The Northern Review
Exploring human experience in the North
The Northern Review 59: 13–51
https://doi.org/10.22584/nr59.2026.005
Published at Yukon University, Canada

Research Article

The Future of Nature-Based Solutions for Climate in Northern Canada: Indigenous Knowledge, Land Stewardship, and Economic Development

Katharine B. Baldwin* and Bob Kayseas*

Abstract: Climate change is affecting Northern Canada at a rapid rate and posing challenges to Indigenous ways of life. Climate solutions in the North are often applauded for protecting carbon rich ecosystems, reducing greenhouse gas emissions, and cultivating economic development, but when northern Indigenous perspectives, world views, and leadership are not integrated, solutions become little more than green colonialism. Indigenous Peoples have been leading land stewardship initiatives for millennia. Implementing nature-based solutions for climate (NbSC) using Two-Eyed Seeing could provide intersecting benefits for Indigenous communities including cultural revitalization, economic development, youth empowerment, reconciliation, carbon storage, ecosystem stewardship, and biodiversity. The Athabasca Denesųłiné First Nations care for their Traditional Territory, Nuhenéné, across Northern Saskatchewan, the Northwest Territories, and Nunavut. Through interviews with members of the Athabasca Denesųłiné First Nations and supporting organizations, we consider six NbSC that could be options for sustaining Athabasca Denesųłiné Peoples, lands, and waters, and for supporting the local economy in the face of climate change. Our analysis, utilizing a structured evaluation criteria, suggests that the most appropriate NbSC for Nuhenéné territory are wildfire management, Indigenous-led area-based conservation, and supporting barren-ground caribou conservation. These recommendations assume leadership by Indigenous Peoples, stewardship of the land in line with Dene values, and recognition of the legacy of colonialism. Our work stems from a commitment to respect and honour Indigenous voices, build trustworthy relationships, and provide useful information for local communities, with particular attention paid to economic opportunities associated with climate mitigation and adaptation.

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Article de Recherche

L'avenir des solutions fondées sur la nature pour lutter contre les changements climatiques dans le Nord canadien : savoirs autochtones, gestion des terres et développement économique

Katharine B. Baldwin* and Bob Kayseas*

Les changements climatiques affectent le Nord canadien à un rythme accéléré, imposant des défis majeurs aux modes de vie des peuples autochtones. Les solutions climatiques dans le Nord sont souvent célébrées pour leur protection des écosystèmes riches en carbone, leur réduction des émissions de gaz à effet de serre et leur promotion du développement économique. Cependant, sans intégrer les perspectives, visions du monde et leadership autochtones du Nord, ces solutions ne sont guère plus que du colonialisme vert. Les peuples autochtones pratiquent la gestion des terres depuis des millénaires. La mise en œuvre de solutions climatiques basées sur la nature (SCBN), suivant l'approche du double regard, offrirait des avantages intersectionnels aux communautés autochtones, notamment la revitalisation culturelle, le développement économique, l'autonomisation des jeunes, la réconciliation, le stockage du carbone, la gestion des écosystèmes et la préservation de la biodiversité. Les Premières Nations Athabasca Denesųłiné prennent soin de leur territoire traditionnel, le Nuhenéné, qui s'étend sur le nord de la Saskatchewan, les Territoires du Nord-Ouest et le Nunavut. S'appuyant sur des entrevues avec des membres des Premières Nations athabascanes dénésųłiné et avec des organisations de soutien, nous examinons six SCBN qui pourraient convenir à la gestion des terres et des eaux athabascanes dénésųłiné, tout en appuyant les économies locales face aux changements climatiques. Notre analyse, en utilisant des critères d'évaluation structurés, conclut que les SCBN les plus adaptées au Nuhenéné sont la gestion des incendies forestiers, la conservation dirigée par les Autochtones et la conservation du caribou de la toundra. Ces recommandations privilégient le leadership des peuples autochtones, la gestion des terres conformément aux valeurs dénées et la reconnaissance de l'héritage colonial. Notre travail découle d'un engagement à respecter et rendre hommage aux voix autochtones, à bâtir des relations de confiance et à fournir des renseignements utiles aux communautés locales, avec un accent particulier sur les opportunités économiques découlant des mesures d'atténuation et d'adaptation climatiques.

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Nuhenéné is the Traditional Territory of Black Lake, Fond du Lac, and Hatchet Lake Denesųłiné First Nations. Nuhenéné spans from the Athabasca Basin at the northern edge of the boreal forest in Saskatchewan to the Canadian Shield taiga and tundra of the Northwest Territories and Nunavut. The Athabasca Denesųłiné First Nations have been stewarding this carbon-rich landscape for millennia and have choices about how to steward Nuhenéné as the climate changes.

Like many Indigenous Nations, the Athabasca Denesųłiné have an intimate relationship with their Traditional Territory:

> To the Athabasca Denesųłiné, Nuhenéné is more than territory. It is home. It is where the caribou pass, where the fish feed the people, where the medicines grow, and where the spirits of the ancestors still walk … Everything the people are, their language, ceremonies, and values, comes from this land … (Ya'thi Néné Lands and Resources, 2025a)

Despite ongoing attempts by the Government of Canada over the past 200-plus years to disconnect Indigenous Peoples from their lands, environmental stewardship remains strongly ingrained in Athabasca Denesųłiné culture and law. Residents regularly spend time on the land as they hunt, fish, and gather food, and their connection with barren-ground caribou provides physical, spiritual, social, and cultural well-being. "Protecting Nuhenéné is not something [the Athabasca Denesųłiné] chose. It is a sacred duty passed down from the ancestors. The elders say: Take care of the land, and it will take care of you" (Ya'thi Néné Lands and Resources, 2025a).

This deep connection to place means that the effects of climate change are not felt only in the land and animals, but also in the cultural practices and daily lives of the Athabasca Denesųłiné. Northern Canada is warming at twice the rate of the global average (D'Orangeville et al., 2023) and many boreal forest and tundra areas are now carbon emitters instead of carbon sinks (Howard, 2025). Forest fires burn four times as much area as in the 1970s (Rutgers, 2025), lakes freeze five weeks later in fall (Settee, 2020), and weather is less predictable (Löf & Naomi, 2011). Barren-ground caribou migrations change as the animals navigate icy snow and burned forests (Kayseas & Baldwin, 2025; Löf & Naomi, 2011; Settee, 2020); muskox and polar bear travel further south and west, entering Saskatchewan (Dokis-Jansen et al., 2021; Settee, 2020); and fish spawning and migration shift (Kayseas & Baldwin, 2025; Löf & Naomi, 2011). For the First Nations that rely on the land, unsafe travel conditions, wildfire, and uncertainty around the arrival of migratory and seasonal food sources impact personal safety, cultural practices,

and subsistence harvests (Löf & Naomi, 2011), and may push people to rely more on wage labour (much of which comes from industrial resource extraction) in order to afford food at grocery stores. For Indigenous northerners, climate change is yet another act of colonialism, where those who have contributed least to the climate crisis are those most negatively affected (Hanaček et al., 2024).

The Athabasca Denesųłiné have an opportunity to respond to climate impacts affecting Nuhenéné and, at the same time, promote relationships with land and develop their local economy in ways that align with their values. Scientists have suggested that, for many ecosystems, continuing with business-as-usual stewardship could endanger human lives, ecosystem services, and Indigenous ways of life (Intergovernmental Panel on Climate Change [IPCC], 2022; Pelai et al., 2021). Engaging in land stewardship to adapt to and mitigate climate change could help the Athabasca Denesųłiné enact their responsibility to care for Nuhenéné, while also diversifying the economy away from its reliance on mining and towards a conservation economy. A conservation economy aligns well with Athabasca Denesųłiné values and is being pursued by local development organizations (Ya'thi Néné Lands and Resources, 2024). In a conservation economy, local communities care for the land and natural resources for future generations, while also creating business opportunities, such as renewable energy, ecotourism, fisheries, research, land management, Indigenous Guardians programs, healing and cultural centres, and new capital infrastructure investment. Investments in and income generated through conservation economies can have multiplier effects on the economy; in the Great Bear Rainforest and Haida Gwaii, for example, development of a diversified conservation economy created 118 new and expanded businesses between 2007 and 2022 (Coast Funds, 2022; Social Ventures Australia, 2016).

Envisioning the relationship with the land that the First Nations desire in fifty years or seven generations could help the Athabasca Denesųłiné make informed stewardship decisions today (see Sarkki et al., 2025). Nature-based solutions for climate (NbSC) are one framework for land stewardship that, when implemented using Two-Eyed Seeing (Bartlett et al., 2012), could meet intersecting goals of caring for Nuhenéné, supporting Indigenous ways of life, helping ecosystems adapt to a changing climate, mitigating climate change, and fostering local economic development (Powell et al., 2024). NbSC[1] are actions to protect, sustainably manage, and restore ecosystems, which address climate change effectively and adaptively, while simultaneously providing human well-being, biodiversity, and other benefits (Cohen-Shacham et al., 2016). Using land management to address climate change has great potential: through mitigation alone, natural climate solutions could provide over one-third of the cost-effective climate mitigation needed between 2017 and 2030 to stabilize warming below 2°C (Griscom et al., 2017). Examples of NbSC include mangrove restoration, regenerative farming, prairie restoration, protecting peatlands, wetland restoration, reforestation, and afforestation (Townsend & Craig, 2020).

Many NbSC projects have been highly Eurocentric at the expense of Indigenous and local peoples (Aboukakrine et al., 2025; McFetridge & Collins, 2021; Townsend & Craig, 2020; Trottier, 2024). In many projects, lands and waters are viewed as empty and open for development, nature is commodified in spreadsheets and offsets, human well-being is understood as separate from that of nature, and climate change is considered a biophysical problem that can be fixed using technology, finance, and economic modelling (Hanaček et al., 2024; Nature-Based Climate Solutions Summit, 2020). In response to these projects that reinforce colonial world views and impinge on Indigenous rights and ways of life (Dietz, 2024), Indigenous and marginalized groups have labelled such projects green colonialism (Lang et al., 2024) and/or carbon colonialism (Townsend et al., 2020). Gunn-Britt Retter, a Sámi advocate from Norway, writes, "We were first colonized by people from outside our lands, then colonized by climate change itself, driven by people from outside our lands, and are now being colonized a third time by responses to climate change"—in her case, wind turbines on reindeer herding lands (2021). The Canadian North, specifically, has become a sacrifice zone for forestry, mining, and now green energy and climate projects to support the carbon-intensive lifestyles of those who caused the climate crisis (Hanaček et al., 2024).

In this article, we bring Indigenous Knowledge and perspectives into conversation with the Western science concept of NbSC. Instead of evaluating NbSC solely on measurements like carbon storage, biodiversity protection, and net income, we position our analysis around needs, values, and priorities articulated by local Indigenous groups. In this case study, we take First Nations leadership, land stewardship in line with Dene values, and history of colonization as foundational requirements, and we evaluate nature-based solutions for climate based on their ability to contribute to First Nations relationships with land, conservation of barren-ground caribou, local economic opportunity, and fostering common goals amongst community members. These foundational requirements derive from Reed's (2022) three lessons for implementing nature-based solutions from the perspectives of Indigenous Peoples: centre colonization as an interpretive lens, engage with Indigenous Knowledge systems, and uphold the rights and responsibilities of Indigenous Peoples. Two-Eyed Seeing is key to both the foundational requirements and evaluative concepts, as we look to the strengths of both Indigenous and Western knowledges to support Indigenous northerners

as they seek to improve their quality of life and resilience. Mi'kmaw Elder Albert Marshall defines Two-Eyed Seeing as "learning to see from one eye with the *strengths* of Indigenous knowledges and ways of knowing, and from the other eye with the *strengths* of Western knowledges and ways of knowing, and to using both these eyes together, for the benefit of all" (Bartlett et al., 2012, p. 8). The strengths of Indigenous Knowledge systems include taking a holistic approach, prioritizing well-being and relationships over profit, being rooted in relationship, and supporting Indigenous self-determination; these are essential if NbSC are to benefit Indigenous Peoples (Aboukakrine et al., 2025; Manahan, 2024; Nature-Based Climate Solutions Summit, 2020; Reed, 2022). Two-Eyed Seeing helps NbSC break free from their current dependence on Western knowledge and knowledge systems and better serve Indigenous communities (Reed, 2022).

By incorporating Indigenous Knowledge and leadership, NbSC have successfully benefited Indigenous communities in Australia, New Zealand, and parts of Canada, but many Canadian First Nations have met with resistance to their NbSC (Townsend & Craig, 2020); despite growing recognition of Indigenous rights, the federal government and many provinces remain unwilling to recognize Indigenous jurisdiction and understandings of land, thereby blocking Indigenous-led NbSC (Reed, 2022). Canada's current political climate is compounding these challenges, leaning towards less environmental oversight, greater focus on profit, and reduced support for climate initiatives.

The Athabasca Denesųłiné First Nations are deeply committed to expanding economic opportunities within their territories, and their journey is already well underway. These three Nations, along with four small northern municipalities, are majority owners of Athabasca Basin Development, a successful Indigenous-owned investment company established in 2002. Athabasca Basin Development holds interests in over a dozen companies across multiple sectors, with a focus on the uranium mining supply chain. As majority owners, the Athabasca Denesųłiné already hold significant economic and governance roles in regional economic development, particularly in the mining sector. Their experience with Athabasca Basin Development reflects a model of Indigenous-led economic development that retains control, redistributes wealth within communities, and aligns with local governance structures (Wasacase-Merasty et al., 2024). Each First Nation also has a development corporation, and the communities are represented by Ya'thi Néné Lands and Resources, an Indigenous-led and owned non-profit organization that builds agreements with mining and exploration companies to protect the interests of the land and people.

At the same time as desiring economic opportunities, community members have expressed a deep emotional, cultural, and spiritual attachment to their Traditional Territory, Nuhenéné, that they are unwilling to sacrifice. Community members have voiced concern about climate impacts to the land, water, animals, and seasonal cycles that are disrupting long-held land-based relationships and subsistence activities (Kayseas & Baldwin, 2025). While economic development remains a community priority, it must not come at the cost of environmental degradation or cultural disconnection. Community members have emphasized the importance of stewardship and expressed values consistent with what has been termed a conservation economy. This alignment between Indigenous principles and conservation economies has been recognized across Canada as a pathway to both climate resilience and economic justice (Coast Funds, 2022; Planche et al., 2021).

In this context, Indigenous-led NbSC could uphold First Nations responsibilities to place, mitigate climate change, steward ecosystems that support northern Indigenous ways of life, support economic development, increase biodiversity, revitalize culture, empower youth, and promote reconciliation (Powell et al., 2024). In this article, we explore the economic development possibilities of and local perceptions towards six potential NbSC in Nuhenéné, the Traditional Territory of the Black Lake, Fond du Lac, and Hatchet Lake Denesųłiné First Nations in Northern Saskatchewan, the Northwest Territories, and Nunavut. We share these NbSC not to "save" northerners or prescribe actions, but to present information so that community members are aware of options for sustaining their lands and waters while also pursuing economic development within their communities.

Author Positionality

The authors share their positionalities with the understanding that who they are and who they are becoming have implications for how this research is designed and carried out (Hurley & Jackson, 2020; S. Wilson, 2008).

Katharine Baldwin: I am a white, disabled settler with a Master's in Geography from the University of British Columbia and dual bachelor's degrees in Anthropology and Social-Ecological Sustainability from the University of Minnesota. I grew up on Kaskaskia, Miami, and Shawnee lands in Central Ohio and now live on the traditional, ancestral, and unceded lands of the xʷməθkʷəy̓əm (Musqueam), Sḵwx̱wú7mesh (Squamish), and səlilwətaɬ (Tsleil-Waututh) Nations in Vancouver, British Columbia. I was once an avid backpacker and environmental educator and now enjoy slowing down with backyard birding and phenology. My passion for land and interest in advocacy have shaped my career. I support Indigenous adaptation to climate change as a research assistant at the First Nations University of Canada. I respect Indigenous connection to land, resilience, tradition, and kinship. I believe that Indigenous leadership is the foundation for

the collective world view shift required to address climate change, and I approach cross-cultural research as a privilege and continual learning process.

Bob Kayseas: My positionality is grounded in my identity as an Anishinaabe (Saulteaux) scholar from Noochikinoonzaywaning, Fishing Lake First Nation, shaped by lived experience in community, family histories of residential school impacts, and the intergenerational responsibilities I now carry as a grandfather raising my grandchildren. Professionally, I serve as a professor in the School of Business and Public Administration at the First Nations University of Canada, where my teaching, research, and curriculum development focus on Indigenous entrepreneurship, strategy, nation-building, and economic sovereignty. My applied work as Chair of Fishing Lake First Nation Ventures and as a strategic planning and governance advisor to First Nations organizations situates me at the intersection of theory and practice, where I engage directly in institutional development, trust governance, and community economic strategy. Across these roles, my perspective is informed by a commitment to relational accountability, the revitalization of Indigenous governance systems, and the advancement of sustainable, self-determined futures for our Nations.

Methodology

Our research is grounded in Indigenous research methodologies that prioritize community-engaged learning, relational accountability, community benefit, respect for Indigenous ways of knowing, and the principles of OCAP®—ownership, control, access, and possession of data—as articulated by the First Nations Information Governance Centre (Chilisa, 2012; First Nations Information Governance Centre, 2025; S. Wilson, 2008). Our research collaboration began in summer 2024 with reaching out to Ya'thi Néné Lands and Resources, an Indigenous-led and owned non-profit organization that protects the interests of the land and people on behalf of Athabasca Basin communities. After initial conversations with staff members and our proposal of a research project adhering to their guidelines, our project was approved by Ya'thi Néné Lands and Resources. The organization has since supported our work by announcing our visits to community leaders, communicating regularly via email and video chat, providing guidance and advice, coordinating visits, helping us meet community members, and reviewing our draft publications. The research was approved by the University of Regina Research Ethics Board (REB #896) after the collaboration was solidified. Ongoing colonialism has damaged trust with outsiders, and our work stems from a commitment to build trustworthy relationships, respect and honour Indigenous voices, and provide useful information for local communities.

Semi-structured interviews with community members were conducted during winter/spring 2025, when one member of our research team spent four days in Black Lake Denesųłiné First Nation. Other interviews were conducted when community members travelled to Prince Albert or Saskatoon for other meetings. Overall, we spoke with nine members of Black Lake, Fond du Lac, and Hatchet Lake Denesųłiné First Nations: Elder Billy Adam (former firefighter), Terri-Lynn Beavereye (Black Lake Ventures Executive Director), David Bigeye (educator and former councillor), Derek Cook (entrepreneur and former community land technician), Ricky Robillard (uranium mine community relations liaison and former Chief), Elder Freddie Throassie (uranium mine employee and former Chief), Ray MacDonald (entrepreneur and former councillor), Elder John Toutsaint (current and former councillor), and Elder Rosalie Tsannie-Burseth (educator, doctoral researcher, and former Chief). Most of these people are also land users. We also interviewed staff at organizations that support these First Nations, including Ya'thi Néné staff members Dana Kellett and Tina Giroux-Robillard. (We also spoke with representatives from Athabasca Basin Development and Prince Albert Grand Council, but these conversations were not used in the development of this article.) All participants gave informed consent and understood that their name would be connected to their responses and included in publications.

We first asked questions to determine community members' knowledge and observations of climate change. We then discussed businesses currently active in the northern communities. Finally, we asked whether there were any current businesses addressing climate change and what climate-related business ideas seemed most interesting to community members. For this final question, we provided a two-page visual aid with icons and text describing more than two dozen possible climate-related businesses, such as firefighting, greenhouses, and solar panels.

We transcribed interviews and, using qualitative data analysis, we identified key themes in the interviews. Our heavy use of quotations in the following text is intentional and serves to ensure Athabasca Denesųłiné voices are central to how findings are interpreted and presented. Drafts of this article were shared with Ya'thi Néné Lands and Resources for feedback prior to publication.

Potential Nature-Based Solutions for Climate

Wildfire Management

Wildfires have become increasingly common in Northern Saskatchewan. Across Canada, the annual area burned by wildfires is four times higher than in the 1970s (Rutgers, 2025), and models suggest that annual area burned will increase another two to five-and-a-half times by 2100 (De Groot et al., 2013). In 1995, wildfire impacts cost Canada $11 billion per year, and by 2016, single fires alone cost $10.9 billion (Alam et al., 2019; Schaenman et al., 1995). Climate change is the

driving force behind these increases, with drought, high temperatures, a longer fire season, more lightning strikes, and higher winds leading to megafires that threaten ecosystem resilience and release large amounts of carbon into the atmosphere (Buettner, 2018; Hanan et al., 2021; Scholten et al., 2024). Forests that were once climate-limited systems due to high moisture and humidity are becoming fuel-limited systems, and there is a lot of fuel to burn (Hanan et al., 2021; Krawchuk & Moritz, 2011). Instead of rare-large-intense fires, we are now seeing common-large-intense fires (De Groot et al., 2013; Scholten et al., 2024).

Indigenous people in Canada are 30% more likely to be evacuated due to wildfire and to suffer its impacts (Hoffman et al., 2022). Wildfire smoke makes air unsafe to breathe, evacuations and power failures can result in the closure of local businesses, and infrastructure may be damaged (Rutgers, 2025; Zahara, 2020). Food security is also deeply affected, as traditional harvesting areas burn (MBC News, 2018). For the Athabasca Denesųłiné, barren-ground caribou is a primary food source, and fires destroy caribou winter habitat, causing caribou to avoid burned habitats for decades (Kriese & Barnett, 2025; Thomas, 1998).

Wildfire is intimately tied with colonization of Indigenous Peoples in Canada and has been used by Euro-Canadian settlers as a means of control and appropriation for centuries (Zahara, 2020). Prior to colonization, archaeological evidence suggests that Indigenous Peoples living in what is now Northern Saskatchewan relied on limited, small-scale burns to control and manage traplines and fuel loads around villages (Gulig, 2002) and for communication (Settee, 2020). These cultural burns may have increased biodiversity, improved food security by promoting berry and moose habitat, reduced pests, built community capacity, and decreased the risk of severe wildfire (Berkes & Davidson-Hunt, 2006; Christianson et al., 2022; Hoffman et al., 2022; Kriese & Barnett, 2025). Fewer fires burned after the introduction of smallpox in the eighteenth century, likely from population declines in Indigenous communities, and thereafter cultural burning was criminalized by colonial governments. During the Great Depression, Saskatchewan encouraged settlers to move northwest into forested parts of Saskatchewan, and the government promised fire suppression to make the forest a safer place to live. Although settlers were enticed by the promise of fire suppression, some settlers set fires to clear land for agriculture and mineral prospecting. Instead of avoiding dry periods or high winds as First Nations cultural burners did, prospectors used these weather conditions to burn as much land as possible; when undergrowth grew back the next season, another fire was lit to remove it. These frequent, large fires killed animals and displaced migratory and resident species. First Nations people experienced hunger as a result. Barren-ground caribou especially avoided burned and regenerating areas, and in the 1930s, Saskatchewan experienced the first of several "caribou crises" (Gulig, 2002; Zahara, 2020). After the Second World War, fire suppression increased again, and beginning in the late 1950s, the province recruited and conscripted Indigenous firefighters. Fire management continues to be an important source of employment for Indigenous northerners, whose families have now been paid firefighters for three to four generations (Zahara, 2020).

Use of wildfire to control First Nations is not confined to the past; the Saskatchewan government continues to use fire to control First Nations today. In 2004, Saskatchewan's Ministry of Environment, the provincial department that oversaw forestry and wildfire until 2019,[2] implemented a new, values-based fire management policy. Under this policy, wildfires are allowed to burn until they endanger something "of value" to the province, such as human life, communities, infrastructure, commercial timber, remote structures, or natural resources (Saskatchewan Public Safety Agency, n.d.). Prioritized values do not include cultural sites, traplines, key areas for food security, or other items important to First Nations people. Northerners call this policy "Let-it-Burn" (Dallyn, 2012). The Northern Trappers Alliance, representing Northern Saskatchewan trappers, reports that the policy has "decimated wildlife and destroyed cabins [and] has had a serious impact on [trappers'] ability to make a living and thrive in a culturally sustainable way in their own home territory" (Northern Trappers Alliance, 2014). Other community members have likened the policy to the massacring of buffalo in the 1800s (Zahara, 2020). Northern First Nations routinely call for more fire suppression instead of less, and this call stems from a deep knowledge of and relationship with the land and generations of firefighting expertise (Zahara, 2020). With the decision to only prioritize provincial values, managed wildfire shifts from potentially destructive or rejuvenating force to a colonizing one (Neale et al., 2024). The Northwest Territories' fire management plan does consider social and ecological values, such as burial grounds, protected areas, and wildlife habitat; the plan is critiqued by local Indigenous communities, however, for excluding Indigenous Peoples from decision making, allowing sacred areas to burn, and not prioritizing water quality (Baker, 2025; Northwest Territories, n.d.).

Lack of sufficient provincial fire response and increasing fire risk due to climate change suggest that stepping up fire management could offer significant benefits beyond carbon storage. Increased wildfire management would offer a combination of year-round jobs related to education and mitigation, as well as physically demanding seasonal jobs fighting fires. Additionally, preventative forest management, such as removal of dead, fallen wood near communities and culturally important sites could offer nearly unlimited seasonal employment. The Northern Inter-Tribal Health Authority coordinates fire responses for Northern Saskatchewan Indigenous communities using Indigenous values, and Prince Albert Grand Council is an Indigenous organization that provides various fire

safety and management programs in the North, including fuel management projects, firefighter training courses, cultural burning in the Saskatchewan River Delta, a community fire safety program, emergency preparedness training, search and rescue, and more. Each of these programs could be supported financially and with additional staff. Perhaps, in this new fuel-limited fire regime, cultural burning during cool, wet seasons, which has been practised by other Indigenous Peoples across the Arctic and Subarctic, could mitigate catastrophic wildfires for the Athabasca Denesųłiné (Degteva & Vourc'h, 2025; Kriese & Barnett, 2025). As climate shifts, fire response must shift, too.

Reforestation

More than half of Canada's carbon sequestration via natural climate solutions could come from reforestation (i.e., restoration of forest cover, urban forests, riparian tree planting, silvopasture, and tree intercropping) (Drever et al., 2021). Reforestation projects plant trees in areas where trees were recently killed or removed, such as by logging, wildfire, disease, or industrial activity. Reforestation speeds up regeneration and controls which species reestablish. Currently, in the Northern Saskatchewan boreal forest, reforestation takes place during mine reclamation and after some wildfires; trees may have trouble establishing on hard-packed, post-industrial soil, and extreme wildfires challenge natural regeneration and facilitate ecosystem transitions by destroying seeds and root systems of pre-existing trees and killing young forests before they can reproduce (Arctic Council, 2024; Macdonald et al., 2015). Until recently, most northern boreal forests in Canada experienced strong post-fire regeneration; however, the past few years of extreme forest fires suggest this may be changing. Pine is outcompeting spruce, and broadleaf trees, like birch and aspen, may replace conifers. In some areas, trees may not grow back at all, and the land may experience larger ecosystem transitions. These changes have implications for the people who use the land (Arctic Council, 2024; Carty, 2023).

A variety of organizations and funders have partnered with local groups to plant trees in Northern Saskatchewan. For example, Environment and Climate Change Canada funded a post-wildfire reforestation project led by Clearwater River Dene Nation in Northern Saskatchewan (McLernon, 2023); the apparel company Tentree has supported tree planting across Canada, including in Lac La Ronge Provincial Park (CBC, 2016); the Blue Green Planet Project helped Shoal Lake Cree Nation reforest after a wildfire (Blue Green Planet Project, 2023); and Saskatchewan's Ministry of Environment has been planting trees to restore human-caused disturbances in woodland caribou habitat, such as along old roads, trails, and seismic lines (Saskatchewan, n.d.).

Reforestation is typically well supported by communities as a means of mitigating wildfire and mining impacts, protecting food security and livelihood, and reinstating ecosystem services. The need for reforestation will grow as the climate continues to change. Reforestation projects, along with afforestation and assisted migration projects, offer opportunities for employment in tree cultivation, planting, and transportation. Tree planting is seasonal, physically active work with good wages. This employment could be ideal for young adults who are off school in summer. Tree nurseries could grow culturally important plants and sell to research projects and communities around the country. Financial inputs could have a snowball effect, such that planted areas could provide sites from which non-timber forest products could be gathered and then sold, such as berries or medicines.

Afforestation

Afforestation is a meaningful NbSC when used in the right place, at the right time. Afforestation refers to planting trees on land where trees have not grown for at least 50 years (Schirmer & Bull, 2014). Afforestation projects most often take place on agricultural land, but can also take place on grasslands, degraded areas, and alpine and high-latitude environments (Ojuok, 2020; Trottier, 2024). As with reforestation projects, the new forests store carbon, diversify the landscape, and contribute to local livelihoods.

Although afforestation is supported by the United Nations Framework Convention on Climate Change (UNFCCC) and the UN Strategic Plan for Forests 2017–2030, high-latitude afforestation for climate benefit is controversial (UN Clean Development Mechanism, 2025; UN Forum on Forests, 2017). Afforestation was not considered a natural climate solution for Canada in Drever et al. (2021). Of afforestation projects that have taken place in cold locations where trees do not naturally grow, all known projects occurred in mountainous environments (i.e., high-elevation), rather than in the Far North (i.e., high-latitude) (Gibbon et al., 2010; Grätz et al., 2024). For example, in the Austrian Alps, afforestation projects date back to the early 1900s to prevent avalanches, and as of 2017, the Austrian Alps region has over 3,000 small, high-elevation afforestation sites covering 9,000 hectares (Grätz et al., 2024). Feasibility studies of carbon storage along high-latitude, non-mountain treelines date back to the early 2010s. Scientific interest was sparked by the projection that increased temperatures, access to additional soil nutrients, increased atmospheric carbon dioxide, and shorter winters could lead above-ground biomass (and therefore above-ground carbon storage) in boreal forests to increase 13% by 2100 and allow the treeline to move north (Larjavaara et al., 2021; Pappas et al., 2023). While these outcomes could increase carbon storage in above-ground biomass,

some scientists worry that high-latitude afforestation could have overall negative impacts on climate: potential increases in carbon storage in trees could be offset by speeding up permafrost melt, losses in soil carbon, decreased albedo (i.e., reflectivity of the Earth's surface), and increased wildfire (Dsouza et al., 2025; Hansson et al., 2021; Kristensen et al., 2024; Lemprière et al., 2013). To avoid these negative impacts, high-latitude afforestation must be completed in highly context-dependent manners and with follow-up studies to ensure net positive climate effects.

High-latitude afforestation projects in Northern Canada also require context-specific considerations due to potential interference with barren-ground caribou, historic lack of engagement with Indigenous communities, and respect for Indigenous sovereignty (Kayseas & Baldwin, 2025). As trees grow more thickly along the treeline and into the tundra due to climate change, barren-ground caribou travel through different areas (Dokis-Jansen et al., 2021). One study describes this change:

> Interviews also identified another pattern of change attributed to climate or global warming, specific to the treeline and caribou movement patterns along the treeline. Pete Enzoe describes the northeasterly shift in the use of key crossing sites from the East Arm of Great Slave Lake (Pike's Portage) to K'ásba Deze at the north end of Ɂedacho Kué: ' … And then the trees growing, too, way back when I was growing up, the trees were far apart, and now it's growing thicker. Yeah, the climate is changing.'
> (Dokis-Jansen et al., 2021, p. 300)

Planting additional trees could cause barren-ground caribou to move further away from the people who rely on them for food. If afforestation is considered, it must be done selectively in areas that are not used by caribou and that provide maximum climate benefits.

Assisted Migration

Assisted migration can facilitate climate adaptation among trees that are planted via reforestation or afforestation (Pelai et al., 2021). Within a tree species' range, trees genetically adapt to local conditions. For example, a black spruce in southern Saskatchewan may be more drought and heat tolerant than a black spruce in northern Saskatchewan. Scientists can use this to their advantage by moving the tree adapted to warm, dry conditions to a cooler, wetter place that is expected to become warmer and drier over the next twenty-plus years. One method of assisted migration, known as resistance, aims to maintain current species composition of a forest over time by planting trees more resilient to future climate conditions. Another method of assisted migration aims to improve forest resilience by increasing layers in a forest and increasing species diversity. The third method of assisted migration helps to transition a forest; in this case, trees are planted beyond the current range of the species. This is beneficial if the climate is projected to change very quickly or human or natural barriers limit natural migration (Prasad et al., 2024; Simply Science, 2024).

Assisted migration could be beneficial across Northern Saskatchewan. Assisted migration has high public acceptance; within-range migration is supported by more than half the population and nearly 100% of foresters according to a study from British Columbia (Pelai et al., 2021). The primary risks include introducing invasive, non-native species including insects, displacement of native species, reduced genetic diversity, ethical concerns, and regulatory challenges (Pelai et al., 2021; Twardek et al., 2023). Very little research explores the views of Indigenous Peoples on assisted migration (Pelai et al., 2021; Rayne et al., 2020). Humans have a long history of moving plants for food, medicine, ceremony, and more (Silcock, 2018). Assisted migration today could be particularly beneficial for Indigenous communities, as species of interest could be targeted to ensure their resilience to climate change (Rayne et al., 2020).

Assisted migration also presents emerging opportunities for economic development in northern Indigenous communities. Implementing assisted migration projects requires localized climate modelling, species selection, nursery production, tree planting, and long-term monitoring—all of which could support job creation and skill development (Moreira et al., 2024). For example, Indigenous-owned nurseries could cultivate climate-resilient species, including culturally significant plants, which could then be sold to restoration projects across Canada. Seasonal and youth employment in seed collection, propagation, and planting would align well with existing land-based skills. Additionally, integrating Indigenous Knowledge systems into assisted migration practices could position communities as national leaders in climate adaptation forestry, creating potential for partnerships with universities, governments, and conservation organizations. If well designed and locally led, assisted-migration projects could not only increase ecological resilience but also provide a foundation for conservation economies that respect Indigenous self-determination while generating meaningful livelihoods (Coast Funds, 2022).

Indigenous-Led Area-Based Conservation

Indigenous-led area-based conservation (ILABC) projects are places where colonial practices of protection and conservation are redefined to centre Indigenous ways of knowing. As of 2023, more than 50 Indigenous communities have received federal funding to establish ILABC projects (Mansuy et al., 2023). Indigenous Guardians, local Indigenous stewards, often act as "park rangers" within ILABC, monitoring ecological health, maintaining cultural sites, and protecting sensitive areas and species. Across Canada, more than 240 Guardians programs have received funding, employing almost 1,500 Guardians (Environment and Climate Change Canada, 2025). Canada is motivated to support ILABC because ILABC offers one of the most effective ways to conserve biodiversity, meet the goal of protecting 30% of lands and water by 2030, and honour commitments to reconciliation (Mansuy et al., 2023).

ILABC helps Indigenous communities connect to place and culture, revitalize language, heal, provide environmental stewardship, support reconciliation, and develop economically (Indigenous Circle of Experts, 2018). ILABC can form a foundation for local Indigenous economies by diversifying revenue sources and retaining Indigenous community members who may otherwise move to urban centres for employment (Indigenous Circle of Experts, 2018; Mansuy et al., 2023). Revenue sources associated with ILABC include ecotourism, transportation, lodging and food, research, Indigenous Guardians, fisheries and traditional foods, carbon credits, education, and more. Guardians can act as tour guides, site hosts, field researchers, surveyors, enforcement officers, restoration workers, collaborators, emergency responders, and in other roles, providing the human resources necessary for land stewardship. Funding for Guardians can stem from industry and resource user fees and agreements, partner organizations, government funds, and community and private donors (Nature United, 2026). For example, some of the funding for Ya'thi Néné Lands and Resources' current Guardians program comes from exploration and collaboration agreements with mining companies operating in the Athabasca Basin. Guardians programs can be profitable beyond direct income too: for every one dollar invested in Guardian programs, $2.50 to $20 of intangible social, economic, cultural, and environmental value is created (Coast Funds, 2019; Social Ventures Australia, 2016). For example, financial investments into the Guardian Watchmen of the Great Bear Rainforest in British Columbia offer a one to ten return on investment when growth in intangible community values—like taking care of community, governance authority, community well-being, cultural well-being, economic opportunities, community capacity, and financial well-being—are converted to financial value (Coast Funds, 2019).

The Province of Saskatchewan supports increasing protected areas to 12% by 2030 under the condition that proposed protected areas promote economic development. In Northern Saskatchewan, Indigenous-led area-based conservation would therefore be most well-received by the government if they do not interfere with resource exploration and extraction. At the same time, mining and exploration companies desire certainty, social licence from communities, and access to existing and potential future mineral holdings, so mining companies may offer support for ILABC to strengthen relationships with communities (Henderson, 2021). Ya'thi Néné Lands and Resources is developing four ILABC projects, called Etthén Néné Stewardship Areas or Barren-Ground Caribou Lands Stewardship Areas, in Northern Saskatchewan. Etthén Néné Stewardship Areas are high-use areas where caribou migrate and members harvest. These areas are rich in cultural history, stories, and teachings and serve as living classrooms for local First Nations (Ya'thi Néné Lands and Resources, 2025b). To support these lands as the climate changes, the Etthén Néné Stewardship Areas in Nuhenéné should have climate management plans. The plans should contain provisions to protect climate refugia (places where the local climate is expected to remain more stable) and climate corridors (associated transition zones) so that conserved areas remain relevant, high-impact locations even as species distributions alter with climate change (Martinez, 2025; N. Wilson, 2018).

Supporting Barren-Ground Caribou

Barren-ground caribou are vital for the physical, cultural, social, and spiritual well-being of the Athabasca Denesųłiné. Barren-ground caribou are also a keystone species for ecosystem function and impact carbon storage and nutrient cycling in plant communities via grazing. Large herbivores, including caribou, have net climate benefit on tundra landscapes; as 1) grazing targets shrubs, which increases albedo and decreases permafrost melt; 2) animals compact snow when walking and digging for food, which allows cold air to penetrate deeper into the ground; and 3) waste fertilizes the ground and speeds plant growth, storing carbon in both above- and below-ground vegetation (Windirsch et al., 2022). Barren-ground caribou are recognized as threatened in the Northwest Territories and face challenges due to climate change, diseases and parasites, disturbance, predators, wildfires, and cumulative effects (NWT Species at Risk, 2026).

The Beverly and Qamanirjuaq Caribou Management Board co-manages the two barren-ground caribou herds that winter in Nuhenéné. In 2023, the Management Board released a management plan detailing measures "to ensure the long-term conservation of the … herds for Indigenous peoples who wish to maintain a lifestyle that includes the use of caribou, as well as for all Canadians

and people of other nations" (Beverly & Qamanirjuaq Caribou Management Board [BQCMB], 2023, p. 8). The management plan lists a limited number of climate impacts on caribou but recognizes that more information is needed about each herd's seasonal range use patterns and habitat use, activities that damage caribou habitat, how much time is required for recovery of disturbed areas, ways to avoid or reduce negative effects on habitats, and impacts of climate change on caribou habitat and well-being. Current recommendations include restricting development and industrial disturbance in certain areas, wildfire management to protect forested winter range, and stronger requirements for how industrial projects are planned, approved, monitored, and enforced. A priority is assessing caribou habitat and maintaining corridors of unburned forest to connect areas of productive habitat (BQCMB, 2023).

In addition to the recommendations from the Beverly and Qamanirjuaq Caribou Management Board, our research led us to several projects supporting barren-ground caribou. First, in South Slave Lake, Northwest Territories, lichen is being transplanted after wildfire and industrial use to accelerate the restoration of functioning winter range for barren-ground caribou (NWT Species at Risk, 2023). Since greening of the tundra and northward movement of the treeline are likely impacting caribou movements (Dokis-Jansen et al., 2021), forest encroachment prevention might also be considered. Third, the Inuvialuit Regional Corporation owns 6,000 reindeer that provide cultural training, food security, and employment (Brown, 2024). This would do little to support migratory barren-ground caribou but could serve as an economic development project for communities and provide hands-on learning about cultural traditions, especially if the barren-ground caribou population shrinks below safe harvest levels. This would, however, change the foundation of the Dene relationship with caribou from opportunistic hunting of a migratory species to herding and husbandry (Löf & Naomi, 2011). Finally, a breeding and conservation program by the West Moberly First Nation and Saulteaux First Nation is conserving the Klinse-Za woodland caribou in British Columbia. Working with the province and community groups, the First Nations increased the size of the herd from 38 individuals in 2013 to 113 in 2022 using predator reduction, maternal penning, and long-term habitat protection. The project has created jobs in research and conservation and is increasing cultural connection to caribou: youth collect lichen, community members engage in conservation discussions, a First Nations non-profit has been created, and the First Nations hope to soon harvest one to two individuals for ceremonial use (Arseneault, 2022; Lamb et al., 2022). Although woodland caribou are a different subspecies from barren-ground caribou and face different challenges, the Klinse-Za woodland caribou project suggests that conservation projects for barren-ground caribou could bring jobs, cultural revitalization, youth engagement, and ecological benefits to Nuhenéné as well.

Athabasca Denesųłiné Perspectives

In conversations with Athabasca Denesųłiné community members, we discussed potential nature-based solutions for climate for Nuhenéné and how local Indigenous Knowledge and values bring a Two-Eyed Seeing perspective that could alter how NbSC are considered and evaluated. Community members expressed the desire to continue to live off the lands and waters and care for Nuhenéné in the way that they have for millennia. People were most interested in NbSC that respond to climate impacts currently affecting communities. Managing wildfire and supporting caribou were popular solutions, and Indigenous-led area-based conservation peaked interest due to ongoing discussion around establishing ILABC in the Athabasca Basin.

Support for NbSC projects was conditional, however, and many interviews began with community members expressing generalized resistance to "land management." Community members questioned whether NbSC were green colonial projects that went against the best interests of the First Nations. "Land management" and "climate solutions" were seen to be the government's way of controlling Athabasca Dene Traditional Territory and extracting additional resources from the land. Taking no action was viewed as better than allowing outsiders to manage the land in ways that might potentially be extractive or harmful to caribou and Dene ways of life. Concerns about sovereignty were most apparent in discussions about NbSC that addressed emerging, projected, and minimally known climate impacts.

Acknowledging green colonialism helped us shift conversations towards Indigenous stewardship and Two-Eyed Seeing and allowed more nuanced perspectives on NbSC to emerge. Some of the same people who said they did not want to see land management projects later clarified that they supported land stewardship for climate change, "especially when it's gonna be bringing in more caribou to the people" (MacDonald, 2024). Another community member, Ricky Robillard (2024), said that he supports land-based projects that aim "to save our communities, to save our assets." Community members' comments align with the statement on Ya'thi Néné Lands and Resource's website, as described in Henderson (2021), stating:

> The Athabasca Denesųłiné First Nations and Athabasca Basin Communities desire greater control and management of their traditional territories and the chance to benefit from any future economic opportunities … it is fair to say that the greater the degree of local control achieved, the more likely the Communities will be to favour an agreement. The Communities are also in favour of economic development that is sustainable, protects traditional lands and waters, and benefits local people. They are generally opposed to development that damages the environment and principally benefits outsiders.

To address concerns about colonialism and sovereignty, we name three requirements that must be met before an NbSC is considered: leadership by Indigenous Peoples, stewardship of the land in line with Dene values, and recognition of the legacy of colonialism. We also used community members' responses to create criteria to define which NbSC are most suitable for Nuhenéné; the most appropriate NbSC support connection to land, conserve barren-ground caribou, increase economic well-being (both short-term jobs and the long-term creation of a conservation economy), and foster common goals amongst community members.

Wildfire Management

The Athabasca Denesųłiné shared how their communities are heavily impacted by wildfire, and community members strongly support wildfire management projects, including more fire suppression to protect Dene assets.[3] During wildfires, homes and lives are at risk, evacuations are stressful, and traplines and cabins are destroyed. The impacts on Elders are important, as Ray MacDonald (2024) explained: "It's a lot of stress, a lot of strain on the people, especially when there's a forest fire and they have to be relocated. There's some Elders that are not capable of moving around. And we're risking their lives when we let these fires burn." After wildfires, barren-ground caribou avoid burned areas, and community members must travel further to harvest caribou. Ricky Robillard (2024) described how harvesters struggle after losing access to caribou: "They've lost their means of survival, revenue … It's taken away a lot of their opportunities in terms of economic sustainability." Community members are aware that fire brings new growth, such as additional blueberry bushes, but they do not see this as a reason to let vast swaths of forest burn.

Prince Albert Grand Council leads fire management activities and trainings in the communities, but when large fires burn, the First Nations still rely on the government for firefighting. David Bigeye (2025) explained that "If there's a forest fire starts, you call in [to the province], they won't put it out. They'll just say let it burn and then it stretch out [i.e., spreads]. The whole Canada is just brown now." Community members wish they could address the fires. "Do we have any resources to fight it?" posed Freddie Throassie (2025), "No, we don't. Nothing whatsoever … We can do a lot of things if only we could have the right people in there and get the fundings, get the project going."

The province's wildfire management decisions have fostered a sense of mistrust among the First Nations. "People don't realize that this is a climate change, they blaming the government right now for all this, this burning in the area," explained Freddie Throassie (2025). One community member, harking back to how Euro-Canadian settlers, supported by the government, once burned forests to enable mining and exploration, believes the government may be setting fires again to enable mining (Toutsaint, 2025). Another community member suggested that the government has allowed the forests to burn so that now the government can come in, plant trees, and expand industry in the North (Bigeye, 2025).

Community members also wish that wildfire management engaged Indigenous Knowledge. One person noted that the province is not incorporating Indigenous firefighting knowledge into fire management and is relying on technology that does not seem to help. Billy Adam (2024) explained, "Like the Elders would say, best time to fight fire is at night. There's no sun, no wind, it just slowed down." When Adam fought fires, firefighters used hand tools to successfully extinguish fires. Nowadays, there are hose lines and big planes, which have "lots of air [i.e., wind] and then they spread the flames." Adam reminisced, "[If] They were fighting fire like way before, way back in the '60s, you know, then it would have been different." Additional research into modes of firefighting suggests that increased fire intensity may explain the shift from hand tools to planes. Hand tools are effective on fires up to 500 kW/m, hose lines are useful up to 2000 kW/m, and air tankers are used on more intense fires. Current average fire intensity in Canadian boreal forests is approximately 10,000 kW/m and may exceed the air tanker control limit by the end of the century (De Groot et al., 2013). Nonetheless, fires do not burn uniformly, and there may be locations or times of day in which hand tools could be effective. Prince Albert Grand Council's forthcoming Wildfire Resilience Initiative study may offer useful insight into how Indigenous firefighting knowledge can inform fire management in this age of intense, climate-driven wildfire and how this knowledge can be implemented.

When Indigenous Knowledge and values are integrated, wildfire management becomes a top NbSC to pursue, whereas Western science-based provincial wildfire management chronically underfunds this solution. Wildfire management supports people's connection to land by keeping harvesting areas populated with plants, animals, and medicines, protects caribou habitat, provides jobs for community members, protects land that could be used for non-timber forest products or

tourism, and has strong support and consensus amongst the community. As with all solutions, wildfire management is only acceptable if it is done with Athabasca Denesųłiné leadership, is in line with Dene stewardship values, and recognizes the history of colonialism.

Reforestation

Community members see few opportunities for reforestation in the North. Forests around communities are dense and not logged, and forests have been regenerating after wildfire. Reforestation is in line with Dene values, however, for reclaiming mining and exploration sites. Mining and exploration companies clear paths through the forest and create hard-packed platforms for their drilling operations. When the company leaves, sometimes trees are replanted, which community members like to see.

> I think it's a good idea because … They do a lot of land cutting … With the tree replanting after the fact … They've done that on a couple of mine sites that have shut down. There's reclamation, and they've toured local members on that site where vegetation is regrowing and local members like to see that. So I think it would be very well received by membership if the mine companies did something like that to give back to the community, to put that land back to almost at its original state. (Robillard, 2024)

As Ricky Robillard explained, reforestation would be welcomed as a part of mine reclamation, assuming it was carried out it a good way.

Another case in which reforestation might be considered is in burnt areas. Some community members were open to planting trees to speed up regeneration after a fire, but others noted that natural regeneration was occurring and planting trees would not speed up growth by more than a few years. Tree regeneration after wildfire is projected to change with the climate, and further research should examine which species are growing back, in what proportions, how this compares to existing forests, and how changes may impact land users (Arctic Council, 2024; Carty, 2023). If tree planting is planned, assisted migration of more-adapted members of a tree species should be considered.

Overall, reforestation could bring jobs to the community that involve planting on the land and growing plants in nurseries, but it would likely have little impact on barren-ground caribou conservation. Community members are not in consensus that this is the best NbSC to pursue.

Afforestation

Community members questioned whether afforestation is in line with Dene values, let alone whether afforestation would support caribou conservation or have community support. With our foundational requirements not met, we include discussion of afforestation with caution. Community members expressed concern for the muskox, grizzly bear, polar bear, and all of Mother Nature if afforestation occurred. David Bigeye (2025) worried, "And all these wildlife live in there and they're born and used to it. And when we start planting trees there, we're growing vegetation, trees and all that, right. And they're going to change their behaviour." Community members also wondered whether increased vegetation along the treeline would affect barren-ground caribou migration and deter caribou from coming near communities. David Bigeye (2025) asked, "Why would we choose to plant in that area when the caribou migrate in that area?" Ray MacDonald (2024) expressed concern that, "If all this grows in, we might be losing [caribou] forever." There are accounts from the Northwest Territories where greening of the treeline deterred barren-ground caribou, and afforestation would likely exacerbate this problem (Dokis-Jansen et al., 2021).

Additional concerns about afforestation were related to unintended consequences of assisted migration and cultural appropriateness of trees planted. Ricky Robillard (2024) highlighted the need to pay attention to invasive species, be cautious about insects associated with imported vegetation, and receive input from community members on decisions. He said:

> There's like that Dutch Elm disease and all that, but we don't have these kind of trees up in the area here. Maybe different species of, you know, different types of trees may bring different species up here, or insects. But that's something that needs to be investigated more, what would be safe to grow up in our region. And at the same time, it should be consulted with our members, membership, you know, bringing in something that's like an import into the North. (Robillard, 2024)

Like many, Robillard has concerns about moving species into new areas via assisted migration. These concerns would apply to reforestation projects as well.

Afforestation risks disregarding Dene values and decreasing access to barren-ground caribou, an essential species for the Athabasca Denesųłiné. The carbon storage potential of this option must not distract from these real risks to threatened species and already marginalized people.

Indigenous-Led Area-Based Conservation

Community members are cautiously optimistic about ILABC, and the communities are already making moves towards ILABC. Ya'thi Néné Lands and Resources has been hosting meetings for community members to develop four ILABC projects, or Etthén Néné Stewardship Areas, in the Athabasca Basin. In addition to these proposed areas, community members ratified the North of 60 Final Agreement in June 2025, giving the Athabasca Denesųłiné First Nations treaty rights in the Northwest Territories and Nunavut;[4] the agreement includes core funding that could be used for community monitoring of the land, which could be managed via ILABC, albeit without the official designation. Community members identified benefits of ILABC to include protecting barren-ground caribou and First Nations high use areas from mining and exploration, economic development and diversification, and greater land sovereignty. In the past, on-the-land camps have been interrupted by unannounced helicopters and exploration activities, and ILABC could protect from these unexpected encounters (T. Giroux-Robillard, personal communication, April 1, 2025). ILABC could also bring tourism, which is seen by many community members as a worthwhile pursuit that could bring communities additional jobs and income, although some worry about tourists wanting to purchase land in the area or otherwise undermining Indigenous economies and ways of life. ILABC supports scientific goals of carbon storage and biodiversity conservation through land stewardship, while also supporting Denesųłiné needs for connection to land, caribou conservation, economic opportunity, and likely community acceptance.

Supporting Barren-Ground Caribou

Barren-ground caribou are the foundation of Dene life, and community members prioritize well-being of and access to caribou. People already see the impacts of wildfire and warmer temperatures on barren-ground caribou, and they are worried.

> A lot of [our culture] has got to do with hunting caribou and all that. If there's a big climate change, the caribou and that is going to be further and further and further and it'll be even harder to get. And the lifestyles will have to change with it too. And slowly we'll be losing our identity as Dene people if the climate changes drastically. (MacDonald, 2024)

Already, some years, families are not able to harvest enough or any meat (Cook, 2025). The Athabasca Denesųłiné NeNe Land Corporation created an Athabasca Denesųłiné Barren-ground Caribou Relationship Plan[5] in hopes of protecting caribou (BQCMB, 2024). The plan is not yet public, and not yet known to what extent it addresses climate change.

Community members are supportive of land stewardship that would benefit barren-ground caribou, such as ensuring community members follow traditional harvesting protocols, protecting areas important for caribou from industrial development, and increasing fire management. We did not ask specifically about reindeer herding as a climate adaptation, but Terri-Lynn Beavereye (2025) shared that some community members are interested in raising other animals like chickens, turkeys, and pigs. Given the reverence people have for caribou, confining and domesticating caribou may be seen as disrespectful; importing reindeer from Nordic nations may be more appropriate. Building relationships with Nordic reindeer herders may be beneficial in other ways as well. Rosalie Tsannie-Burseth (2024) mentioned visiting reindeer herders in Norway and trying "to connect them to the [Prince Albert Grand Council] and back home, for them to come and talk to our community and talk about how they can work with caribou to protect it." Nothing came of this, as far as she knows, but Tsannie-Burseth's experience shows openness to integrating herders' knowledge and techniques into caribou management.

Barren-ground caribou conservation is both an NbSC and a measure of Dene support for NbSC. Caribou conservation is in line with Dene land stewardship values, and conservation supports connection to land, economic well-being, and community cohesion. Without Two-Eyed Seeing, caribou conservation might be undervalued, as access to caribou is a higher priority for many Indigenous people in Northern Canada than to the average Canadian.

Community Capacity and Funding

Community members are optimistic that NbSC could benefit their communities and are interested in engaging in work and businesses opportunities. Community members' abilities to engage Two-Eyed seeing ensures maximum climate benefit without disregarding community needs, values, and priorities. Many people already operate businesses or have plans to start ventures that could align with NbSC-related activities, such as cultural tourism, ecological monitoring, food security initiatives, and renewable energy. For instance, Indigenous-led nurseries growing culturally significant and climate-resilient tree species could supply reforestation and assisted migration projects. Similarly, local contracting companies could support wildfire mitigation and fuel reduction efforts, while youth might find employment through Guardian programs, research partnerships, or data monitoring initiatives.

Youth engagement is especially valued, and Rosalie Tsannie-Burseth (2024) reported that youth responded eagerly to the prospect of working for land-based projects associated with the North of 60 Agreement:

> The youth, it's unbelievable. They like going out on the land … And when I told them about this North of 60 project, you know, one day you're going to go on the land, you're going to manage it, you're going to patrol our land. You could just see it in their face, right? They're all excited about it because it's monitoring our own backyard.

Given youth's enthusiasm for working with land-based projects, similarly Indigenous-led NbSC projects would likely garner interest and participation. With proper support, these projects can help create a robust, self-sustaining conservation economy that diversifies revenue streams and decreases dependence on extractive industries.

A foundation for any NbSC project is leadership by and collaboration between local organizations and individuals. Groups that currently organize land-based activities in Nuhenéné include Prince Albert Grand Council; Ya'thi Néné Lands and Resources; the Athabasca Denesųłiné NeNe Land Corporation (who represent the First Nations in the North of 60 Final Agreement negotiations; their operations may be taken over by Nįh hoghedi Koé, the North of 60 Treaty Office); the Beverly and Qamanirjuaq Caribou Management Board; Black Lake Ventures; Hatchet Lake Development; Fond du Lac Development Corporation; and the band offices and schools of Black Lake, Fond du Lac, and Hatchet Lake Denesųłiné First Nations. Ya'thi Néné Lands and Resources currently manages Indigenous Guardians and land use in Nuhenéné. Cameco and Orano, the two biggest mining companies in Northern Saskatchewan, could also be engaged as funding partners or supporters of NbSC, particularly where reclamation or stewardship intersects with their operational areas. (Ya'thi Néné Lands and Resources' mining and exploration agreements with Cameco and Orano, amongst others, gives the First Nations a stronger and more beneficial relationship with industry than many other Indigenous communities in Canada. The agreements include local environmental oversight, local hiring quotas, use of local businesses' services, training opportunities, and financial compensation.)

The Government of Canada has funding available for NbSC, and market-based funding could be pursued. In 2020, Canada announced its Natural Climate Solutions Fund,[6] a $1.4 billion, ten-year fund that included the 2 Billion Trees project, the Nature Smart Climate Solutions Fund, and the Agricultural Climate Solutions Program (Canada, 2024). Within the Natural Climate Solutions Fund, up to $76.9 million is set aside for Indigenous-led projects (Environment and Climate Change Canada, 2024). However, government funding changes at the whims of political leadership; the 2 Billion Trees project has been cancelled and current federal and provincial priorities have reoriented away from environmental efforts and towards defence and economic development. Accessing funding could help communities initiate NbSC pilot projects with employment, training, and infrastructure components. Many Indigenous communities in Canada are already protecting and restoring ecosystems, and more explicit alignment with natural climate solutions may allow Indigenous communities to access additional funding sources (Powell et al., 2024). However, funding can come with strings attached that can limit Indigenous use of the funds and therefore Indigenous self-determination.

NbSC can also be funded through market-based mechanisms such as carbon and biodiversity offset trading. Offset trading has been critiqued for being a technological, financial, and economic modelling solution to a perceived biophysical problem, rather than the social problem that climate change is; offset trading may not align with Indigenous world views as well as other solutions. Nonetheless, the income from reputable offset trading schemes can fund important work in Indigenous communities that benefits the climate, connection to the land, Indigenous culture, local economies, and more. Offset trading will require substantial administrative and political work before becoming possible for land-based projects on Crown land in Saskatchewan. An agreement like British Columbia's Atmospheric Benefit Sharing Agreement must be developed by the province to clarify First Nations rights before offset trading would be possible.[7] Biodiversity offsets might be more appropriate than carbon offsets for Nuhenéné, as biodiversity conservation, especially related to caribou, is a higher priority for community members than landscape carbon sequestration. Biodiversity offsets could enable the monetization of Indigenous-led habitat protection, caribou stewardship, and culturally important species conservation. Ensuring community support and leadership, accurate monitoring with control plots, and accounting for leakage of impacts into other locations, additionality, and permanence will help offsets be high quality and attractive to investors (Pan et al., 2023). In the absence of full market readiness, communities could also establish direct partnerships with philanthropic or private-sector organizations interested in investing in Indigenous-led climate solutions.

Discussion

Indigenous Peoples have long stewarded lands and waters in Northern Canada. With the rapid rate of climate change, Indigenous well-being, self-determination, and future economic participation is at risk. Meaningful engagement in climate-related stewardship initiatives, such as NbSC, that have intersecting benefits for Indigenous Peoples could mitigate climate risk and support adaptation. A Two-Eyed Seeing approach to NbSC brings together Western science and priorities of conservation and climate storage with Indigenous world views that prioritize relationality, holistic well-being, and sovereignty. This enables solutions that benefit both human and natural communities without sacrificing certain marginalized communities for the "good of the whole."

Building from Reed's conclusions, using colonization as an interpretive lens, engaging with Indigenous Knowledge systems, and respecting the rights and responsibilities of the First Nations (Reed, 2022), we developed a similar set of foundations that must be established before NbSC can be implemented: local Indigenous leadership, alignment with Dene land stewardship values, and recognition of the history of colonialism. These foundations developed as we listened to community members describe their wariness of green colonialism and show enthusiasm towards projects led by community members that intersected with multiple community goals. Language such as "land management" and "climate solutions" was often associated with colonial projects, while terms like "land stewardship" and "land-relationship planning" better resonated with participants (see Nature-Based Climate Solutions Summit, 2020).

A common thread across conversations was the importance of barren-ground caribou and the need to reduce impacts of climate change and potential NbSC on caribou. This finding likely applies to most Indigenous communities living on the North American taiga and tundra, since other communities also rely on barren-ground caribou for sustenance. We established barren-ground caribou conservation as a criterion by which to measure the appropriateness of NbSC for Nuhenéné, along with whether a NbSC supports connection to land, increases economic opportunity, and fosters consensus amongst community members.

Our analysis suggests that the most appropriate nature-based solutions for climate for Athabasca Denesųłiné territory are wildfire management, Indigenous-led area-based conservation (ILABC), and supporting barren-ground caribou. Wildfire management is desired by Athabasca Denesųłiné community members and would have positive benefits for carbon sequestration, biodiversity, barren-ground caribou, and Indigenous land use. Prince Albert Grand Council already provides many wildfire-related services to the communities. ILABC in the Athabasca Basin is underway by Ya'thi Néné Lands and Resources, and their process is worth watching and supporting as ILABC can foster growth in all sectors of the local economy and protect caribou. These approaches also offer the greatest immediate potential for local job creation, infrastructure investment, and youth training programs. Reforestation, particularly in post-mining contexts, and assisted migration of trees also hold promise for local enterprise development, such as planting, nursery production, and seed harvesting. Finally, current research suggests that afforestation has questionable climate benefit and high risks for barren-ground caribou. Other research funded under the same grant as this article may lead to better understandings of specific ecological niches or habitats that could be appropriate for afforestation. Given the current uncertainties, we suggest that afforestation be approached with caution and only pursued further once additional research clarifies its ecological viability and cultural acceptability in this region. Athabasca Denesųłiné communities have the interest, knowledge, and organizational capacity to develop and lead NbSC if appropriate funding is made available.

This research is limited by a small sample size of eleven participants, the majority of whom are from Black Lake Denesųłiné First Nation. The findings should be interpreted with caution as they may not be representative of the Athabasca Denesųłiné nor of all Indigenous Peoples in Northern Canada.

Conclusion

In Northern Canada and beyond, NbSC must be evaluated not only for their environmental outcomes but for their capacity to empower communities. NbSC must support Indigenous connection to land and barren-ground caribou for present and future generations. They must increase both short- and long-term economic opportunity, such as generating local employment and supporting the development of conservation economies through varied enterprises ranging from forestry, fire management, ecological monitoring, research, tourism, and cultural revitalization to food security. Finally, NbSC must generate consensus and support amongst community members rather than conflict and disagreement. NbSC are strategic pathways for community well-being and empowerment. Community needs, values, and priorities must not be treated as an add-on to climate solutions—they must be central, community-defined, and respected. Nature-based solutions for climate are meritless if not aligned with Indigenous rights, values, and long-term visions for the land.

Acknowledgements

We would like to thank Ya'thi Néné Lands and Resources for supporting and facilitating this research. This project would not have been possible without those who shared their stories: Billy Adam, Terri-Lynn Beavereye, David Bigeye, Derek Cook, Ray MacDonald, Ricky Robillard, Freddie Throassie, John Toutsaint, Rosalie Tsannie-Burseth, and Ya'thi Néné staff members Dana Kellett and Tina Giroux-Robillard. Special thanks to Juleah Duesing-Bird for her help as a research assistant. We would also like to thank the reviewers of this article for their thoughtful feedback. This project was funded by Natural Sciences and Engineering Research Council (NSERC) grant ALLRP 577162-2022. This research was approved by the University of Regina Research Ethics Board and Ya'thi Néné Lands and Resources.

Notes

1. We purposefully use the term Nature-based Solutions for Climate (NbSC) to encompass both climate mitigation and adaptation. Similar terms, such as natural climate solutions and nature-based climate solutions (NbCS), only include the mitigation component of NbSC (Buma et al., 2024; Ellis et al., 2024). Additionally, we do not use the term, "nature-based solutions," more generally, as this refers to actions that use ecosystems to address any societal challenge, not just climate change (Cohen-Shacham et al., 2016).
2. In 2019, the wildfire management branch moved from the Ministry of Environment to the Saskatchewan Public Safety Agency.
3. While involvement of the provincial government is often perceived negatively, the "Let-it-Burn" policy was described as "the only thing that the government should more focus on" (Bigeye, 2025).
4. The North of 60 Agreement provides land rights above the 60th parallel, in the Northwest Territories and Nunavut, to the Athabasca Denesųłiné First Nations. The First Nations have lived, travelled, and harvested on this land for millenia, yet original agreements (Treaty 8 and Treaty 10) provided no rights to this land (Athabasca Denesųłiné NeNe Land Corporation, 2024; CIRNAC, 2024).
5. The name of the Athabasca Denesųłiné Barren-ground Caribou Relationship Plan is a prime example of Two-Eyed Seeing. A management plan is a Western concept but renaming the document as a relationship plan forefronts Athabasca Denesųłiné world view and values.
6. The Government of Canada uses "Nature-based Solutions" and "Natural Climate Solutions" interchangeably.
7. Poplar River First Nation has been negotiating a carbon finance benefit sharing agreement with Manitoba for more than 15 years (Townsend & Craig, 2020; Wilt, 2020). The project has been delayed due to lack of support from the province (Wilt, 2020).

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The Northern Review
Exploring human experience in the North
The Northern Review 59: 53–86
https://doi.org/10.22584/nr59.2026.006
Published at Yukon University, Canada

Research Article

Melting Boundaries: Navigating Competing Interests for Deep-Sea Mining in the Arctic

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Abstract: As Arctic ice recedes, previously inaccessible seabed resources are becoming increasingly viable for extraction, drawing global attention to deep-sea mining (DSM) in the region. This article examines the evolving legal landscape of DSM in the Arctic, which is fragmented and shaped by competing national interests, unresolved territorial claims, and differing commitments to international law. As the Arctic coastal states weigh the economic potential of DSM against environmental and geopolitical concerns, the region remains a contested space where law, policy, and strategic interests continue to evolve. This article begins with an overview of the international regulatory framework, including the *United Nations Convention on the Law of the Sea* (UNCLOS), the International Seabed Authority, and key regional agreements such as the Arctic Council's guidelines. It then provides an in-depth analysis of the DSM policies of the five Arctic coastal state—Canada, Denmark (Greenland), Norway, Russia, and the United States—assessing how each state's approach is shaped by its political priorities, legal commitments, and strategic interests. A comparative discussion explores how these states navigate their obligations under UNCLOS, their extended continental shelf claims, and their broader geopolitical strategies. Additionally, the article considers the growing interest of non-Arctic states, particularly China, in Arctic deep-sea mining, highlighting the broader international implications of resource development in the region.

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