen diversity and infection rates in Bluenose-East and Dolphin and Union caribou.

Pathogen	Herd/population		Impacts
	Bluenose-East	**Dolphin and Union**	
Brucella suis bovar	<1% (seroprevalence[6] very low) (Hee et al. 2026)	~16% (seroprevalence ranging from 0-31%) (Hee et al. 2026)	Association between *Brucella* past or current infection (seropositivity) and lower body condition, birth rate, and possible survival (Aguilar et al. 2023).
Filarioids	High prevalence (*Onchocerca* and *Setaria*). 28.9% (11 out of 38 total animals) of the harvested caribou in Kugluktuk at the end of summer/beginning of fall 2023 presented with abnormalities potentially related to infestation by filarioid nematodes.	No *Onchocerca*, lower prevalence of *Setaria* than Bluenose-East caribou. Only one individual was reported showing abnormalities potentially related to infestation of *S. vehi*.	Severe pathology and inflammation have been associated with the emergence of the two filarioid parasites known to occur in Bluenose-East caribou. It is unknown if this is a result of high exposure/high parasite intensity, increased susceptibility (due to other stressors), or a host switch (i.e., from moose). Suspect at least one other species present. Impact at the population level is unknown. *Setaria* outbreaks (mosquito-borne) are a new occurrence in barren-ground caribou.
Pestivirus/ Circulating border disease virus type 1[7]	Often >10% sample seroprevalence, with interannual variability. Seroprevalence ranged from 30-75%, with higher seroprevalence in recent years. Higher seroprevalence than in Dolphin and Union caribou for 2023-2025 (Hee et al. 2026). Border disease present.	Other than higher seroprevalence in 2015-2016 (46-60%), often <20% sample seroprevalence, with interannual variability. Lower than Bluenose-East caribou in recent years. Border disease present.	Not well known in caribou, but in livestock can cause fever, diarrhea, coughing, hemorrhage, and death (Schweizer and Peterhans 2014). Can also cause persistently infected animals, who transmit the virus to other animals but may not themselves show clinical signs. High confidence that border disease is circulating in both Bluenose-East and Dolphin and Union caribou, but uncertainty regarding its effect on recruitment. In other species, border disease virus infections can induce abortion or stillbirths, or may affect the immune systems of calves, leading to lower immunity during acute infection, secondary infections, and higher disease rates. Infection also reduces fertility in many animal species. Health effects in caribou are not known.
Erysipelothrix rhusiopathiae	Seroprevalence variable and higher than Dolphin and Union caribou for 2023-2025;	Seroprevalence variable but low since 2018 (Hee et al. 2026).	Health effects in caribou are not well known, but the pathogen has been isolated from found carcasses of caribou in Alberta and British Columbia (Forde et

[6] Seroprevalence means the proportion of samples that were positive for an infectious agent; positivity is determined by whether there are antibodies in the blood or not, meaning we are measuring if the animal was exposed to an infectious agent, not if they are actively infected.
[7] Border disease is a member of the pestivirus group.

	may be increasing in comparison to before 2020 (Hee et al. 2026).		al. 2016). Bacterium implicated in muskoxen mass mortalities in the Canadian arctic (Kutz et al. 2015).
Herpesvirus	~38-88% sample seroprevalence, with interannual variability (Hee et al. 2026).	~11-92% sample seroprevalence (Hee et al. 2026).	There are many different herpesviruses, and as such, it is difficult to comment on their impact. It is likely that every caribou is infected with one or more herpesviruses. Broadly, herpesviruses may cause various health issues (lesions, respiratory disease, death of young, abortion). Infection is lifelong, with periods of latency and reactivation during times of stress (das Neves et al. 2010).
Neospora	Only assessed in 2017-2019 samples. Seroprevalence <10% in all three years (Hee et al. 2026).	Exposure variable; some years quite high (e.g., 2020 with ~47%), though not assessed in recent years (Hee et al. 2026).	May cause abortions in caribou (Kutz et al. 2019).
Toxoplasma	Seroprevalence between ~20-34% most years (Hee et al. 2026).	Seroprevalence with interannual variability and a relative decline over the years (Hee et al. 2026).	May cause abortions in caribou (Kutz et al. 2019). Concern for human health as it is zoonotic (can be spread to humans) and may cause abortions or fetal abnormalities.

Complementing this work on caribou health monitoring, CBGCI project CIMP240 (see Part 2) examined the epigenetic (gene activity in individuals) and genetic (herd-level measures like inbreeding and diversity) responses of multiple barren-ground caribou herds to contaminant exposure in their environment. These dimensions of caribou health reflect a herd's capacity to adapt over time. Caribou are exposed to contaminants through their food (especially lichen, which absorbs airborne pollutants) and through their broader environment (Lessard et al. 2026). Sources of some of these contaminants may be natural (e.g., mercury from local geology) or human-caused (e.g., PCBs from industrial use). Communities have expressed concerns about unremediated or partially remediated mine sites east of Great Bear Lake, where lingering contaminants are perceived to affect caribou health, habitat use, and broader ecosystem integrity (CIMP239).

Human-produced contaminants can travel long distances through atmospheric circulation, with the western Arctic receiving contaminants primarily from Asia and the eastern Arctic primarily from the United States (Burkow and Kallenborn 2000, Bard 1999). As global plastics production continues to increase, caribou exposure to plastic-derived contaminants is expected to increase (Burkow and Kallenborn 2000, Bard 1999). Melting permafrost can also release contaminants into the local environment. Acid-generating rock that has not been exposed to water in thousands of years and that is now being exposed may make nearby streams more acidic and some elements more available for uptake by plants and animals (O'Donnell et al. 2025).

FEATURE BOX 4: Border disease virus ELISA (enzyme -linked immunosorbent assays)

This tool is used to detect the immune response (formation of antibodies) in animals following infection with a pathogen. An ELISA test tells us whether an animal had been infected or not before sampling, rather than whether it is actively infected. This tool was tested in 2016-2021 samples from barren-ground caribou of the Bluenose-East and Dolphin and Union herds, from the area of Cambridge Bay and Kugluktuk, Nunavut. While viruses were the focus of CBGCI funded work associated with ELISA tests, these tools can be used to test for other infectious agents as well. ELISA tests are used for most of the pathogens noted in Table 1. Many of these tests are standard in the veterinary field. However, project CIMP239 developed a new ELISA to identify whether caribou had been infected with 'border disease virus' (BDV strains 1, 2, 3, and 8). These tools helped us build understanding of the diversity of pathogens affecting barren-ground caribou, which is essential for understanding their impacts.

Results from the Bluenose-East, Beverly, Porcupine, Qamanirjuaq, and Tuktoyaktuk Peninsula herds suggest that the most important factors shaping caribou gene activity are their diet and environment. Each herd was found to have a distinct contaminant profile, likely reflecting differences in diet, habitat, and geography. Additional chemical profiling revealed a handful of rubber-derived additives that have not been previously detected in caribou. These same additives were also found in lichen samples collected from herd ranges. The detections were too sporadic to assess biological impact, but their presence is a new finding that should be tracked in future monitoring cycles. In response to community concerns about the spraying of fire suppressants and retardants, samples were also screened for the key chemical ingredients in these sprays. None were found in lichen or caribou tissue, likely because these chemicals break down quickly in the environment.

Of all the contaminant classes measured, plastic additives (UV stabilizers, photoinitiators, and organochlorines used in consumer plastics) had the largest biological influence on caribou, producing the strongest coordinated shifts in both liver gene expression and DNA methylation (chemical “on/off” tags on the DNA that regulate gene activity). Some elements (such as cadmium and mercury) and PFAS (“forever chemicals”) also left measurable fingerprints on gene activity, but the plastic-additive signal was the clearest and most consistent across the different molecular layers examined. Notably, the analysis identified two specific positions on the caribou genome where these methylation tags shifted with plastic-additive exposure, the only individual-position findings to survive the most stringent statistical filters. Both positions sit in stretches of DNA that are unique to caribou and do not appear in humans, cows, or any of the other mammals compared against; neither position falls inside a known gene, so their function is unclear, but they likely represent caribou-specific molecular biomarkers that could be valuable for tracking plastic-additive exposure in future monitoring. To our knowledge, these are the first reported molecular markers of plastic-contaminant exposure in wild caribou anywhere, and we are not aware of analogous markers reported in other wild mammals.

On the genetic side, all five herds were found to have relatively healthy levels of genetic diversity, meaning they currently retain a broad enough range of genetic variation to respond to future challenges. However, the results also revealed important differences between herds that have direct implications for management. The Bluenose-East herd stands out as the most urgent contemporary genetic concern in the study. Based on the genetic data collected, it is currently functioning as if it has an effective breeding population roughly an order of magnitude smaller than any other herd in the study and may be below the threshold generally considered the minimum for maintaining long-term evolutionary viability (Frankham et al. 2014). The Porcupine and Qamanirjuaq herds also show moderately elevated levels of recent individual inbreeding. Porcupine caribou, in particular, have a genomic signature that reflects a historical contraction of roughly 13-fold over the last several centuries; the deepest historical bottleneck detected among the five herds we studied. Fortunately, the herd’s contemporary breeding population has since recovered, and it currently shows no unusual buildup of harmful mutations. For the Qamanirjuaq herd, these results represent a mating-pattern signal. That is, only a small fraction of the total number of bulls in the herd do most of the breeding and reproductive success in females in uneven. Any social or spatial structure within the herd (e.g., calving ground fidelity, matrilineal groups) shrinks the realized mating pool further. As such, a population decline does not need to be visible for inbreeding of this nature to occur and is not evidence of a herd-wide bottleneck. While not immediately critical for the Porcupine and Qamanirjuaq herds, sustained inbreeding over time erodes genetic diversity and can reduce a herd’s ability to adapt. For these herds, the priority is supporting population stability or growth so that inbreeding does not continue to rise, and for Bluenose-East in particular, that priority is more acute given its very small contemporary effective size. This means maintaining conservative harvest levels and protecting key calving and post-calving habitat to give these herds the population stability they need to maintain or rebuild genetic diversity over successive generations.

The large Beverly herd face a different kind of vulnerability. These herds carry a high number of harmful genetic variants that are currently masked by healthy back-up copies of the same genes (most genes come in pairs, one inherited from each parent, so a healthy copy can compensate for a harmful one). As long as populations remain large enough and inbreeding stays low, these variants stay hidden. But if either herd were to experience sustained population declines or increased inbreeding, these hidden variants could be unmasked, potentially reducing survival and reproduction. For these herds, the priority is to avoid sudden or prolonged population declines that could trigger this unmasking. This calls for particular vigilance around cumulative effects from development, habitat disturbance, and harvest pressure during periods of low abundance, because the consequences of decline could be more severe and harder to reverse than in herds without this genetic load.

Overall, these findings show that each herd faces a distinct combination of contaminant exposure and genetic vulnerability tied to its range. Rather than a one-size-fits-all approach, the results support herd-specific management strategies that should account for these differences. Ongoing monitoring of both contaminant levels and genetic indicators will be important for tracking whether current management actions are sufficient, and the research team intends to work with communities and co-management partners to ensure these results can feed directly into herd management planning and decision-making.

Human development

Human development, and industrial development in particular, is likely one of the most important variables adversely affecting barren-ground caribou within the NWT (Species at Risk Committee 2017). Development footprint and associated human activity can affect caribou population dynamics through habitat loss and fragmentation, displacement, altered behaviour (activity), and increased harvest and predation pressure. Roads, in particular, are a high concern for communities, (Species at Risk Committee 2017) (Figure 13).

Figure 13. Caribou on Mackay Lake, 2026. Photo: Petter Jacobsen, Tłı̨chǫ Government.

The Tłı̨chǫ Government and North Slave Métis Alliance collected information about harvesting, predation, and caribou health and behaviour along the Tibbitt-to-Contwoyto winter road and Gahcho Kue spur road (CIMP94/243). Their results provide insight into how roads affect caribou, as well as estimates of harvest and harvest rates in the area of these roads, filling a large information gap.

During February and March 2025, North Slave Métis Alliance guardians documented 70 independent gut pules with an average of 20 caribou per gut pule (90% credible interval 16-26), with instances of wastage present at approximately 10% (range = 4.5-19%) of observed gut piles (Phelan et al. in review). Using this information and extrapolating across the season and length of the road, an estimated 2,814 (90% CI = 2,610-3,150) barren-ground caribou were harvested and butchered directly along the Tibbitt-to-Contwoyto winter road (Phelan et al. in review). Tłı̨chǫ monitor observations further suggest that about half of the harvest occurred on the land and away from the road (Jacobsen pers. comm. 2026); as these were not captured in the above estimate, this suggests a true annual harvest along the Tibbitt-to-Contwoyto winter road may be closer to 5,000 animals. Tłı̨chǫ monitors also recorded 12 cases of meat wastage[8] at gut piles, along with seven wounded but living caribou with visible bullet damage.

We note that harvest in 2025 may have been higher than in other years given that most of the winter road on Mackay Lake and Lac de Gras, plus the Gahcho Kue spur road, were west of the Mobile Core Bathurst Caribou Management Zone (a no-hunting zone). More information is needed to determine if this level of harvest is sustainable, particularly herd and sex class information. However, if all harvested animals were from the larger Beverly herd (which is considered likely), this would represent between approximately 1.85% (2,814 animals harvested) and 3.29% (5,000 animals harvested) of the total herd.

Considering harvest near roads through the lens of simulation (assuming 5% of caribou within 10 km of a road will be harvested) and spatial harvest restrictions notwithstanding, proximity to roads could have a moderate to large effect on Bathurst caribou population dynamics (38% population reduction by 2050), a low effect on Bluenose-East and Cape Bathurst caribou (4% and 2% population reduction by 2050), and negligible impact on Bluenose-West and Tuktoyaktuk Peninsula caribou (<1% population reduction by 2050) (CBGC ALCES n.d.). However, it is important to note that this simulation does not capture the influence of the Mobile Core Bathurst Caribou Management Zone (mobile no-hunting zone) that was established in January 2015 and is the means for managing and implementing the total allowable harvest of zero for the Bathurst herd in the NWT (Wek'èezhìı Renewable Resources Board 2019a). Harvest of any caribou is prohibited within the mobile no-hunting zone. The benefit of the mobile no-hunting zone is, however, underscored by these harvest simulations. Greater vulnerability to future harvest in the Bathurst herd reflects substantial range overlap with the proposed Arctic Economic and Security Corridor. This road would also affect the Beverly and Bluenose-East herds, while the Cape Bathurst herd is primarily affected by the Inuvik-to-Tuktoyaktuk Highway.

North Slave Métis Alliance and Tłı̨chǫ Government monitors also observed cases of disrespectful harvest practices[9] adjacent to the roads (Figure 15). This included over-harvesting, a wounding and meat wastage (see rates of wastage described above), littering, and unsafe shooting (i.e., near misses of other people). Instances of wastage and wounding were reported to GNWT Renewable Resource Officers by monitors each year so that enforcement action could be pursued. Because of snowfall and road maintenance efforts, gut pules were visible for only a few days following their deposit.

It must be emphasized that cases of disrespectful harvest should not colour perceptions of most hunters. Only a small portion of the total harvest would be considered disrespectful. However, the presence of the road allowed hunters to drive in close proximity to areas where caribou were congregating, and hunt and butcher them with relative ease, which can facilitate disrespectful harvesting among those harvesters who

[8] Cases of meat wastage consisted of most of the animal being left behind, with just the legs taken.

[9] Disrespectful harvest, in this context, refers to traditional laws and protocols for harvest not being followed (e.g., taking more than you need, wastage, harassing wildlife).

have not been appropriately educated in respectful harvesting practices or who are disinterested in these protocols. This disrespectful harvest is the practice that should be the point of focus in mitigation and enforcement. Harvesting is an important cultural tradition in the region, informing practice, language, and ways of life. However, researchers suggest that the ease of harvesting off the winter road encourages disrespectful harvest practices and suggest that emphasis should be placed on shifting harvest pressure from the winter along the road to the fall, or to areas further away from the road.

"Saw carcasses near ice road, only quarts and back strap taken. Left heads and most of the carcass. Lots of wastage. What a tragedy. I was happy to see caribou moving and that mobile zone moved to protect them." (NSMA guardian observation form)

Figure 14. Wasted caribou carcasses on Tibbitt-to-Contwoyto winter road (left photo: Mackay Lake, 2025, Petter Jacobsen, Tłı̨chǫ Government; right photo: North Slave Métis Alliance).

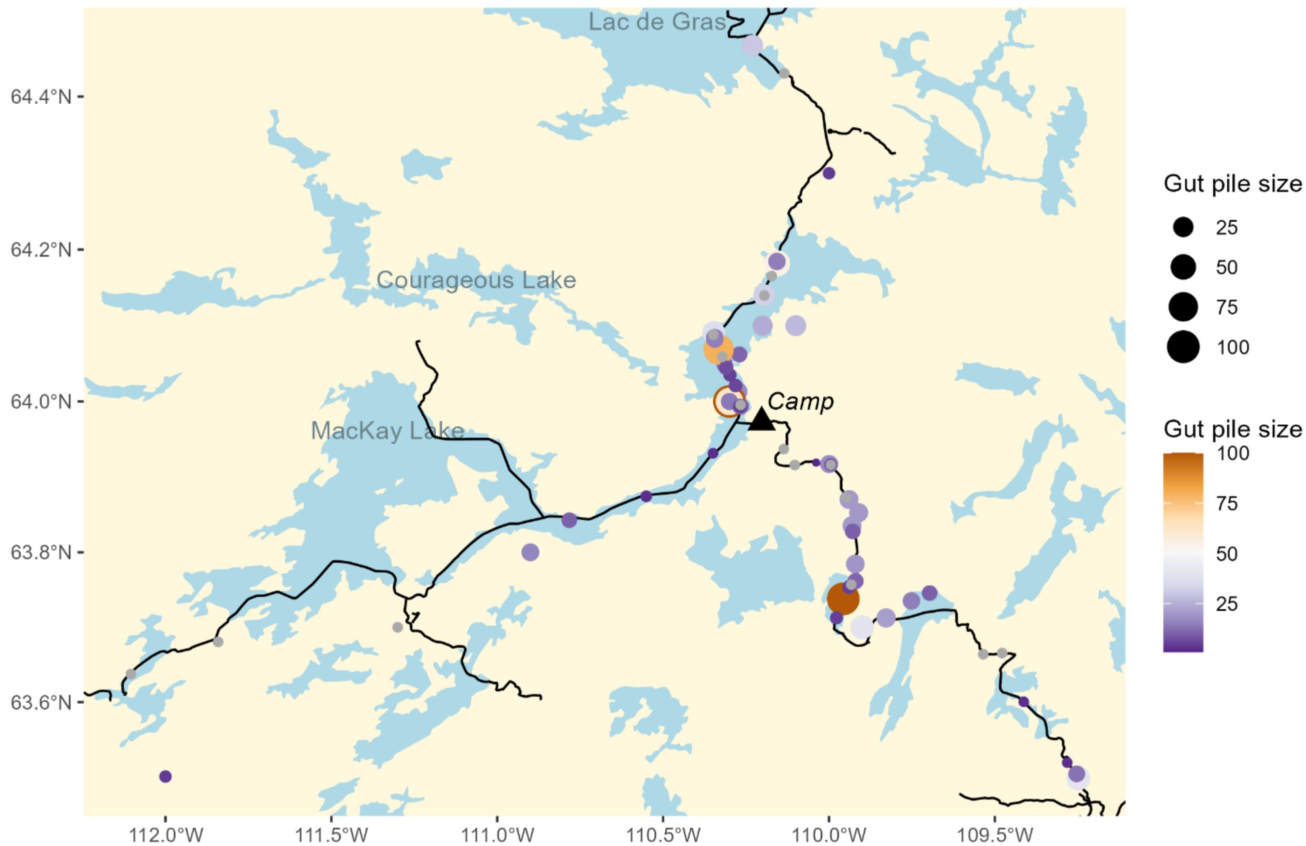


Figure 15. Map of gut pile observations by North Slave Métis Alliance guardians in 2025. The colour and size of the point correspond to the number of animals a given gut pile represents (courtesy North Slave Métis Alliance and A. Cox).

Gut piles left by hunters also serve to attract scavenging wolves to the area (Figure 16), which may increase predation pressure on caribou whose congregation near road already serves to attract wolves. Certainly, monitors have described an 'influx' of wolves attracted to both the gut piles and animals congregated near roads (Jacobsen 2026). In this context, the presence of the road also changes how wolves themselves are harvested. For example, guardians monitoring the Tibbitt to Contwoyto winter road have reported instances of harvesters shooting wolves from directly beside the road and creating an unsafe environment for other harvesters.

Wolf management has, and continues, to be pursued in this region, in an effort to reduce predation pressure on barren-ground caribou. Most recently, this has been done through the wolf harvest management program, which supported enhanced wolf harvest through financial incentives to harvesters. There is interest among management authorities in the region in determining the impact this wolf management program is having on wolf population dynamics and barren-ground caribou. A review of the enhanced wolf harvest incentive is currently ongoing.

Figure 16. (a) Wolf scavenging discarded caribou gut pile along the Tibbitt-to-Contwoyto winter road (photo: North Slave Métis Alliance). (b) Wolf feeding on caribou, 2025 (photo: Petter Jacobsen, Tłı̨chǫ Government).

Instances of harassment were also recorded by monitors. For example, monitors from the Tłı̨chǫ Government recorded low flying of a helicopter over Bathurst caribou in September 2021, associated with mine surveying and exploration. In one instance, flight altitude was estimated at just 20 m and occurred directly above a group of Bathurst caribou. The presence of the aircraft making repeated low passes over the same area caused the group of caribou (bulls, cows, and calves) to move away from the area (Tłı̨chǫ Research and Training Institute 2022). These instances were reported to the mining company, and the low-level flying was stopped for that time period when caribou were in the area. Likewise, passing mine vehicles sometimes interrupted caribou attempting to cross the road. For example, in 2024, North Slave Métis Alliance guardians noted 150 caribou starting to cross the Tibbitt-to-Contwoyto winter road. A passing mine vehicle startled the group, which split into two smaller groups, with one group refusing to cross the road thereafter. Five additional animals stayed on the road itself for some time after this encounter, apparently too confused to move away in any direction (CIMP243). This type of interruption is to be expected if staff are not in the vicinity to alert officials to the need for a temporary halt to traffic to permit caribou crossing as stopping vehicles on the ice road itself represents a safety hazard (i.e., excessive vehicle weight on ice).

"Profiler scared caribou while crossing the road. Came too close to them. Security took our name. Now caribou on the west side are heading south instead of crossing. 5 stragglers on the ice road for one hour. They're very interested in the surface. Sniffing around a lot." (NSMA guardian observation form)

It is worthwhile highlighting that the observations presented above (i.e., disrespectful harvest, scavenging, harassment, interruption) were recorded and reported only because Indigenous guardian programs were present on the roads. The simple fact of their presence meant that instances of disrespectful harvest were more regularly reported, and officers could be directed to the appropriate areas to pursue enforcement action. Regular presence of monitors on roads also minimized instances of disrespectful harvest (i.e., these actions are typically only done in the absence of witnesses), which helped increase compliance with harvesting regulations and best practices without needing to rely on enforcement actions. The presence of monitors in the area also allows for monitoring to be conducted in real time and can help prevent (e.g., temporary halt to traffic) and address activities (e.g., low flying) that are negatively affecting caribou.

Looking more broadly at barren-ground caribou range in the NWT, the current direct development footprint is 530 km^2, accounting for <0.1% of the 822,965 km^2 area within the ranges of the Bathurst, Cape Bathurst, Tuktoyaktuk Peninsula, Bluenose-East, and Bluenose-West herds (CBGC ALCES n.d.; Figure 2). Within this area, over the next 40 years and considering projects that are known or reasonably foreseeable, development footprint is projected to increase by 159 km^2, to cover 689 km^2 of the area. The largest area of projected growth was road expansion in the Slave Geological Province Corridor, such that the Bathurst range was the most affected (Stubbs et al. 2023). The degree to which herds were affected by development footprint was assessed by comparing the location of habitat to footprint zones-of-influence (1-15 km buffer depending on type of footprint, consistent with the Bathurst Caribou Range Plan; Government of the Northwest Territories 2019). Based on overlap between habitat and zones-of-influence, Bathurst caribou are estimated to spend, on average, 18% of the year within the footprint zones-of-influence (Bluenose-East = 3.5%, Bluenose-West = 0.5%, Cape Bathurst = 2.8%, Tuktoyaktuk Peninsula = 2.2%) (CBGC ALCES n.d.). However, this assessment reflects development footprint across the historic range of the focal herds, not current, contracted ranges, and these simulations should therefore be interpreted with caution. Within their current range, the Bathurst herd is the herd that interacts the most with existing infrastructure, with CBGCI project CIMP241 estimating that 71% of Bathurst caribou collar locations occur within 10 km of active roads (Beverly = 52%, Bluenose-East = 18%, Bluenose-West = 4%, Cape Bathurst, Tuktoyaktuk Peninsula = 8%), although these figures reflect only periods when roads are open to traffic, and the proportion of locations falling within the road footprint would be higher if winter roads were included regardless of operational status. Applying this idea (portion of habitat within 10 km of a road) to CBGC ALCES (n.d.) simulations for 2050, a sizeable portion of the Bathurst herd range occurs within 10 km of a road (Table 4). Using these same simulations, the portion of habitat within 10 km of a road was low for other herds, with the exception of Cape Bathurst herd winter range, where 10% of habitat occurred within 10 km of the Inuvik-to-Tuktoyaktuk Highway (CBGC ALCES n.d.).

Table 4. Simulated proportion of Bathurst herd habitat within 10 km of a road in the year 2050, without and with projected future road development (CBGC ALCES n.d.).

Season	Without projected future development	With projected future development
Spring migration range	26%	40%
Calving range	3%	10%
Summer range	22%	40%
Fall range	28%	40%
Winter range	20%	32%

However, development footprint alone represents only part of the picture. Secondary impacts from development (e.g., altered energetics, increased harvest access, barriers to herd movement) can be substantial despite a relatively small footprint (Fullman et al. 2025, Joly et al. 2025). Russell et al. (2024) showed increased energetic expenditures during these footprint encounters, which have the potential to drive cow and calf weight loss, which in turn could reduce the birth rate and increase calf mortality, respectively. Incorporating the work of Russell et al. (2024) into the CBGC ALCES (n.d.) model[10], simulations suggest that each encounter with development footprints results in a 0.34% reduction in recruitment. Applying this relationship to Bathurst footprint encounters estimated from CBGC ALCES (n.d.) simulations could account for a 23% reduction in recruitment when current development footprint is considered and a 31% reduction in recruitment when current and projected future development are considered (Bluenose-East = 4.3%, Bluenose-West = 0.7%, Cape Bathurst = 3.5%, Tuktoyaktuk Peninsula = 2.8%). It is important to note that this estimate is very approximate, relying on simplified assumptions such as footprint encounters having the same effect on recruitment regardless of season and that the relationship between weight loss and recruitment is linear. Both these assumptions are likely false.

[10] Assuming a 1 kg reduction in cow body weight would lead to a reduction in the probability of pregnancy of 2.6% and a 1 kg reduction in calf body weight would lead to an increase in overwinter mortality of 5% (Russeel et al. 2024).

However, the coarse assessment serves to illustrate the potential importance of the energetics pathway and the need to improve its representation in future work. Such effects may not be visible in survival analyses (CIMP241) and future analyses should consider fine-scale behavioural responses to roads, in addition to survival.

North Slave Métis Alliance monitors have reported behavioural signs of disruption in caribou observed near roads, with animals running away as vehicles passed (CIMP243).

"Approx. 50 m from road. Caribou got startled by 3 big trucks passing. They started running and circled back after. Walking back to where we spotted them." (North Slave Métis Alliance monitor form)

In this context, the permeability of roads (i.e., the capacity or ability of caribou to cross) must be considered. A permeability analysis conducted by CBGCI project CIMP242 using caribou movement data in the area of the Tibbitt-to-Contwoyto winter road between 2016 and 2023 suggests the road is almost entirely impermeable to caribou when it is operational (permeability index = 0.009), thus representing a significant impediment to movement (Table 5, Figure 17). In this case, this score likely reflects the seasonal nature of this road; because the season during which this transportation option is available is short, traffic is correspondingly heavier during that period (Table 6). This makes the road less permeable to caribou and represents a source of habitat fragmentation. However, low permeability is not entirely a function of traffic volume. The Misery all-season access road permeability score is almost as low as the score for the Tibbitt-to-Contwoyto winter road (0.03, Table 5). In this case, low permeability is not caused by traffic, but rather, by road design (e.g., steep slopes, large boulders) (Barbour et al. in press), although this road does include caribou crossing structures at several locations. Avoidance of this feature was also reported by Tłı̨chǫ monitors (Tłı̨chǫ Research and Training Institute 2023) and audio data collected along the Tibbitt-to-Contwoyto winter road suggests significant impact of noise to the permeability of roads (i.e., noise from traffic) (CIMP242). Although a goal of that project and ongoing audiologging work is to study the effect of roads and industrial disturbance, only one female caribou with an audiologger approached a mining road (the Misery access road). At one moment, this female showed a clear and atypical increase in activity levels near the road, suggesting direct disturbance, though it was not possible to pinpoint the immediate cause (CIMP242). However, this observation did point to high potential capacity for identifying the immediate causes and consequences of industrial disturbance, although we note that it is unclear whether permeability of a road in the tundra differs from a road within the boreal forest. Delays in migration as a result of these barriers do not appear to have affected calving dates (assuming encounters are occurring on the way to calving grounds); these delays do, however, force caribou to complete their migrations more rapidly once the barrier has been cleared.

Permeability analysis

This new tool allows users to assess how easily animals can cross linear features like roads. It returns a number between 0 and 1, with 0 meaning no capacity for an animal to cross the feature and 1 meaning the feature has no impact on animal movement. This new tool is available publicly as a statistical package: https://github.com/NickiBarbour/permeability (Barbour et al. in press, Beyer et al. 2016).

Table 5. Permeability index scores for Tibbitt-to-Contwoyto winter road, Misery access road, and Sable haul road, calculated from data collected between 2016 and 2023.

Road	Length (km)	Type of road	Permeability index score (95% CI)
Misery access road	30	All-season	0.03 (0.02-0.05)
Sable haul road	21	All-season	0.34 (0.28-0.41)
Tibbitt-to-Contwoyto winter road & Gahcho Kue spur road	604	Winter supply	
• Before open season (Dec-Jan)			0.155 (0.130-0.185)
• Open season (Feb-Mar)			0.009 (0.005-0.014)
• After open season (Apr-May			0.103 (0.091-0.118)

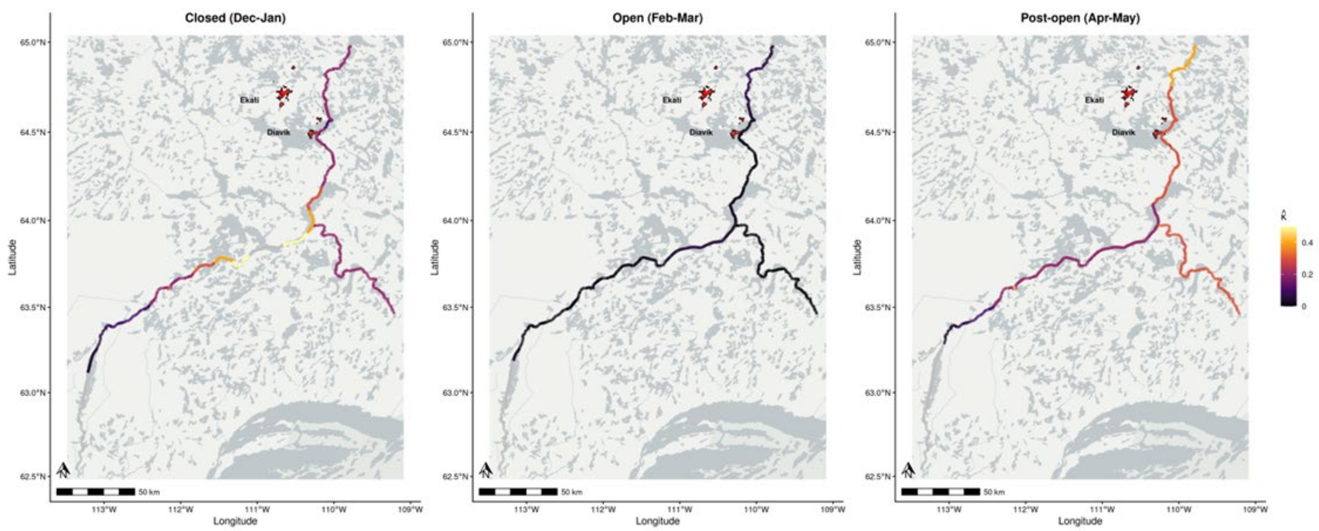


Figure 17. Spatial variation in permeability of the Tibbitt-to-Contwoyto winter road and Gahcho Kue spur road during the closed season (Dec-Jan), open season (Feb-Mar), and post-open season (Apr-May). Dark colours (e.g., during the open period) indicate extremely low permeability.

Table 6. Summary of vehicle traffic in 2024 and 2025 before, after, and on the Gahcho Kue spur road, as a sub-sample of cameras deployed by the North Slave Métis Alliance. Veh/day and veh/hr are reported as a mean (SD, min-max) (GK = Gahcho Kue). These represent the first complete estimates of traffic volume and flow along these roads; previous information was limited to volume of mine vehicles only.

Camera	Year	Section	Start	End	Total events	Days	Veh/day	Veh/hr
R04	2024	On GK spur	Feb 22	Mar 28	3119	36	86.6 (23.9; 12-129)	3.7 (3.4; 0-27)
R02	2024	North of GK spur turn off	Feb 22	Mar 29	4030	35	115.1 (53.2; 2-227)	4.7 (4.6; 0-26)
R03[1]	2025	North of GK spur turn off	Feb 14	Mar 26	5075	41	123.8 (65.6; 8-258)	5.3 (4.9; 0-27)
R07	2025	North of GK spur turn off	Feb 22	Mar 26	1893	33	57.4 (29.4; 2-106)	2.5 (2.7; 0-17)

[1] R03 located after the Gahcho Kue spur road, close to Diavik. A portion of traffic would likely have missed this camera, having turned off the main road.

The landscape shows evidence of the low permeability of these roads. Tłı̨chǫ monitors have observed that the caribou trails on the south side of the Misery access road at the Ekati diamond mine are now grown in and have not been used by caribou in many years (Figure 18). The same is true for the Lac du Sauvage Road that extends north from the Misery Project at Ekati Mine and bisects an important land crossing between Ek'ati (Lac de Gras) and Łıwets'aɂòats'ahtì (Lac du Sauvage), which is also not being used any longer by caribou, despite the presence of good forage (Tłı̨chǫ Research and Training Institute 2023).

"You can see by the poop, but no poop on that side [south of road]." (Anonymous Elder, Tłı̨chǫ Research and Training Institute 2023: 41)

"The Misery Road is blocking caribou migration. When they first started [mining operations] it was good, with lots of caribou around. Sometimes caribou cross the road. But caribou know this area, so they have changed their route." (Anonymous Elders, Tłı̨chǫ Research and Training Institute 2023: 41)

"Now its an empty land." (Joe Zoe, Tłı̨chǫ Research and Training Institute 2023: 42)

Overall, permeability is affected by a combination of (a) traffic, (b) road design, and (c) routing. Impact to caribou is then a function of the herd's susceptibility to harvest and predation, the potential energetic costs of avoiding roads/not being able to access forage, and the potential delays to migration caused by the barrier.

The results of these projects suggest that roads impact barren-ground caribou in a variety of ways, including by facilitating access for both harvesters and predators, making space for disrespectful harvest through that ease of access, fragmenting habitat, disrupting and delaying migration, and affecting the behaviour and health of caribou. These impacts show that even in areas where development projects have a relatively small footprint and thus appear to remove little physical habitat, their impacts extend far beyond their boundaries.

Figure 18. (a) Regrown caribou trail on west side of river between Lac de Gras and Lac du Sauvage, August 2022. (b) Regrown caribou trail south of Misery Road, Ekati diamond mine. Photos: Petter Jacobsen, Tłı̨chǫ Government. Reproduced from Tłı̨chǫ Research and Training Institute (2023).

PART 4: What do we understand now and what's next

The information presented in the previous pages summarized improvements to the state of knowledge for barren-ground caribou in the NWT, related to the scope of the seven CBGCI projects that were completed. Several important insights can be gleaned from this work that speak to the central question posed in this funding initiative, 'What is driving the population trends of barren-ground caribou in the NWT?'

This collaborative research initiative shows clearly that barren-ground caribou behaviour, movements, and sometimes even survival, can be significantly impaired by high average summer temperatures, too little snow, and insect harassment. Additionally, other climate variables, parasites and pathogens, changes in forage quality and availability, and the cumulative impacts of roads are adversely impacting barren-ground caribou, albeit with less certainty regarding their influence at the population level. Given first synchronized declines across all herds and then divergence in herd-specific trajectories, it is also clear that range-specific drivers are affecting caribou. As significant overlap exists in winter ranges, this suggests range-specific drivers at other times of the year.

More research is needed to better understand the effects of many of these drivers on barren-ground caribou survival; however, it is important to note the link between several of these drivers and climate change. Climate change is already happening, with signs already clearly visible within the NWT. These changes will continue into the future. In this context, it must be acknowledged that the goal of restoring barren-ground caribou to a past state (e.g., range, population) is likely to be substantially impacted by continuing climate change (Ripple et al. 2026). While caribou are capable of adapting to changing environmental conditions, it is unclear how the magnitude of projected change may strain their capacity for adaptation (Species at Risk Committee 2017). Goals and expectations for the future must therefore be informed by future climate scenarios.

In this context of multiple interacting threats, it is important to consider the most appropriate approaches in conserving barren-ground caribou and the most effective management levers in that pursuit. Across all known and potential drivers of caribou population change considered here, all are directly or indirectly affected by human activities (e.g., greenhouse gas emissions, development, roads, harvesting behaviour). Thus, management efforts must focus on the actions of humans. Conservation efforts implemented to date have included harvest restrictions, mitigations implemented through environmental assessment processes, fire fighting, range planning, and predator removal within the ranges of the Bathurst, Bluenose-East (Wilson et al. 2024), and Qamanirjuaq herds (although the effectiveness of this action has been questioned, e.g., Sahtú Renewable Resources Board 2023), and substantial effort related to monitoring, research, and education has been expended (Conference of Management Authorities 2026). Other conservation measures such as habitat offsetting and development of best management practices are under consideration or in development (Conference of Management Authorities 2026). While conservation efforts to date have been significant and valuable, it is also clear that these efforts alone may not be sufficient to ensure recovery of barren-ground caribou in the NWT, given continued decline in some herds. More effective and aggressive actions should be pursued in the short term. This sentiment is not novel; various management agencies have put forward similar recommendations (e.g., Government of the Northwest Territories 2019, Conference of Management Authorities 2020). However, plans, strategies, monitoring, research, or indeed, reports such as this one, while necessary for tracking change and guiding progress, do not constitute tangible conservation action themselves without corresponding management application of their recommendations and results.

Directly addressing some known key drivers of barren-ground caribou population change, such as climate and weather, may not be reasonably possible at the local level, and mitigating these impacts may also be difficult, while remaining respectful of the political, logistical, and financial challenges that decision-makers face at all levels. This may reflect both barriers in the regulatory system and diverging socio-economic priorities but also signals complexity in addressing the forces affecting barren-ground caribou. While it is agreed that climate change represents an overriding driver of caribou population changes in the NWT, addressing this threat directly (i.e., mitigation) requires national and global commitment. Decision-makers in the NWT must therefore largely focus on local efforts as recovery objectives for barren-ground caribou are pursued.

Removing or substantially reducing non-climate threats to barren-ground caribou must therefore be a priority to reduce the pressure from cumulative drivers of population change, along with pursuing conservation actions that provide caribou with a greater chance of successfully adapting to climate change. The priority actions here should focus on those actions that most effectively reduce barren-ground caribou vulnerability to climate change, by, for example, maintaining or restoring habitat connectivity or protecting climatic refugia. In this context, the CBGCI put forward several key recommendations for consideration by decision makers.

First, the CBGCI urges decision-makers to address the multiple threats posed by roads as a priority issue. Roads within the range of barren-ground caribou are expected to have adverse impacts, but those within the ranges of herds experiencing the most significant declines should be prioritized, including the Tibbitt-to-Contwoyto winter road, Misery access road, and the proposed Arctic Economic and Security Corridor. Specifically, the project leads strongly recommend that:

- Route options be systematically assessed using both traditional knowledge and scientific modeling to ensure the least impactful routing option is selected,
- Key insect relief habitats be avoided during planning, construction, and operations (e.g., Kǫ̀kètì (Contwoyto Lake)),
- Proponents be required to follow a set of standard terms and conditions when building roads that intersect with caribou migrations to ensure they are permeable to caribou (i.e., grade, materials, seasonal road closures, slope),
- Seasonal road closures on roads within barren-ground caribou range be implemented to permit migratory movements without traffic,
- Proponents be required to collect and publicly share traffic data on private roads,
- A mandatory no-shooting corridor be established on either side of roads to minimize impacts from increased harvester access, consistent with recommendations from the Respected Harvesters Meeting held in Yellowknife, August 6, 2025, and
- Guardian and enforcement presence be funded and increased on roads to encourage and ensure compliance with regulations and respectful harvest practices.

Second, the CBGCI emphasizes the importance of long-term monitoring and surveillance of wildlife populations. Understanding the causes of a decline and the conditions necessary for recovery requires knowledge of the conditions a population experiences pre-decline. Waiting for a population to decline to engage in monitoring, research, and surveillance means that decision-makers will always be operating at a disadvantage. Fully integrated traditional knowledge, community-based monitoring, and scientific research approaches should be employed in building understanding of, and responding to changes in, barren-ground caribou populations. In the context of the project results presented within this report, traditional knowledge added important context by showing how caribou are understood and discussed within Indigenous knowledge systems. This is informed through a combined set of observations that come from watching caribou on the land, from experiences during harvesting and preparation, and drawing on knowledge that has been shared and passed on over time and generations. Improving training opportunities for traditional knowledge holders and harvesters would help bring their voices and expertise to the fore in decision-making, increase confidence in country foods, and ensure early detection of emerging issues among caribou populations. For example, leveraging the community-based surveillance and guardian network to improve intergenerational knowledge transfer, enhancing interagency communication, and encouraging respectful harvesting practices to reduce meat wastage.

Looking beyond these high-impact, priority recommendations, the CBGCI further recommends the implementation of mandatory sex- and age-class harvest reporting across all hunter classes and herds, enhanced and targeted education to help develop a respectful practice among all harvesters, prohibition of the sale of meat, legally protecting areas that may serve as effective climate refugia for barren-ground caribou (i.e., areas considered less vulnerable to climate change (as in Stralberg 2018), and improving data access across researchers and agencies.

The research presented here suggests that these actions will be the most impactful short-term steps decision-makers can take to minimize impacts to barren-ground caribou and effectively pursue recovery. This renewed conservation effort should be combined with continued efforts to build our understanding of the drivers of barren-ground caribou population changes, including identifying thresholds where drivers of population change begin to critically impact caribou populations and improving focus of research to include the indirect effects of threats. These areas for research focus complement and build upon those already published by other organizations.

References

Advisory Committee for Cooperation on Wildlife Management. 2021. Taking Care of Caribou: the Cape Bathurst, Bluenose-East, and Bluenose-East barren-ground caribou herds management plan. Wek'èezhìı Renewable Resources Board, Yellowknife, NT. 88 pp.

Advisory Committee for Cooperation on Wildlife Management. 2026. Annual status meeting summary for the Cape Bathurst, Bluenose-West, and Bluenose-East caribou herds – November 2025. Yellowknife, NT.

Aguilar X.F., L.M. Leclerc, Kugluktuk Angoniatit Association, Ekaluktutiak Hunters and Trappers Organization, Olokhaktomiut Hunters and Trappers Committee, F. Mavrot, A. Roberto-Charron, M. Tomaselli, G. Mastromonaco, A. Gunn, M. Pruvot, J.L. Rothenburger, N. Thanthrige-Don, E.Z. Jahromi, and S. Kutz. 2023. An integrative and multi-indicator approach for wildlife health applied to an endangered caribou herd. Scientific Reports, 13(1): 16524.

Barbour, N., E. Gurarie, A. Kelly, and J. Hodson. (in press). The permeability R package: a maximum-likelihood tool to quantify the permeability of linear barriers to animal movement. Methods in Ecology and Evolution.

Barbour, N., E. Gurarie, S. Nandy, O. Phelan, A. Kelly, and J. Hodson. [submitted]. Quantifying the impact of the Lockhart All-Season Road Project on barren-ground caribou (*Rangifer tarandus groenlandicus*) populations. Report prepared for Government of the Northwest Territories, Yellowknife, NT.

Barboza, P.S., R.D. Shively, D.D. Gustine, and J.A. Addison. 2020. Winter is coming: conserving body protein in female reindeer, caribou, and muskoxen. Frontiers in Ecology and Evolution 8: 10.3389/fevo.2020.00150.

Bard, S.M. 1999. Global transport of anthropogenic contaminants and the consequences for the Arctic marine ecosystem. Marine Pollution Bulletin, 38(5): 356-379.

Bathurst Caribou Advisory Committee. 2021. Bathurst Caribou Management Plan. Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, NT. 72 pp.

Beaulieu, D. 2012. Dene traditional knowledge about caribou cycles in the Northwest Territories. Rangifer Special Issue No. 20: 59-68.

Beaupré, C., K. Joly, M.D. Cameron, O. Couriot, W.F. Fagan, and E. Gurarie. 2026. Winter survival shaped by forage abundance and snow depth for a long-distance migratory ungulate. Polar Biology, 49: 2.

Beaupré, C. and O. Phelan. 2023. Collaborative research on barren-ground caribou. North Slave Métis Alliance and Fate of the Caribou results presentation report (unpubl.).

Beverly and Qamanirjuaq Caribou Management Board. 2023. Caribou is Life: Beverly and Qamanirjuaq Caribou Management Plan 2023-2032. Beverly and Qamanirjuaq Caribou Management Board, Paddockwood, SK. 52 pp.

Beyer, H.L., E. Gurarie, L. Börger, M. Panzacchi, M. Basille, I. Herfindal, B.R. Van Moorter, S. Lele, and J. Matthiopoulos. 2016. 'You shall not pass!': quantifying barrier permeability and proximity avoidance by animals. Journal of Animal Ecology, 85(1): 43-53.

Boulanger, Y., S. Gauthier, and P.J. Burton. 2014. A refinement of models projecting future Canadian fire regimes using homogeneous fire regime zones. Canadian Journal of Forest Research, 44: 365-376.

Burkow, I.C. and R. Kallenborn. 2000. Sources and transport of persistent pollutants to the Arctic. Toxicology Letters, 112-113: 87-92.

Caminade, C., K.M. McIntyre, and A.E. Jones. 2019. Impact of recent and future climate change on vector-borne diseases. Annals of the New York Academy of Sciences, 1436(1): 157-173.

Campbell, M., J. Boulanger, J. Ringrose, D.S. Lee, and E. Greene. 2024. Estimating abundance of the Qamanirjuaq mainland migratory barren-ground caribou sub-population: June 2022. File Report #01-2023. Nunavut Department of Environment, Wildlife Research Division, Iqaluit, NU. 102 pp.

Campbell, M., J. Boulanger, J. Ringrose, J. Danahy, R. Kite, and A. Roberto-Charron. 2025. Abundance and trends of the Beverly mainland migratory subpopulation of barren-ground caribou (*Rangifer tarandus groenlandicus*) June 2011-June 2023. File Report #01-25. Nunavut Department of Environment, Wildlife Research Division, Iqaluit, NU. 194 pp.

CBGC ALCES. n.d. Overview. Website: https://cbgc.alces-flow.com/public/web/docs/index.html [Accessed March 2026].

Chenery, E.S., N.J. Harms, H. Fenton, N.E. Mandrak, and P.K. Molnár. 2023. Revealing large-scale parasite ranges: an integrated spatiotemporal database and multisource analysis of the winter tick. Ecosphere, 14(1): e4376.

Colville Lake Renewable Resources Council. 2019. Dehlá Got'ı n̨e ʔədə Plan (Colville Lake Caribou Stewardship Plan). Colville Lake Renewable Resources Council, Colville Lake, NT. 32 pp.

Conference of Management Authorities. 2020. Recovery Strategy for Barren-ground Caribou in the NWT. Conference of Management Authorities, Yellowknife, NT.

Conference of Management Authorities. 2026. **Draft** Progress Report on the Recovery of Barren-ground Caribou (*Rangifer tarandus groenlandicus*) in the NWT (2021-2025). Conference of Management Authorities, Yellowknife, NT. 131 pp.

Couriot, O.H., M.D. Cameron, K. Joly, J. Adamczewski, M.W. Campbell, T. Davison, A. Gunn, A.P. Kelly, M. Leblond, J. Williams, and W.F. Fagan. 2023. Continental synchrony and local responses: climatic effects on spatiotemporal patterns of calving in a social ungulate. Ecosphere, 14(1): p.e4399.

Culler, L.E., M.P. Ayres, and R.A Virginia. 2015. In a warmer Arctic, mosquitoes avoid increased mortality from predators by growing faster. Proceedings on Biological Science, 1(1815): 20151549.

das Neves, C.G., S. Roth, E. Rimstad, E. Thiry, and M. Tryland. 2010. Cervid herpesvirus 2 infection in reindeer: a review. Veterinary Microbiology, 143(1): 70-80.

Dickinson, E.R., J.B. Mosbacher, C. Arnison, K. Beckman, S.D. Côté, J. Di Francesco, S.V. Hansson, E.Z. Jahromi, D.W. Kinniburgh, G. Le Roux, L.-M. Leclerc, F. Mavrot, N.M. Schmidt, M.J. Suitor, J. Taillon, M. Tomaselli, and S.J. Kutz. 2025. Qiviut trace and macro element profile reflects muskox population trends. Ecology and Evolution, 15: e71020.

Environment and Climate Change. 2022. NWT State of the Environment Report. Website: https://www.gov.nt.ca/ecc/en/services/nwt-state-environment-report [February 2026].

Environment and Climate Change. 2026. NWT Water Monitoring Bulletin – March 13, 2026. Website: https://www.gov.nt.ca/ecc/en/newsroom/nwt-water-monitoring-bulletin-march-13-2026 [Accessed March 2026].

Environment and Climate Change. Unpubl. data. 2025. Survey results for the Tuktoyaktuk Peninsula, Cape Bathurst, Bluenose-West, Bluenose-East, and Bathurst barren-ground caribou herds. Presentations at the 2025 Wildlife Act s. 15 meeting. Data provided by A. Kelly (Wildlife Biologist (Ungulates)) and T. Davison (Regional Biologist, Ungulates, Beaufort-Delta Region). Government of the Northwest Territories, Yellowknife, NT.

Ewacha, M.V.A., J.D. Roth, W.G. Anderson, D.C. Brannen, and D.L.J. Dupont. 2017. Disturbance and chronic levels of cortisol in boreal woodland caribou. The Journal of Wildlife Management 81(7): 1266–1275. https://doi.org/10.1002/jwmg.21288.

Fancy, S.G. and R.G. White. 1985. Energy expenditures by caribou while cratering in snow. The Journal of Wildlife Management, 49: 987-993.

Fauchald, P., R. Rødven, B.-J. Bårdsen, K. Langeland, T. Tveraa, N.G. Yoccoz, and R.A. Ims. 2007. Escaping parasitism in the selfish herd: age, size and density-dependent warble fly infestation in reindeer. Oikos, 116: 491-499.

Ferguson, M.A.D., R.G. Williamson, and F. Messier. 1998. Inuit knowledge of long-term changes in a population of Arctic tundra caribou. Arctic 51:201–219

Flueck, W.T., J.M. Smith-Flueck, J. Mionczynski, and B.J. Mincher. 2012. The implications of selenium deficiency for wild herbivore conservation: a review. European Journal of Wildlife Research 58: 761-780

Forde, T.L., K. Orsel, R.N. Zadoks, R. Biek, L.G. Adams, S.L. Checkley, T. Davison, J. De Buck, M. Dumond, B.T. Elkin, L. Finnegan, B.J. Macbeth, C. Nelson, A. Niptanatiak, S. Sather, H.M. Schwantje, F. van der Meer, and S.J. Kutz. 2016. Bacterial genomics reveal the complex epidemiology of an emerging pathogen in Arctic and boreal ungulates. Frontiers in Microbiology, 7: 1759.

Frankham, R., C.J.A. Bradshaw, and B.W. Brook. 2014. Genetics in conservation management: revised recommendations for the 50/500 rules, Red List criteria and population viability analyses. Biological Conservation, 170: 56-63.

Fullman, T., K. Joly, D.D. Gustine, and M.D. Cameron. 2025. Behavioral responses of migratory caribou to semi-permeable roads in Arctic Alaska. Scientific Reports, 15: 24712.

Government of the Northwest Territories. 2019. Bathurst Caribou Range Plan. Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, NT. 86 + iii pp.

Government of the Northwest Territories. 2025. News release: 2025 population survey results released for the Bathurst and Bluenose-East barren-ground caribou herds. Website: https://www.gov.nt.ca/en/newsroom/2025-population-survey-results-released-bathurst-and-bluenose-east-barren-ground-caribou#:~:text=The%20GNWT%20has%20released%20population%20estimates%20for,a%20decline%20of%2047%25%20over%20three%20years [accessed February 2026].

Griffith, B., D.C. Douglas, N.E. Walsh, D.D. Young, T.R. McCabe, D.E. Russell, R.G. White, R.D. Cameron, and K.R. Whitten. 2002. Section 3: The Porcupine Caribou Herd. Pg. 8-37 In Arctic Refuge Coastal Plain

Terrestrial Wildlife Research Summaries. United States Geological Survey Biological Science Report, No. 1.

Gunn, A. 2003. Voles, lemmings and caribou - population cycles revisited? Rangifer Special Issue No. 14:105–111.

Gurarie, E., C. Beaupré, O. Couriot, M.D. Cameron, W.F. Fagan, and K. Joly. 2024. Evidence for an adaptive, large-scale range shift in a long-distance terrestrial migrant. Global Change Biology, 30: e17589.

Gurarie, E., M. Hebblewhite, K. Joly, A.P. Kelly, J. Adamczewski, S.C. Davidson, T. Davison, A. Gunn, M.J. Suitor, W.G. Fagan, and N. Boelman. 2019. Tactical departures and strategic arrivals: divergent effects on climate and weather on caribou spring migrations. Ecosphere, 10(12): p.e02971.

Handeland, K., H. Viljugrein, S. Lierhagen, M. Opland, A. Tarpai, and T. Vikøren. 2017. Low copper levels associated with low carcass weight in wild red deer (*Cervus elaphus*) in Norway. Journal of Wildlife Diseases 53(1): 176-180.

Hee, O., J. Invik, and Kutz Research Group. 2026. Draft Community-based Wildlife Health Surveillance Program Summary Interim Report (unpubl.).

Hoar, B.M., K. Ruchstuhl, and S. Kutz. 2012. Development and availability of the free-living stages of *Ostertagia gruehneri*, an abomasal parasite of barrenground caribou (*Rangifer tarandus groenlandicus*), on the Canadian tundra. Parasitology, 139(8): 1093-1100.

Jacobsen, P. 2026. Ekwǫ̀ Nàxoèhdee K'e – Boots on the Ground: Final Report, NWT Cumulative Impact Monitoring Program. Government of the Northwest Territories, Yellowknife, NT. 23 pp.

Johnson, H.E., E.A. Lenart, D.D. Gustine, L.G. Adams, and P.S. Barboza. 2022. Survival and reproduction in Arctic caribou are associated with summer forage and insect harassment. Frontiers in Ecology and Evolution, 19(10): 10:899585.

Joly, K., C. Beaupré, T.J. Fullman, M.D. Cameron, N. Barbour, and E. Gurarie. 2025. Barrier impermeability is associated with migratory ungulate survival rates. Scientific Reports, 16: 152.

Joly, K., S.K. Wasser, and R. Booth. 2015. Non-invasive assessment of the interrelationships of diet, pregnancy rate, group composition, and physiological and nutritional stress of barren-ground caribou in late winter. PLoS One 10(6): e0127586.

Kafle, P., P. Peller, A. Massolo, E. Hoberg, L.-M. Leclerc, M. Tomaselli, and S. Kutz. 2020. Range expansion of muskox lungworms track rapid arctic warming: implications for geographic colonization under climate forcing. Scientific Reports, 10(1): 17323.

Kinley, T.A., J. Bergenske, J.-A. Davies, and D. Quinn. 2003. Characteristics of early-winter caribou, *Rangifer tarandus caribou*, feeding sites in the southern Purcell Mountains, British Columbia. The Canadian Field-Naturalist, 117: 352-359.

Kutz, S., T. Bollinger, M. Branigan, S. Checkley, T. Davison, M. Dumond, B. Elkin, T. Forde, W. Hutchins, A. Niptanatiak, and K. Orsel. 2015. *Erysipelothrix rhusiopathiae* associated with recent widespread muskox mortalities in the Canadian Arctic. The Canadian Veterinary Journal, 56(5): 560-563.

Kutz, S.J., E.P. Hoberg, L. Polley, and E.J. Jenkins. 2005. Global warming is changing the dynamics of Arctic host-parasite systems. Proceedings of the Royal Society B: Biological Sciences, 272(1581): 2571-2576.

Kutz, S.J., S. Checkley, G.G. Verocai, M. Dumond, E.P. Hoberg, R. Peacock, J.P. Wu, K. Orsel, K. Seegers, A.L. Warren, and A. Abrams. 2013. Invasion, establishment, and range expansion of two parasitic nematodes in the Canadian Arctic. Global Change Biology, 19(11): 3254-62.

Kutz, S.J., S. Laaksonen, K. Åsbakk, and A.C. Nilssen. 2019. Chapter 6: Parasitic infections and diseases. In: Tryland, M. & S. Kutz. (Eds.) Reindeer and Caribou: Health and Disease. 1st Ed. CRC Press, Boca Raton, FL, USA. 550 pp.

Laaksonen, S., J. Pusenius, J. Kumpula, A. Venäläinen, R. Kortet, A. Oksanen, and E. Hoberg. 2010. Climate change promotes the emergence of serious disease outbreaks of filarioid nematodes. Ecohealth, 7(1): 7-13.

LaPerriere, A.J. and P.C. Lent. 1977. Caribou feeding sites in relation to snow characteristics in northeastern Alaska. Arctic, 30: 101-108.

Lessard, E., P.D. Walker, and E. Vander Wal. 2026. Northern development and *Rangifer* risks: a review of the impacts of resource extraction for caribou and reindeer. Environmental Reviews, 34: 1-13.

Liao, Q., E. Gurarie, and W.F. Fagan. 2026. Dynamic lake ice conditions shape caribou water-crossing behavior in the Arctic. Global Change Biology, 32: e70858.

Łutsël K'é Dene First Nation. 2020. Yúnethé Xá ʔetthën Hádı (Łutsël K'é Dene First Nation's Caribou Stewardship Plan). Łutsël K'é Dene First Nation, Łutsël K'é, NT. 47 pp.

Mallory, C.D. and M.S. Boyce. 2017. Observed and predicted effects of climate change on Arctic caribou and reindeer. Environmental Reviews, 26(1): 13-25.

Matias, M.T., J.M. Ramage, E. Gurarie, and M.J. Brodzik. 2024. Snowmelt onset and caribou (*Rangifer tarandus*) spring migration. Remote Sensing, 16: 2391.

Mennell, R. 2021. Spatial and temporal trends in range-use by the Bathurst caribou during a population decline, 1997-2019. Queen's University (Canada).

Molnár, P.K., A.P. Dobson, and S.J. Kutz. 2013. Gimme shelter – the relative sensitivity of parasitic nematodes with direct and indirect life cycles to climate change. Global Change Biology, 19(11): 3291-3305.

Neyelle, M., L. Kenny, A. Taniton, D. Blondin, G. Baton, J. Dillon, R. Tutcho, & W. Bayha. 2016. Belarewı lé Gots'ę́ ʔekwe (Caribou for All Time): A Délı̨nę Got'ı̨nę Plan of Action. Deline, NT. 48 pp.

National Oceanic and Atmospheric Administration (NOAA). 2018. What's the difference between weather and climate? Website: https://www.ncei.noaa.gov/news/weather-vs-climate [Accessed March 2026].

National Oceanic and Atmospheric Administration (NOAA). 2023. Monthly global climate report for annual 2022. Website: https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202213 [Accessed May 2026].

National Oceanic and Atmospheric Administration (NOAA). 2024. Monthly global climate report for annual 2023. Website: https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202313 [Accessed May 2026].

National Oceanic and Atmospheric Administration (NOAA). 2025). Monthly global climate report for annual 2024. Website: https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202413 [Accessed May 2026].

NWT Species at Risk. 2026. NWT List of Species at Risk. Website: https://www.nwtspeciesatrisk.ca/en/nwt-list-species-risk [Accessed February 2026].

O'Donnell, J.A., M.P. Carey, J.C. Koch, C. Baughman, K. Hill, T. Evinger, A. Pruitt, C. Thompson, E. Graham, and B.A. Poulin. 2025. Rusting rivers: assessing the causes and consequences in Alaska and across the Arctic. NOAA Technical Report OAR ARC, 25-14 (Arctic report Card).

Oster, K.W., D.D. Gustine, F.E. Smeins, and P.S. Barboza. 2024. Estimating mineral requirements of wild herbivores: modelling Arctic caribou (*Rangifer tarandus granti*) in summer. Animals, 14(6): 868.

Padilla, B., S. Kutz, M. Pruvot, A.O. Aleuy, A. Dobson, and P. Jacobsen. 2023. Bridging traditional and scientific knowledge through a novel predictive approach to understand the role of pathogens in the decline of a key Arctic species. NWT Cumulative Impact Monitoring Program, Final Report Form 2022-2023. Website: https://nwtdiscoveryportal.enr.gov.nt.ca/geoportaldocuments/2022-23-Deliverable-CIMP214(Padilla)-Final%20Report.pdf [Accessed March 2026].

Paltan, H., J. Dash, and M. Edwards. 2015. A refined mapping of Arctic lakes using Landsat imagery. International Journal of Remote Sensing, 36(23): 5970-5982.

Parkinson, A.J., B. Evengard, J.C. Semenza, N. Ogden, M.L. Børresen, J. Berner, M. Brubaker, A. Sjöstedt, M. Evander, D.M. Hondula, B. Menne, N. Pshenichnaya, P. Gounder, T. Larose, B. Revich, K. Hueffer, and A. Albihn. 2014. Climate change and infectious diseases in the Arctic: establishment of a circumpolar working group. International Journal of Circumpolar Health, 73: 25163.

Phelan, O., Mercredi, W., Cox, A., (2026) Quantifying harvest of Barren-ground caribou off the Tibbitt to Contwoyto winter road in the Northwest Territories – An Indigenous Guardian-led initiative [Under review].

Porcupine Caribou Technical Committee. 2026. Porcupine Caribou Herd Annual Monitoring Update 2024-2025. Accessed online: https://pcmb.b-cdn.net/wp-content/uploads/2026/01/PCH-Technical-Report_2026_WEB.pdf [Accessed March 2026].

Puls, R. 1994. Mineral levels in animal health: diagnostic data. 2nd ed. Sherpa International.

Rankins, S.T., R.W. DeYoung, A.M. Foley, J.A. Ortega-S., T.E. Fulbright, D.G. Hewitt, C.D. Hilton, L.R. Schofield, and T.A Campbell. 2023. Regional copper deficiency in white-tailed deer. Open Journal of Ecology, 13: 9-21.

Ripple, W.J., C. Wolf, J. Rockström, K. Richardson, N. Wunderling, J.W. Gregg, T. Westerhold, and H.J. Schellnhuber. 2026. The risk of a hothouse Earth trajectory. OneEarth, 9(2): 101565.

Russell, D.E., A. Gunn, and L. Frid. 2024. Vulnerability assessment of the Bathurst caribou herd for the proposed Slave Geological Province Road, NWT. Manuscript Report No. 323. Environment and Climate Change, Government of the Northwest Territories, Yellowknife, NT.

Russell, D.E., P.H. Whitfield, J. Cai, A. Gunn, R.G. White, and K. Poole. 2013. CARMA's MERRA-based caribou range climate database. Rangifer, 33: 145.

Saalfeld, S.T., B.L. Hill, C.M. Hunter, C.J. Frost, and R.B. Lanctot. 2021. Warming Arctic summers unlikely to increase productivity of shorebirds through renesting. Scientific Reports, 11: 15277.

Saalfeld, S.T., D.C. McEwen, D.C. Kesler, M.G. Butler, J.A. Cunningham, A.C. Doll, W.B. English, D.E. Gerik, K. Grond, P. Herzog, B.L. Hill, B.J. Lagassé, and R.B. Lanctot. 2019. Phenological mismatch in Arctic-breeding shorebirds: impact of snowmelt and unpredictable weather conditions on food availability and chick growth. Ecology and Evolution, 9: 6693-6707.

Sahtú Renewable Resources Board (ʔehdzo Got'ı̨ nę Gots'ę ̨Nákedı). 2023. ʔełets'ewéhkwę Godı (Living with Wildlife) – Predators and Competitors. Report on the Délı̨nę 2021 Public Listening (Hearing) Session. Sahtú Renewable Resources Board, Tulı̨́t'a, NT. 94 pp.

Schmidt, N.M., C. Grøndahl, A.L. Evans, J.-P. Desforges, J. Blake, L.H. Hansen, L.T. Beumer, J.B. Mosbacher, M. Stelvig, E.G. Greunz, M. Chimienti, and F.M. van Beest. 2020. On the interplay between hypothermia and reproduction in a High Arctic ungulate. Scientific Reports, 10: 1514.

Schweizer, M. and E. Peterhans. 2014. Pestivirses. Annual Review of Animal Bioscience, 2(1): 141-163.

Soetan, K.O., C.O. Olaiya, and O.E. Oyewole. 2010. The importance of mineral elements for humans, domestic animals and plants: a review. African Journal of Food Science 4(5): 200-222

Species at Risk Committee. 2017. Species status report for Porcupine caribou and barren-ground caribou (Tuktoyaktuk Peninsula, Cape Bathurst, Bluenose-West, Bluenose-East, Bathurst, Beverly, Ahiak, and Qamanirjuaq herds) (*Rangifer tarandus groenlandicus*) in the Northwest Territories. Species at Risk Committee, Yellowknife, NT. 281 pp.

Species at Risk Committee. 2023. Species status report for Dolphin and Union caribou (*Rangifer tarandus groenlandicus x pearyi*) in the Northwest Territories. Species at Risk Committee, Yellowknife, NT. 230 pp.

Stephen, C. 2014. Toward a modernized definition of wildlife health. The Journal of Wildlife Disease, 50(3): 427-430.

Stralberg, D. 2018. Climate-projected distributional shifts and refugia for North American ecoregions [dataset]. http://doi.org/10.5281/zenodo.1407176. Available at https://adaptwest.databasin.org.

Stubbs, T., M. Carlson, and J. Nishi. 2023. Barren-ground caribou range land-use scenarios in the NWT 2022-2072. Prepared for the cumulative effects assessment of four barren-ground caribou herds in the NWT. Cumulative Impact Monitoring Program and Environment and Climate Change Canada, Yellowknife, NT. 23 pp.

Telfer, E.S. and J.P. Kelsall. 1984. Adaptation of some large North American mammals for survival in snow. Ecology, 65: 1828-1834.

Thomas, A.M., G.G. Verocai, J. Soghigan, F. Mavrot, N. Jutha, J. Adamczewski, et al. 2025. Widespread geographic distribution of filarioid nematodes in caribou (*Rangifer tarandus* sspp.) in Canada. International Journal of Parasitol Parasites in Wildlife, 26: 101030.

Tlicho Research and Training Institute. 2018. Boots on the Ground Caribou Monitoring Program: 2017 Results. Tłı̨chǫ Traditional Knowledge and Land Use Study. Tłı̨chǫ Research and Training Institute, Behchokǫ̀, NT. 99 pp. Website: https://research.tlicho.ca/sites/default/files/2017bootsonthegroundresults.pdf [Accessed March 2026].

Tłı̨chǫ Research and Training Institute. 2019. Ekwǫ̀ Nàxoèhdee K'è, Boots on the Ground: 2018 Results. Tłı̨chǫ Government, Behchokǫ̀, NT. 105 pp.

Tłı̨chǫ Research and Training Institute. 2020. Ekwǫ̀ Nàxoèhdee K'è, Boots on the Ground: 2019 Results. Tłı̨chǫ Government, Behchokǫ̀, NT. 67 pp.

Tłı̨chǫ Research and Training Institute. 2022. Ekwǫ̀ Nàxoèhdee K'è: 2021 Results. Tłı̨chǫ Government, Behchokǫ, NT. 51 pp.

Tłı̨chǫ Research and Training Institute. 2023. Ekwǫ̀ Nàxoèhdee K'è: 2022 Results. Tłı̨chǫ Government, Behchokǫ, NT. 65 pp.

Tłı̨chǫ Research and Training Institute. 2024. Ekwǫ̀ Nàxoèhdee K'è: 2023 Results - Kokètì, Deèzàatì. Tłı̨chǫ Government, Behchokǫ, NT. 49 pp.

Tłı̨chǫ Research and Training Institute 2025. Ekwǫ̀ Nàxoèhdee K'è: 2024 Results - Kokètì, Deèzàatì, Ek'atì. Tłı̨chǫ Government, Behchokǫ̀, NT. 69 pp.

Trondrud, L.M., G. Pigeon, E. Krol, S. Albon, E. Ropstad, J. Kumpula, A.L. Evans, J.R. Speakerman, and L.E. Loe. 2023. A summer heat wave reduced activity, heart rate, and autumn body mass in a cold-adapted ungulate. Physiological and Biochemical Zoology, 96(4): 282-293.

Tulp, I. and H. Schekkerman. 2008. Has prey availability for Arctic birds advanced with climate change? Hindcasting the abundance of tundra arthropods using weather and seasonal variation. Arctic, 61(1): 48-60.

van de Kerk, M., S. Arthur, M. Bertram, B. Borg, J. Herriges, J. Lawler, B. Mangipane, C.L. Koizumi, B. Wendling, and L. Prugh. 2020. Environmental influences on Dall's sheep survival. The Journal of Wildlife Management, 84: 1127-1138.

Van Soest, P.J. 1994. Nutritional ecology of the ruminant. Cornell University Press.

Wek'èezhìı Renewable Resources Board (WRRB). 2016a. Report on a public hearing held by the Wek'èezhìı Renewable Resources Board, 23-24 February 2016, Yellowknife, NT and reasons for decisions related to a joint proposal for the management of the Bathurst ekwǫ̀ (barren-ground caribou) herd - PART A. Wek'èezhìı Renewable Resources Board, Yellowknife, NT.

Wek'èezhìı Renewable Resources Board (WRRB). 2016b. Report on a public hearing held by the Wek'èezhìı Renewable Resources Board, 6-8 April 2016, Behchokǫ, NT and reasons for decisions related to a joint proposal for the management of the Bluenose-East ekwǫ̀ (barren-ground caribou) herd - PART A. Wek'èezhìı Renewable Resources Board, Yellowknife, NT.

Wek'èezhìı Renewable Resources Board (WRRB). 2016c. Reasons for decisions related to a joint proposal for the management of the Bluenose-East ekwǫ̀ (barren-ground caribou) herd - PART B. Wek'èezhìı Renewable Resources Board, Yellowknife, NT.

Wek'èezhìı Renewable Resources Board (WRRB). 2016d. Reasons for decisions related to a joint proposal for the management of the Bathurst ekwǫ̀ (barren-ground caribou) herd - PART B. Wek'èezhìı Renewable Resources Board, Yellowknife, NT.

Wek’èezhìı Renewable Resources Board (WRRB). 2019a. Reasons for decisions related to a joint proposal for the management of the Kǫk’èetì ekwǫ̀ (Bathurst caribou) herd. Wek’èezhìı Renewable Resources Board, Yellowknife, NT.

Wek’èezhìı Renewable Resources Board (WRRB). 2019b. Reasons for decisions related to a joint proposal for the management of the Sahtì ekwǫ̀ (Bluenose-East caribou) herd. Wek’èezhìı Renewable Resources Board, Yellowknife, NT.

Wek’èezhìı Renewable Resources Board (WRRB). 2021. Reasons for decisions related to a joint proposal for dìga (wolf) management in Wek’èezhìı. Submitted to Tłı̨chǫ Government and Department of Environment and Natural Resources, Government of the Northwest Territories, January 8, 2021. Wek’èezhìı Renewable Resources Board, Yellowknife, NT.

Wek’èezhìı Renewable Resources Board (WRRB). 2025. Wek’èezhìı Renewable Resources Board recommendations and reasons for decision on management actions for Sahtì ekwǫ̀ (Bluenose-East caribou) herd. Wek’èezhìı Renewable Resources Board, Yellowknife, NT.

Wilson, A., J. Hodson, R. Abernethy, S. Behrens, N. Jutha, J. Nishi, and B. Woodworth. 2024. Technical Report, Wolf (Dìga) Management Program, January-October 2024. Manuscript Report No. 335. Environment and Climate Change, Government of the Northwest Territories, Yellowknife, NT. 88 pp.

Zoe, J.B. 2012. Ekwǫ̀ and Tłı̨chǫ nàowo / caribou and Tłı̨chǫ language, culture and way of life: An evolving relationship and shared history. Rangifer Special Issue, No. 20: 69–74.

Appendix A: NWT CIMP Final Reports 2025-26

- CIMP94 - Ekwǫ̀ Nàxoèhdee K'e – Watching Caribou with our 'Boots on the Ground'
- CIMP207 - Decision-support Tools for Understanding Cumulative Impacts on Barren-ground Caribou
- CIMP239 - Community-defined and Monitored Indicators of Recovery in Barren-ground Caribou *and* Diversity and Impacts of Viruses in Barren-ground Caribou
- CIMP240 - Contaminants, Epigenetics, and Genetic Health in Caribou
- CIMP241 - Understanding Adult Survival in Barren-ground Caribou
- CIMP242 - Acoustic Monitoring of Disturbance Impacts on Barren-ground Caribou
- CIMP243 - North Slave Métis Alliance Guardianship Program: Monitoring Road Impacts on Barren-ground Caribou