



Landscape Carbon Workshop, February 4 to 6, 2025

Synthesis Report

January | 2026

Atelier sur les milieux riches en carbone Du 4 au 6 février 2025

Rapport de synthèse

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Le présent document contient la traduction française du sommaire et du message du sous-ministre du ministère de l'Environnement et du Changement climatique ainsi que scientifique en chef et vice-président, recherche de Savoir polaire Canada

In partnership with:

En partenariat avec:



Polar Knowledge
Canada

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Canada

Government of
Northwest Territories

Gouvernement des
Territoires du Nord-Ouest



K'áhshó got'jne xədə k'é hederı Ɂedjhtl'é yerınıwə ní dé dúle.
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ʔerihth'ís Dēne Sų́líné yatı t'a huts'elkēr xa beyáyatı theɁə Ɂat'e, nuwe ts'ēn yółtı.
Dēne Sų́líné

Edı gondı dehgáh got'je zhatié k'éé edat'éh enahddhę nıde naxets'é edahí.
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Jii gwandak izhii ginjik vat'atr'ijáhch'uu zhit yinoththan jì', diits'àt ginohkhìi.
Dinjii Zhuh Ginjik

Uvanittuaq ilitchurisukupku Inuvialuktun, ququaqłuta.
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Inuktitut

Hapkua titiqqat pijumagupkit Inuinnaqtun, uvaptinnut hivajarlutit.
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kīspin ki nitawihtīn ē nīhīyawihk ōma ācimōwin, tipwāsinān.
nēhiyawēwin

Tłıchq yatı k'èè. Dı wegodı newq dè, gots'o gonede.
Tłıchq

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Acronyms

CH ₄	Methane
CO ₂	Carbon Dioxide
CO ₂ e	Carbon Dioxide Equivalent
ECC	Environment and Climate Change (GNWT)
ECCC	Environment and Climate Change Canada
GHG	Greenhouse Gas(ses)
GNWT	Government of the Northwest Territories
IFM	Improved Forest Management
IPCA	Indigenous Protected and Conserved Area
ha	Hectares
M	Million
Mt CO ₂ e	Million Tonnes of Carbon Dioxide Equivalent
NbS	Nature-based Solutions
NSC	Nature Stewardship Credit
NWT	Northwest Territories
POLAR	Polar Knowledge Canada
SOC	Soil Organic Carbon

Message from the Government of the Northwest Territories – Robert Jenkins, Deputy Minister, Department of Environment and Climate Change

The Northwest Territories' boreal forests, peatlands and permafrost are an essential foundation of the northern landscape and way of life. These landscapes are also critical carbon sinks for Canada and the world and play an important role for our climate.

Peatlands in the Northwest Territories alone store approximately 27 billion tonnes of carbon in their soils, far exceeding the carbon stored in above-ground vegetation. Globally rising temperatures are presenting risks to these landscapes: peatlands are drying, permafrost is thawing and forests are experiencing more frequent and intense wildfires.

This workshop was a unique opportunity to learn and share knowledge. Participants came together to share knowledge about landscape carbon in the NWT, foster collaboration, and explore potential solutions and innovative next steps.

The workshop explored potential nature-based solutions relevant to the Northwest Territories and potential mechanisms to enable these solutions, including the funding mechanisms that are needed to ensure their sustainability and the economic needs of NWT residents over the long term.

Responding to the impacts of climate change is a shared responsibility, and we need to work together to find solutions.

The workshop also acknowledges the deep connection that Indigenous peoples have with the land around us, and the invaluable role that Indigenous knowledge has in identifying and addressing the pressing challenges of climate change. Indigenous land stewardship practices were perceived as avenues to address landscape carbon in the NWT.

The workshop format was open and collaborative. Diverse perspectives and expertise were brought together over three days.

Message du gouvernement des Territoires du Nord-Ouest
Robert Jenkins, sous-ministre du ministère de l'Environnement et du Changement climatique

Les forêts boréales, les tourbières et le pergélisol des Territoires du Nord-Ouest font partie intégrante du paysage du Nord et sont essentiels au mode de vie de ses habitants. Emmagasinant une grande quantité de carbone, ils influencent considérablement le climat du Canada et du monde entier.

Les tourbières des TNO stockent à elles seules environ 27 milliards de tonnes de carbone dans leur sol, ce qui dépasse de loin la quantité stockée dans la végétation aérienne. La hausse des températures à l'échelle mondiale présente un risque pour les forêts boréales, les tourbières et le pergélisol. En effet, les tourbières s'assèchent, le pergélisol fond et les forêts brûlent plus souvent et plus intensément.

L'atelier de février 2025 était une occasion unique d'apprendre et de diffuser le savoir. Les participants se sont réunis pour échanger leurs connaissances sur le carbone présent dans les milieux naturels des Territoires du Nord-Ouest (TNO), renforcer leur collaboration, explorer de nouvelles pistes de solutions pour l'avenir.

Durant l'atelier, on s'est penché sur les solutions naturelles qui pourraient être mises en œuvre aux TNO ainsi que sur les mécanismes nécessaires pour les mettre en œuvre, notamment les modes de financement qui permettraient d'assurer leur viabilité et de répondre aux besoins économiques des habitants des TNO à long terme.

Puisque la lutte aux changements climatiques est une responsabilité commune, nous devons trouver des solutions ensemble.

Les participants ont également reconnu le lien profond qu'entretiennent les Autochtones avec le territoire ainsi que le rôle précieux des connaissances autochtones pour relever les enjeux urgents liés au changement climatique et leur faire face. Les pratiques autochtones d'intendance des terres ont été proposées comme moyens pour gérer le carbone présent dans les milieux naturels des TNO.

L'atelier, qui a accueilli des gens aux diverses perspectives et expertises pendant trois jours, s'est déroulé dans un esprit convivial et collaboratif.

Message from Polar Knowledge Canada – David Hik, Vice President, Research and Chief Scientist

During this time of nation-building, economic stimulus, climate change and an increasing need to address northern and Arctic security issues for the well-being of our communities, the Landscape Carbon Workshop plays an important role in bringing us together to exchange ideas to help forge a path forward in landscape carbon management in the Northwest Territories, and as a model for other regions across Canada's North.

The knowledge and ideas exchanged here provide an opportunity to outline and guide processes involving Indigenous, territorial and federal governments working together with the science community, Indigenous knowledge holders, research institutions, community partners, industry and stakeholders to codevelop a green economy that prioritizes, conserves and protects landscape carbon and greenhouse gas sinks in key ecosystems in the Northwest Territories. The raw wilderness and beauty of the Northwest Territories is rich in peatlands, wetlands, permafrost, boreal forest, and watersheds – all of which store billions of tonnes of globally significant landscape carbon.

As the Northwest Territories continues to address climate change alongside evolving economic and community priorities, the Workshop offered a forum to explore a range of approaches for conserving and managing landscape carbon stores. Participants explored a range of solutions with the potential to address increasing climate change issues while advancing stewardship and economic opportunities for northern and Indigenous communities for future generations.

Message de Savoir polaire Canada – David Hik, scientifique en chef et vice-président, recherche

En cette période de reconstruction nationale, de relance économique, de changements climatiques et de préoccupations grandissantes en matière de sécurité dans le Nord et l'Arctique pour le bien-être des collectivités, l'atelier sur les milieux riches en carbone tombe à point. Les participants ont pu se réunir pour partager leurs idées sur la gestion du carbone dans les milieux naturels des Territoires du Nord-Ouest (TNO) et celles-ci pourront être utilisées comme modèles par d'autres régions nordiques du Canada.

Les connaissances et les idées échangées durant cet atelier ont permis d'orienter les démarches impliquant les gouvernements autochtones, territoriaux et fédéral, la communauté scientifique, les détenteurs de connaissances traditionnelles, les établissements de recherche, les partenaires communautaires, le secteur privé et les autres parties prenantes. Ensemble, ces acteurs pourront bâtir une économie verte qui priorise, préserve et protège les puits de carbone et de gaz à effet de serre présents dans les écosystèmes des TNO. Les tourbières, les milieux humides, le pergélisol, les forêts boréales et les bassins versants font des Territoires du Nord-Ouest une région si belle et si sauvage, mais stockent des milliards de tonnes de carbone.

Dans un contexte où les Territoires du Nord-Ouest continuent de lutter contre les changements climatiques et de s'adapter aux nouvelles priorités économiques et communautaires, l'atelier a permis aux personnes participantes d'analyser différentes approches de conservation et de gestion des stocks de carbone. Les participants ont examiné diverses solutions susceptibles de répondre aux enjeux croissants liés au changement climatique, tout en favorisant l'intendance et les débouchés économiques des collectivités nordiques et autochtones pour les générations futures.

Acknowledgements

The Landscape Carbon Workshop was co-hosted by the Government of the Northwest Territories and Polar Knowledge Canada in Yellowknife, Northwest Territories, from February 4 to 6, 2025.

We thank all speakers, facilitators, participants, and partner organizations whose contributions informed the workshop and this synthesis report.

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L'atelier sur les milieux riches en carbone a été organisé conjointement par le gouvernement des Territoires du Nord-Ouest et Savoir polaire Canada, et a eu lieu à Yellowknife, aux Territoires du Nord-Ouest, du 4 au 6 février 2025.

Nous remercions toutes les personnes qui ont pris la parole, assuré l'animation ou participé à l'atelier, ainsi que les organisations partenaires, dont les contributions ont enrichi l'atelier et permis la rédaction du présent rapport de synthèse.

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Executive Summary

Canada is home to some of the world's largest carbon-rich ecosystems, with billions of tonnes of carbon stored in the first meter of soil, mainly in peatlands, wetlands, permafrost, and boreal forests. Peatlands in the Northwest Territories (NWT) alone store approximately 27 billion tonnes of carbon in their soils. For centuries, much of this carbon has remained locked in place.

Climate change is now altering these ecosystems. Rising temperatures, changing precipitation, and increased wildfire activity are accelerating carbon emissions from landscapes that were once long-term carbon sinks. These emissions are not always well captured in current climate models or carbon inventories, yet they have implications for communities, ecosystems, and climate outcomes far beyond the territory.

To better understand these changes and explore options for action, the Government of the Northwest Territories (GNWT) in partnership with Polar Knowledge Canada (Canadian High Arctic Research Station), convened the Landscape Carbon Workshop in February 2025.

The three-day educational workshop in Yellowknife brought together more than 175 participants, including 38 speakers, from across the NWT, Canada, and beyond. Participants included Indigenous governments and Indigenous organizations, territorial and federal governments, researchers, non-profits, and industry. The workshop combined presentations, panels, and breakout discussions to share knowledge, discuss emerging research, and explore areas for collaboration.

Workshop discussions highlighted clear risks to northern landscape carbon.

Participants consistently noted that peatland disturbance and drying, permafrost thaw, and more frequent and intense wildfires are the primary and interconnected drivers of landscape carbon emissions in the NWT. These processes reinforce one another. For example, wildfire can damage peatlands and permafrost, while thaw and drying can increase wildfire risk.

Many participants emphasized that some northern ecosystems are increasingly shifting from carbon sinks to carbon sources because of climate change. While the scale and timing of future emissions remain uncertain, there was agreement that emissions from carbon-rich landscapes are likely underestimated.

The workshop also explored opportunities and limits of nature-based solutions (NbS).

Participants discussed NbS as approaches to protect, manage, and restore carbon-rich landscapes. Fire management and land stewardship were identified as particularly relevant options in northern contexts. Speakers emphasized that these approaches could deliver co-benefits, such as supporting biodiversity, protecting water systems, and reducing wildfire risk near communities.

At the same time, participants stressed that nature-based solutions are not a substitute for reducing human-caused greenhouse gas emissions. Their effectiveness in the North will depend on local

conditions, long-term climate trends, and improved evidence from northern-specific research and monitoring.

Some key barriers were also identified.

Participants highlighted limited data, monitoring, and modelling capacity as a major challenge. Gaps in understanding carbon stocks, methane emissions, winter processes, and ecosystem interactions make it difficult to quantify emissions and assess the effectiveness of interventions.

Access to financing was another key barrier. Discussions pointed to the lack of northern-specific carbon accounting approaches and the limitations of existing financing tools in carbon-rich but climate-stressed landscapes.

Indigenous leadership, knowledge, and governance were described as essential.

Indigenous participants emphasized that long-term, place-based knowledge is critical for understanding landscape change and for interpreting scientific data. Indigenous-led stewardship practices, including cultural burning, guardianship programs, conservation initiatives, and Indigenous Protected and Conserved Areas, were repeatedly identified as important approaches for supporting healthy, resilient landscapes and communities.

Participants stressed that any future research, monitoring, or financing approaches in the NWT must be developed with Indigenous governments and Indigenous organizations and reflect community priorities, governance systems, and timelines.

Overall, the workshop reinforced that landscape carbon presents both risks and opportunities for the territory. Participants emphasized that improving understanding of landscape carbon can support decision-making by helping governments, Indigenous governments and Indigenous organizations, communities, and industry better understand climate-related risks, ecosystem change, and potential trade-offs among environmental, cultural, social, and economic objectives. This information can help inform wildfire management, land-use planning, infrastructure development, resource management, community safety, and long-term stewardship while supporting resilient ecosystems and communities.

Insights from the Landscape Carbon Workshop provide a shared foundation for continued dialogue and collaboration. The GNWT will consider how these insights can inform future research, partnerships, and discussions on landscape carbon in the NWT, in collaboration with Indigenous governments, Indigenous organizations, and other partners.

Sommaire

Le Canada compte quelques-uns des plus grands écosystèmes riches en carbone du monde, lesquels stockent des milliards de tonnes de carbone dans le premier mètre du sol. On parle principalement de tourbières, de milieux humides, de zones de pergélisol et de forêts boréales. Les tourbières du territoire stockent à elles seules dans leur sol environ 27 milliards de tonnes de carbone. Pendant des siècles, une grande quantité de ce carbone y est restée piégée.

Toutefois, les changements climatiques menacent ces écosystèmes. La hausse des températures, les changements dans les précipitations et l'intensification des feux de forêt accélèrent les émissions de carbone provenant de ces milieux qui ne sont plus, comme autrefois, des puits de carbone à long terme. Ces émissions ne sont pas toujours bien prises en compte dans les modèles climatiques ou les inventaires de carbone actuels, même si elles ont des répercussions sur les collectivités, les écosystèmes et les résultats climatiques bien au-delà des TNO.

Pour mieux comprendre les changements et trouver des pistes de solution, le gouvernement des Territoires du Nord-Ouest (GTNO) et Savoir polaire Canada (Station canadienne de recherche dans l'Extrême-Arctique) ont organisé un atelier sur le carbone présent dans les milieux naturels en février 2025.

Cet atelier éducatif de trois jours, qui s'est déroulé à Yellowknife, a réuni plus de 175 personnes (dont 38 conférenciers) des Territoires du Nord-Ouest, du reste du Canada et d'ailleurs dans le monde. Y ont notamment pris part des chercheurs ainsi que des représentants de gouvernements et d'organisations autochtones, des gouvernements territoriaux et fédéral, d'organismes sans but lucratif et du secteur privé. Cet atelier, qui proposait des présentations, des tables rondes et des discussions en petits groupes, visait à favoriser la diffusion du savoir et les échanges sur les recherches émergentes ainsi qu'à explorer les nouvelles possibilités de collaboration.

Les discussions qui ont eu lieu lors de l'atelier ont mis en évidence les risques évidents liés au carbone présent dans les milieux naturels du Nord.

Les personnes participantes ont répété à plusieurs reprises que la perturbation et l'assèchement des tourbières, la fonte du pergélisol ainsi que la multiplication et l'intensification des feux de forêt constituent les principaux facteurs des émissions de carbone aux Territoires du Nord-Ouest. Ces événements perturbateurs sont étroitement liés entre eux et se renforcent mutuellement. Par exemple, les feux de forêt endommagent et assèchent les tourbières, et font fondre le pergélisol, ce qui fait accroître le risque de feu.

Durant l'atelier, on a souvent souligné qu'en raison des changements climatiques, de plus en plus d'écosystèmes nordiques passent du statut de « puits de carbone » à « source de carbone ». Bien que l'on ne connaisse pas encore avec certitude l'ampleur et le moment des émissions à venir, on s'accorde à dire que les émissions provenant des espaces naturels riches en carbone sont probablement sous-estimées.

Les personnes participantes ont également examiné les possibilités et les limites des solutions fondées sur la nature.

Les personnes participantes ont envisagé ces solutions en tant que mécanismes pour protéger, gérer et restaurer les paysages riches en carbone. La gestion des feux et l'intendance territoriale ont été mentionnées comme options particulièrement intéressantes en contexte nordique. Les conférenciers ont indiqué que ces mécanismes pouvaient avoir des avantages connexes, par exemple la préservation de la biodiversité, la protection des réseaux hydrographiques et la réduction du risque de feu incontrôlé près des collectivités.

Les personnes participantes ont aussi rappelé que les solutions fondées sur la nature doivent s'ajouter à la réduction des émissions de gaz à effet de serre d'origine humaine, et non la remplacer. L'efficacité de ces solutions dans le Nord dépendra des conditions locales, des tendances climatiques à long terme et des données plus précises issues de la recherche et de la surveillance nordiques.

Certains obstacles importants ont aussi été mentionnés.

Les personnes participantes ont dit que le manque de données, de surveillance et de capacité de modélisation constituait un enjeu majeur. Nos connaissances sur les stocks de carbone, les émissions de méthane, les processus hivernaux et les interactions touchant l'écosystème sont insuffisantes, ce qui rend difficiles la quantification des émissions et l'évaluation de l'efficacité des interventions.

L'accès au financement est un autre obstacle majeur. On a souligné l'absence de méthodes de comptabilisation du carbone adaptées au Nord, de même que les limites des outils financiers existants pour étudier les milieux riches en carbone soumis à des pressions climatiques.

Le leadership, les connaissances et la gouvernance autochtones ont été mentionnés comme des éléments essentiels.

Les participants autochtones ont souligné que les connaissances acquises sur un endroit au fil du temps sont cruciales à la compréhension de l'évolution du paysage et à l'interprétation des données scientifiques. Les pratiques d'intendance appliquées par les Autochtones, notamment le brûlage culturel, les programmes de gardiens, les initiatives de conservation et les aires protégées et de conservation autochtones, ont été mentionnées à plusieurs reprises comme mécanismes importants pour favoriser la santé et la résilience des milieux culturels et des collectivités.

Les personnes participantes ont souligné que les activités de recherche, de surveillance et de financement à venir aux TNO doivent être planifiées en collaboration avec les gouvernements et organisations autochtones pour que celles-ci puissent tenir compte des priorités, des systèmes de gouvernance et des échéanciers des collectivités.

Globalement, durant l'atelier, on a confirmé que les milieux riches en carbone présentent à la fois des risques et des occasions pour les TNO. On a également souligné que mieux comprendre les milieux riches en carbone peut faciliter la prise de décision. Cela aiderait les pouvoirs publics, les gouvernements et organisations autochtones, les collectivités et le secteur privé à mieux analyser les risques climatiques, les changements touchant les écosystèmes et les compromis potentiels entre les

objectifs environnementaux, culturels, sociaux et économiques. Cette information peut servir à orienter la gestion des feux de forêt, l'aménagement du territoire, la construction d'infrastructures, la gestion des ressources, la sécurité communautaire et l'intendance à long terme, tout en favorisant la résilience des écosystèmes et des collectivités.

Les commentaires formulés durant l'atelier sur les milieux riches en carbone offrent une base commune pour la poursuite du dialogue et de la collaboration. Le GTNO décidera comment les utiliser dans de futures recherches, partenariats et discussions sur le paysage du carbone aux Territoires du Nord-Ouest, en collaboration avec les gouvernements et organisations autochtones ainsi que d'autres partenaires.

The Northwest Territories: A globally significant carbon store under climate stress

This section presents key highlights from the workshop on the role of the Northwest Territories (NWT) in global landscape carbon dynamics in relation to the changing climate.

Landscape carbon in the NWT: A globally significant climate regulator

Landscape carbon refers to the carbon stored and exchanged within ecosystems such as forests, wetlands, peatlands, vegetation, and soils.ⁱ Much of this carbon is stored in vegetation or in partially decomposed organic matter in soils, also known as soil organic carbon (SOC), especially in permafrost soils.

Globally, key carbon sinks are:

- Carbon-rich soils, such as those found in permafrost regions, wetlands, and peatlands. The top three meters of permafrost alone contain about one-third of the world's soil organic carbon, roughly twice the amount of carbon currently in the atmosphere.^{ii, iii, iv}
- Forests, including Canada's boreal forests, which store up to 28 billion tonnes of carbon across biomass, dead organic matter, and soil pools.^{v, vi}

The NWT is extraordinarily rich in landscape carbon (see Figure 1 and Figure 2). Key landscape carbon stores in the NWT are the boreal forests, peatlands, and permafrost.¹ These ecosystems represent significant global carbon stores and have captured significant amounts of atmospheric carbon.^{vii} NWT peatlands alone are estimated to store about 27 billion tonnes of carbon,^{viii, ix} the carbon equivalent of using nearly 226 billion barrels of oil, and much of these peatlands contain permafrost.

Landscape carbon follows a natural carbon cycle of releasing and absorbing carbon to and from the atmosphere.^x **Figure 3** presents an illustration of this balanced natural carbon cycle. These carbon exchanges are primarily in the forms of carbon dioxide (CO₂) and methane (CH₄), which are important greenhouse gases (GHG).^{xi} These exchanges result from natural processes such as plant respiration and photosynthesis, vegetation decomposition and wildfires, and permafrost thaw.^{xii} For instance, carbon stored in boreal forests is released during natural wildfire cycles, while carbon is absorbed during forest regeneration and growth.

Some landscape carbon cycles are relatively short, such as a few centuries for carbon stored in the

¹ These landscape carbon stores are not mutually exclusive. In much of the NWT, peatland soils are found within permafrost, which themselves can be embedded within boreal forest ecosystems. As a result, carbon stored in permafrost, peatlands, and boreal forests can often overlap spatially and functionally, reflecting interconnected carbon pools rather than separate or independent systems.

boreal forests.^{xiii, xiv,xv} Others are much longer. For instance, carbon stored in peatlands is the result of ten thousand years of organic carbon being trapped in these soils. **Overall, presenters expressed how these natural carbon cycle processes are generally known, but the interactions between processes are not well understood, and the stores and exchanges of carbon between landscape and the atmosphere are poorly quantified.**^{xvi}

These processes can be influenced by climate change and by human activities that alter landscapes like land-use change and industrial development.

Focus Box

Peatlands are unique wetland ecosystems that store massive amounts of carbon, built up slowly over thousands of years. When these areas are disturbed or degraded, they can release significant greenhouse gases into the atmosphere. In cool climates, peatland vegetation is mostly made up of *Sphagnum* mosses, sedges and shrubs, which then become primary builders of peat when the vegetation dies.^{xvii} The NWT is home to 5% of the global **peatland**,^{xviii} and of 20% of all peatlands in Canada^{xix}, representing about 215,973km².^{xx}

Permafrost is soil, sediment, or rock that remains below 0°C for two or more years. It is an important component of the northern Canadian landscape, but permafrost temperatures are changing due to climate warming. In the NWT, its coverage varies widely with less than 10% of land in the south containing permafrost, while nearly all of the Arctic tundra is underlain by it. As permafrost keeps organic material from decomposing, it acts like a natural freezer, locking away carbon from vegetation. This carbon has remained stored for thousands of years. Degradation of permafrost will impact its ability to continue to store soil organic carbon.

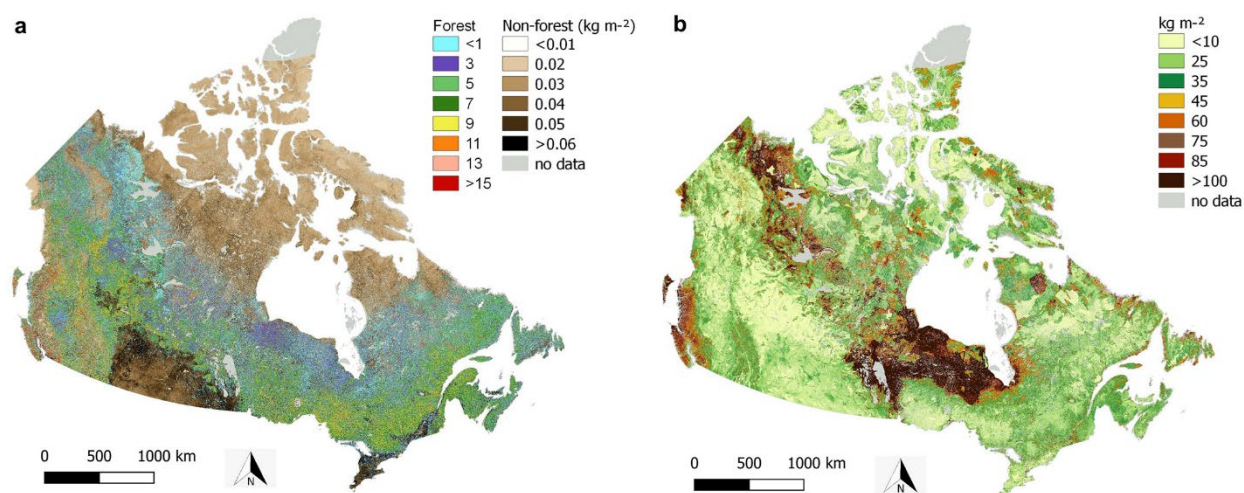


Figure 1. Illustration of distribution of carbon stocks. (a) Total carbon stock of plants in forest and non-forest areas for 2015–2019; (b) Total soil organic C stock in 1 m depth. Source: Sothe, C., Gonsamo, A., Arabian, J., Kurz, W. A., Finkelstein, S. A., & Snider, J. (2022). Large soil carbon storage in terrestrial ecosystems of Canada. *Global Biogeochemical Cycles*, 36, e2021GB007213, adapted by Morse P. and Dallimore S., (2025), Landscape Carbon Workshop, Yellowknife, NT [Workshop presentation].

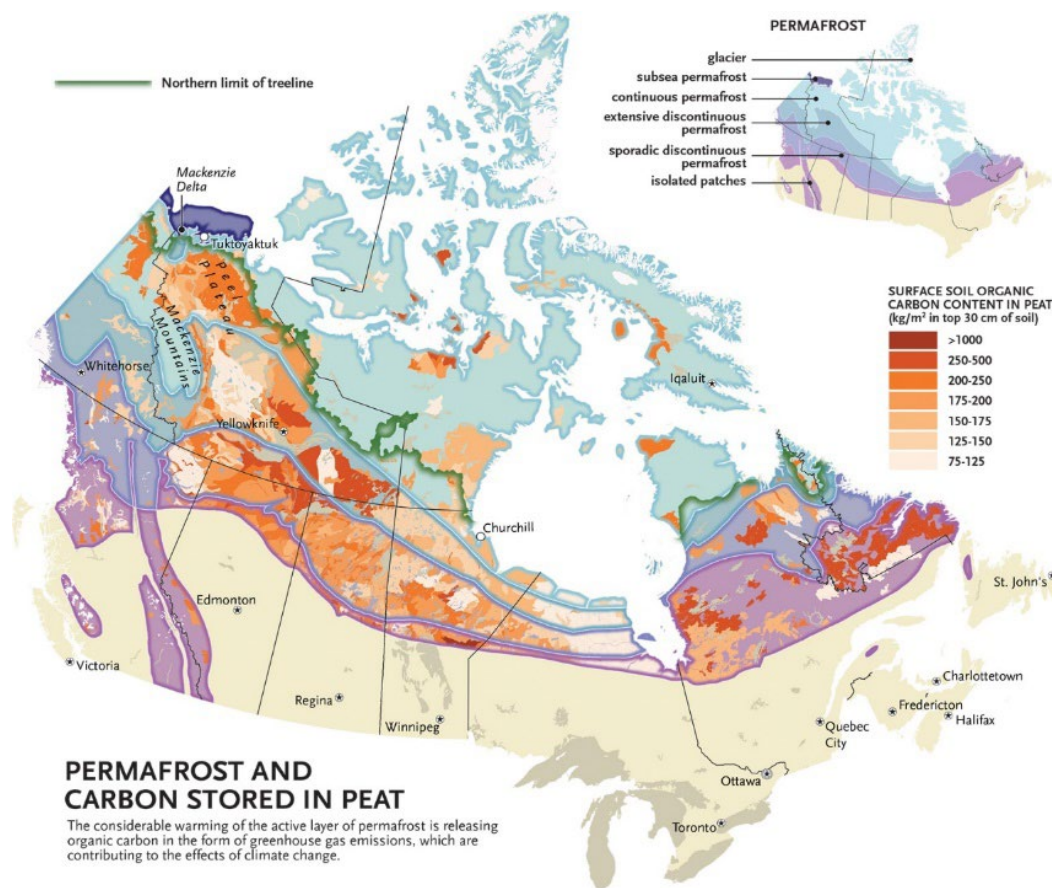


Figure 2. Permafrost and carbon stored in Peatland. Source: Giesbrecht, S. (2023, February 15). Arctic permafrost is thawing - here's what that means for Canada's North and the world. *Canadian Geographic*, adapted by Morse P. and Dallimore S., (2025), Landscape Carbon Workshop, Yellowknife, NT [Workshop presentation].

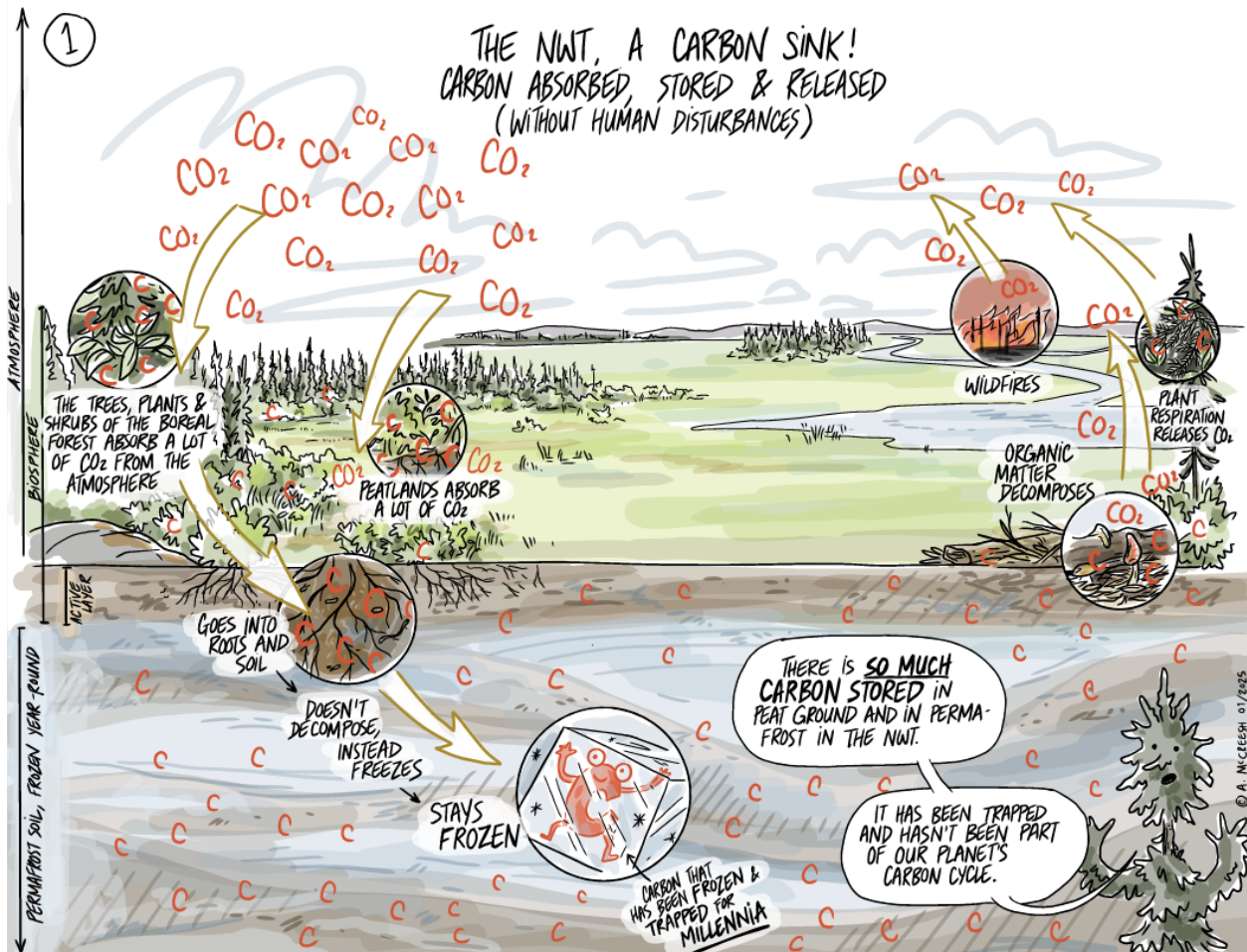


Figure 3. Poster illustrated by Alison McCreesh. © Alison McCreesh.

Climate change is disrupting natural landscape carbon

As the NWT is extraordinarily rich in landscape carbon, disturbances to the balanced natural carbon cycle of its ecosystems can have an impact on our global climate.

Workshop speakers discussed how climate change is altering natural carbon cycles across northern ecosystems. Participants also noted that some land-use change and other human activities can influence carbon storage and emissions, particularly where they affect hydrology, vegetation, permafrost, or wildfire dynamics. A key insight from the workshop suggests that some *NWT ecosystems are moving from a carbon sink to a carbon source due to climate change and human activities*. Changes in precipitation amounts and timing, and increases in average air temperatures, are increasing the frequency and intensity of wildfires and leading to the degradation of permafrost and peatlands. As permafrost thaws, soil organic matter that was previously frozen begins to decompose, releasing carbon dioxide and methane into the atmosphere.^{xxi} This is likely releasing increased amounts of carbon and methane, though the quantities remain uncertain. Methane, in particular, has a substantially higher warming impact (approximately 25–40 more on a CO₂-equivalent basis).^{xxii}

Climate impacts on landscape carbon can be sudden, and, in some cases, irreversible. Discussions emphasized that once tipping points, such as rapid permafrost thaw or deep peatland degradation, are reached, carbon loss accelerates, and ecosystems may never return to previous states. Even with rapid reductions in human-caused emissions, it is expected that northern carbon release will continue in the foreseeable future due to ongoing, natural, internal processes responding to current atmospheric greenhouse gas levels.

Participants identified peatland drying, permafrost thaw, and wildfires as the primary sources of landscape carbon emissions in the NWT. ***In 2023, carbon emissions from wildfires were roughly 270 times higher than human-caused emissions in the NWT.***^{xxiii, xxiv} Emissions from degrading permafrost and peatlands relative to wildfires remain uncertain.

The territory's extensive peatlands, permafrost, and boreal forests were seen not only as vulnerable systems, but also as important components of the NWT landscape that support climate mitigation, adaptation, biodiversity, cultural values, and stewardship.

Presenters highlighted that maintaining the health and function of these ecosystems could deliver multiple benefits, including reducing climate-related risks, supporting biodiversity, reducing wildfire risk near communities, strengthening Indigenous-led stewardship and monitoring, and helping sustain long-term carbon storage. They however noted that landscape carbon emissions and solutions to address them are not fully considered in carbon management strategy approaches in Canada, and worldwide. The workshop highlighted the need to address this blind spot, so landscape carbon emissions are properly accounted for in climate modelling and carbon inventory as well as in approaches to tackle climate change.

Key Takeaways

Overall, workshop presentations and discussions highlighted the scale and importance of northern landscapes for landscape carbon and the growing impacts of climate change on these systems:

- Presenters highlighted that Canada, and the NWT in particular, contains globally significant landscape carbon stores within its peatlands, permafrost, and boreal forests.
- Many presenters and participants discussed evidence suggesting that some northern ecosystems may be shifting from carbon sinks to carbon sources as a result of climate change. Presenters highlighted concerns about increasing year-round emissions, particularly from permafrost and peatlands during winter months.^{xxv, xxvi} Evidence presented also suggested that landscape carbon emissions

may continue to increase as permafrost thaws, peatlands degrade, and wildfire activity changes.^{xxvii}

- Presenters discussed how climate impacts on landscape carbon can be sudden and, in some cases, irreversible, particularly where ecological thresholds or tipping points are crossed.
- Evidence presented at the workshop suggested that landscape carbon dynamics are not always fully reflected in climate models, greenhouse gas inventories, or decision-making frameworks. Participants noted that emissions from relatively intact northern ecosystems remain difficult to quantify and may be underestimated. Presenters highlighted the need for additional ground-truthing and northern-specific data to improve understanding and modelling.

Improving understanding of landscape carbon processes was widely identified as an important foundation for informing policy discussions, strengthening stewardship, and guiding future research, investment, land-use planning, infrastructure development, and collaboration across jurisdictions.

Key threats to NWT landscape carbon

This section presents the key threats to landscape carbon in the NWT identified during the Landscape Carbon Workshop.

Presenters and participants highlighted that the **key threats to landscape carbon in the NWT are driven by climate change, and largely affect undisturbed lands**, which are natural areas that lack direct human management, industrial development, or agriculture.

Three (3) threats emerged as priorities for the NWT. They are presented in order of significance as discussed by participants:

- Peatland degradation;
- Permafrost thaw; and
- Increased intensity and frequency of wildfires.

Presenters noted that these threats rarely occur in isolation. Wildfires and peatland and permafrost degradation interact through reinforcing feedback loops that may accelerate carbon loss across landscapes.^{xxviii} Discussions highlighted that understanding these linkages is essential for identifying opportunities to reduce emissions and better manage carbon-rich landscapes.

Focus Box

Some NWT participants, including community members and Indigenous representatives, shared their observations of how the land is changing and how new landscape carbon dynamics are emerging. These observations included:²

- Changes in the Taiga landscape, where higher shrubs have been growing after wildfire, altering the Taiga's ecosystems and vegetation.
- Smoldering fires that persisted through winter near communities following wildfire, sometimes described by participants as "zombie fires".
- The appearance of large permafrost thaw slumps along riverbanks; and
- Wildfires reoccurring in areas that had been recently burnt.

² Participants shared specific examples, mentioning name and location. They were anonymized to respect protocols on local knowledge.

Peatland degradation

Peatlands store vast amounts of carbon that have accumulated over thousands of years,^{xxix} as well as regulate water, support biodiversity, and serve as natural fire refugia due to their high-water tables and saturated soils, which reduce combustibility during wildfires.

In the NWT, peatlands cover about 230,000 square kilometres of land and store billions of tonnes of carbon.^{xxx} Peatlands are affected by a range of pressures, including climate change and landscape disturbance. Workshop presenters noted that activities such as infrastructure development, mining, and oil and gas development can affect peatland hydrology and vegetation if not carefully planned and managed. Presenters identified key drivers for peatland degradation in the NWT, including:

- Loss of permafrost resulting from climate warming; and
- Severe wildfires that burn deeply into peat soils, as shown in **Figure 4**. Increased intensity of wildfires in boreal regions results in more severe and deep burns that promote the degradation of permafrost and peatlands, which in turn release significant amounts of landscape carbon into the atmosphere.^{xxxi}



Figure 4. Aerial photo of burned peatland in the NWT. Photo by Ryan Connon.

When peatlands degrade, they release stored carbon, commonly as methane and carbon dioxide due to saturated soil conditions.^{xxxii} This degradation also undermines natural recovery processes across the boreal landscape. Peatlands do not respond to climate change at the same pace or in the same way. Presenters noted that peatland vulnerability depends on several factors, including:^{xxxiii}

- The presence and thickness of permafrost within the peatland. When permafrost within a peatland thaws, the ground surfaces subside, bringing it closer to the water table. Over time, continued permafrost and ground surface subsidence in peatlands can convert forests to wetlands.
- Their groundcover (trees, moss, and lichen). The moss type particularly impacts burn severity and carbon loss. Sphagnum moss, for example, is fire resistant and reduces burns severity and carbon loss, whereas feathermoss is not.
- The size of the trees. Bigger trees increase peatland burn severity, as bigger trees have deeper and more extensive root systems underground.^{xxxiv}

Participants stressed that peatland degradation represents both a significant risk and an important area for research, monitoring and management. Since peatlands influence wildfire behavior, hydrology, and permafrost stability, maintaining peatland function was repeatedly described as central to reducing cascading carbon losses across boreal landscapes.

Permafrost thaw

Permafrost is the frozen ground that underlies terrain throughout the NWT's sub-Arctic, Arctic, and mountainous regions. It stores large amounts of carbon that has been trapped for millennia. Throughout the workshop discussions, presenters repeatedly noted that much of Arctic Canada is warming 3-4 times faster than the global average, increasing permafrost thaw.

A key theme raised during the workshop was the close relationship between permafrost thaw and peatland degradation in the NWT. Much of the region's permafrost occurs within peat-rich terrain. Emissions from permafrost thaw are difficult to model because of limited estimation of the amount of carbon stored in permafrost, and a lack of understanding of the scale and rate of permafrost thaw.^{xxxv, xxxvi}

Workshop presenters also emphasized that continued global warming makes permafrost thaw a potentially dominant source of future landscape carbon emissions in the NWT, although the timing, magnitude, and pathways remain uncertain.^{xxxvii, xxxviii} **Figure 5** presents this permafrost feedback loop.

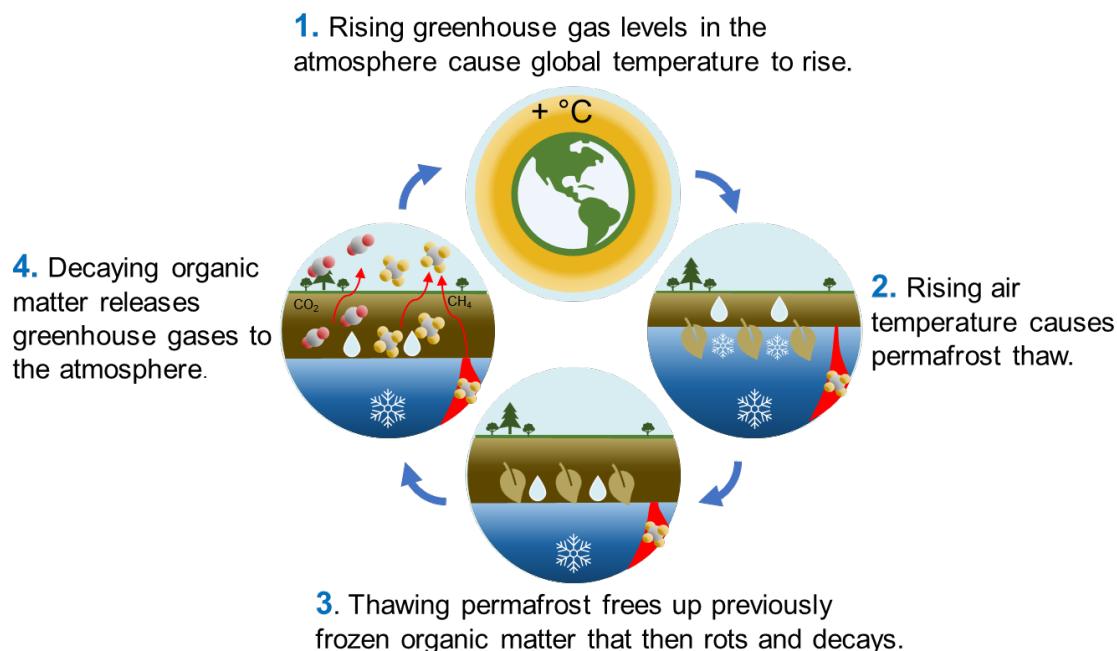


Figure 5. The permafrost carbon feedback loop. Source: Adapted from Morse P. and Dallimore S., (2025), Landscape Carbon Workshop, Yellowknife, NT [Workshop presentation].

Improving the ability to anticipate where and how permafrost thaw occurs was identified as important for climate modelling, infrastructure planning, land-use planning, adaptation efforts and resource management decisions.

First, permafrost thaw is not a linear process. ***Permafrost thaw follows threshold dynamics where once a critical point is reached, the impacts are rapid and irreversible, making them difficult to predict and mitigate.***^{xxxix} Where ice is melting in the ground, this can lead to sudden land slumps or slides. These “thermokarst” processes and resulting landforms are irreversible and further exposed permafrost to thaw, as shown in **Figure 6**. Presenters highlighted that these thermokarst” processes are increasing in activity across the NWT.^{xl}



Figure 6. Image of thermokarst process in the NWT. Photo by Ryan Connon.

Second, the pace and pattern of permafrost thaw vary across the NWT. Although permafrost is widespread, its thickness, temperature, soil composition, and ice content differ from place to place. As a result, thaw occurs at different rates depending on local ground conditions and regional climate. It was noted that different permafrost degradation processes have been observed through thermokarst and resulting landforms.^{xli} These landforms can help show how much ice is present in the ground below the surface. The NWT Geological Survey (NTGS) adopted this landscape-based approach to conduct an inventory of different permafrost thaw processes, looking at slopes, peatlands, lowlands, and lakes and ponds. The NTGS classification of permafrost thaw processes helps to understand the mechanisms that lead to thaw and to anticipate permafrost thaw trajectories to inform climate models.^{xlii}

Finally, increased intensity and frequency of wildfires in Arctic and sub-Arctic regions exacerbates permafrost degradation (see the **Increased intensity and frequency of wildfires** section). Increased severity of burns destroys the organic surface layer that insulates permafrost, and the vegetation canopy that shades the ground surface, making it more vulnerable to thaw.^{xliii} Furthermore, forest fires could remove and char surface vegetation, which has the potential to allow more sunlight and heat to the ground, further amplifying permafrost thaw. Post-fire permafrost degradation has also been observed, where previously stable frozen ground began thawing at unprecedented rates following severe fire seasons.

Increased intensity and frequency of wildfires

Wildfire is a natural process within landscape carbon cycles, but climate change is altering wildfire regimes. Presenters noted that hotter, drier summers and prolonged drought conditions have led to more frequent and intense wildfires across the NWT, as well as longer wildfire seasons, which release vast amounts of carbon and threaten the ability of ecosystems to recover.

Speakers noted that wildfire emissions are currently the most visible and quantifiable form of landscape carbon loss and are therefore often used as an indicator of broader ecosystem change. However, carbon releases from degrading permafrost and peatlands are more difficult to quantify and remain uncertain yet could represent substantial and ongoing sources of emissions that accumulate over time.

Presenters highlighted that **in 2023, over 15 million hectares (ha) burned across Canada, releasing approximately 356 million tonnes of CO₂ equivalent into the atmosphere, a 3,000% increase on the yearly average of areas burned between 1986 and 2022^{xliv}** (represented in Figure 7). **In the NWT alone, 304 wildfires burned over 4.1 million hectares,^{xlv} the worst fire season on record.^{xlvi}**

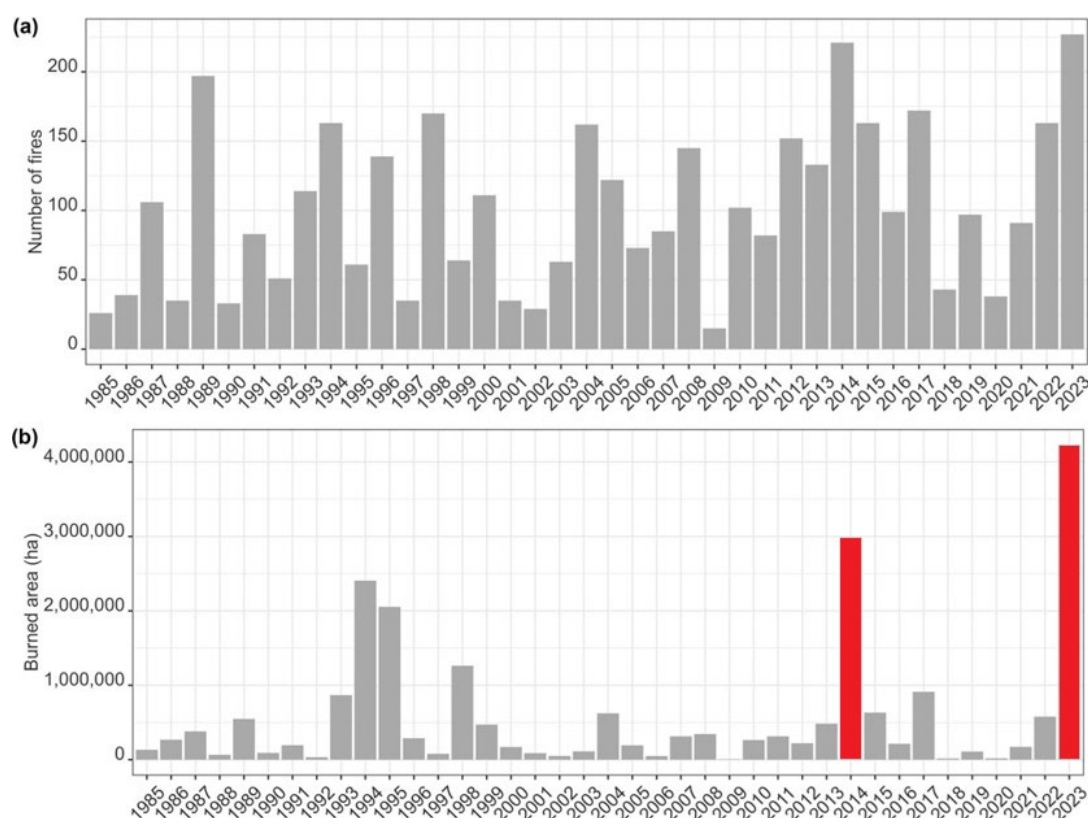


Figure 7. A comparison of the total number of fires (a), and total burned area (b) of fire seasons from 1985 onward for the entire Northwest Territories. Source: Adapted from Baltzer JL, Haché S, Hodson J, Ahmed MR, Carrière S, Coyle M, McIntire EJB, McLaren A, Riordan-Short E, Turetsky MR, van der Sluijs J, Wilson J and Woodworth BK (2025) Impacts of novel wildfire disturbance on landcover and wildlife in boreal North America. *Front. Environ. Sci.* 13:1504568. doi: 10.3389/fenvs.2025.1504568.

It was suggested that these new wildfire regimes are likely disrupting landscape carbon cycles, noting that *the boreal forest, once a carbon sink, is increasingly becoming a net source of carbon emissions in Canada.*^{xlvi, xlviii} Research by Parks Canada was used to highlight this shift, showing that Wood Buffalo National Park, spanning northern Alberta and southern NWT, has become a net source of carbon emissions. Over 1.3 million ha were burned between 2002 and 2020 (this represents an average of 2% of the Park per year). The net total of emissions was estimated to be 63.54 Mt CO_{2e} between 1990 and 2020.^{xliv}

Participants also discussed key observations in relation to how changing wildfire patterns are affecting the landscape:

- **Shorter reburn intervals during drought conditions.** Reburn interval refers to the time between two wildfire events in the same area. Presenters noted that severe and prolonged drought conditions may contribute to shorter reburn intervals, including through overwintering or “holdover” fires that re-emerge in subsequent fire seasons. Historically, boreal forests often had long fire return intervals, allowing time for vegetation recovery and carbon accumulation.^{li} Shorter reburn intervals can reduce opportunities for forests and peatlands to recover, potentially affecting carbon storage, increasing permafrost vulnerability, and altering ecosystem structure over time.^{lii, liii, liv} While research is ongoing to better understand long-term trends in fire return intervals, participants emphasized that drought conditions are increasing the flammability of ecosystems that have historically burned less frequently, including some peatland and wetland types.
- **Overwintering fires in peatland areas.** Presenters highlighted overwintering fires, which occur when smouldering combustion persists beneath the surface, particularly in dry peatlands, allowing fires to re-emerge the following spring. Participants noted that overwintering fires are often associated with extreme drought conditions and may contribute to shorter effective reburn intervals and additional carbon emissions from peat-rich landscapes.^{lv} Monitoring and research are underway to better understand their frequency and long-term trends.
- **Acceleration of peatlands and permafrost degradation.** Participants discussed how severe wildfires can reduce the ability of forests and peatlands to recover. Intense burning may remove vegetation and insulating organic layers, increasing the likelihood of permafrost thaw and longer-term changes to ecosystem function.^{lvi lvii lviii} Presenters noted that similar post-fire permafrost degradation has been observed in Alaska and Siberia. Evidence presented also suggested that wildfire disturbance may contribute to lasting landscape change, including shifts in peatland conditions that can affect long-term carbon storage dynamics.³⁰

Interconnected threats

Workshop participants emphasized the central message that climate-driven changes to peatlands, permafrost, and wildfire regimes are not independent processes. They interact through reinforcing feedback loops that amplify landscape change and increase carbon emissions.

Intact peatlands moderate fire behaviour by retaining moisture and acting as natural fire refugia. However, warming temperatures and altered hydrology are degrading peatlands, reducing their moisture content, and increasing their susceptibility to burning. When peatlands dry and burn more severely, they lose their ability to function as fire breaks and post-fire regeneration sites.^{lix} This can alter vegetation recovery, reduce long-term carbon storage, and increase the vulnerability of surrounding landscapes to more severe wildfire impacts.^{lx lxi}

In many parts of the NWT, boreal forests are underlain by peatlands and permafrost. More intense and frequent wildfires remove insulating vegetation and organic soils, accelerating permafrost thaw. In southern regions of the territory, where permafrost occurs primarily within peatlands, degradation of one system increases vulnerability in the other. Participants emphasized that peatlands and permafrost help stabilize each other; when one degrades, it can trigger further destabilization and carbon release.

Evidence presented from Parks Canada research in Wood Buffalo National Park, where peatlands cover roughly 30% of the area, indicates that wildfire-driven carbon and methane emissions are particularly high in peat-dominated landscapes. This underscores how fire interacting with carbon-rich systems can generate emissions.

In the southern areas of the NWT, presenters highlighted that permafrost exists almost exclusively in peatlands which makes these areas particularly vulnerable. Many groups underscored the idea that peatlands and permafrost help stabilize one another. When either one degrades, it can increase the risk of degradation in the other.

Beyond wildfire interactions, other climate-driven processes are compounding these risks. Coastal erosion associated with rising sea levels is accelerating permafrost thaw and methane release in northern coastal areas. In regions of discontinuous permafrost, thaw-driven expansion of lakes and wetlands is increasing methane emissions.

Overall, participants agreed that these processes reinforce one another. Permafrost thaw increases soil temperatures and greenhouse gas production. Drier conditions increase wildfire risk. Severe fires accelerate peatland degradation and thaw. When these changes occur simultaneously, landscapes become more likely to shift from long-term carbon sinks to sustained carbon sources.^{lxii}

lxiii

This reinforcing feedback complicates both measurement and management, highlighting the need for integrated approaches that treat northern landscapes as interconnected systems rather than isolated components.

Key Takeaways

Workshop presentations and discussions highlighted that the NWT's carbon-rich landscapes are undergoing rapid change. Key messages from this section include:

- Workshop speakers and participants identified permafrost and peatland degradation and extreme wildfires as the key interconnected and reinforcing pressures facing the NWT. Participants described how these processes increasingly overlap, accelerating carbon emissions and potentially shifting parts of the NWT from long-term carbon sinks toward carbon sources.
- The 2023 wildfires were a striking example of this shift, with emissions from the 2023 fire season estimated to be roughly 270 times higher than human-caused emissions in the NWT. Participants stressed that fires are becoming larger, more intense and more frequent, with severe drought conditions increasing the likelihood of overwintering fires in peat-rich landscapes.
- Peatlands and permafrost, long considered stable carbon stores, are showing signs of increasing vulnerability. Participants noted that repeated burning and hydrological change are reducing peatlands' ability to act as fire refugia, while accelerating permafrost thaw is releasing carbon dioxide and methane year-round, including during winter.
- Speakers noted that these emissions may be underestimated because current models and monitoring systems do not capture the full complexity of northern landscapes.
- A central insight from the workshop is that these changes are interconnected and reinforce one another. Presenters noted that permafrost thaw influences hydrology, which affects peatlands, and wildfires alter soil and vegetation, which then influences permafrost. All these factors contribute to a feedback loop in which warming leads to carbon emissions, and in turn carbon emissions accelerate warming. Participants also expressed concerns that some of these changes may be irreversible once certain thresholds are crossed.
- While much remains uncertain about the pace and scale of these processes, participants emphasized that uncertainty is not a reason for inaction. Instead, it highlights the need for decision-making frameworks that acknowledge changing conditions and responds to them proactively.

Nature-based solutions in the NWT:

An opportunity for landscape carbon

This section synthesizes discussions on how nature-based solutions (NbS) could help support landscape carbon management under a changing climate. Solutions are presented for each key threat but are not exhaustive. They reflect the approaches most frequently emphasized by participants as relevant to the NWT and other northern regions.

During the workshop, NbS were discussed as carbon management approaches that protect, manage, or restore natural ecosystems. In the context of landscape carbon, these solutions can help store carbon in vegetation and soils or slow the loss of carbon from ecosystems impacted by climate change. **Figure 8** presents an illustration showing the role of NbS for protecting, managing and restoring landscape carbon.

A recurring theme in the conversations was the applicability and relevance of NbS in the Northern context. They can be deployed across vast landscapes and different ecosystems, spanning forests, rivers, peatlands, and permafrost regions^{lxiv}. Presenters emphasized that this landscape-scale potential is a major advantage over engineered carbon solutions, which tend to be smaller, site-specific, and more expensive to deploy across vast northern regions. As NWT's carbon is inherently stored in expansive and interconnected ecosystems, NbS were viewed as uniquely suited to match the scale of the landscape carbon challenge.

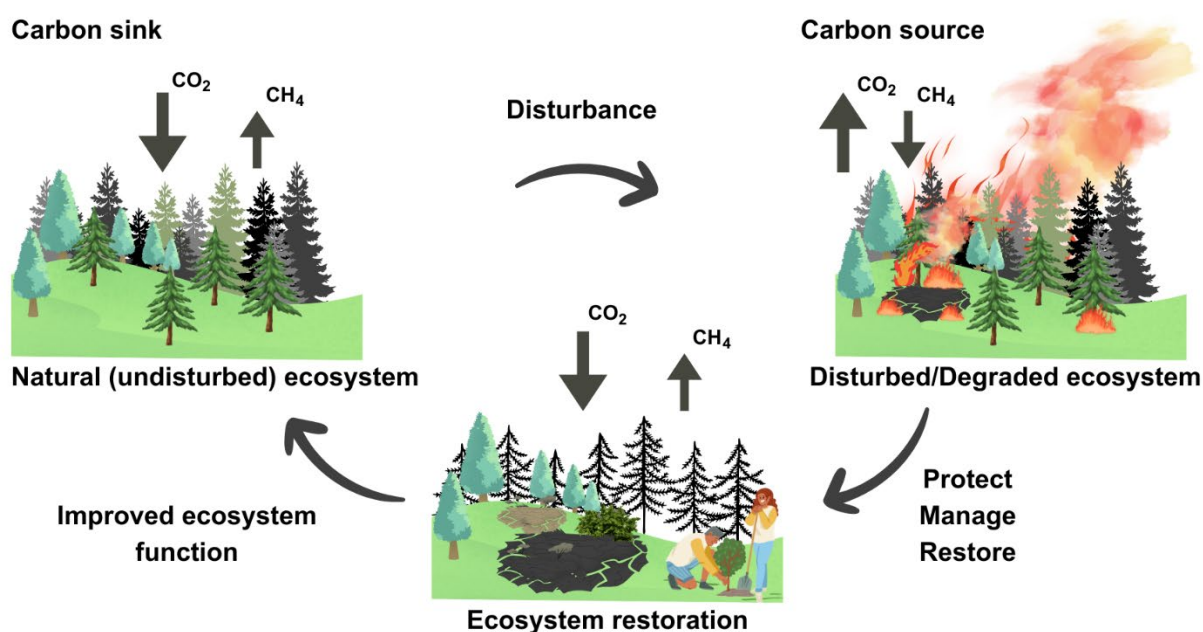


Figure 8. Illustration showing The Role of NbS in Reversing Landscape Carbon Loss. Source: Adapted from Bird, M. (2025). Landscape Carbon Workshop, Yellowknife, NT [Workshop presentation].

Participants also emphasized that NbS often deliver co-benefits, including biodiversity protection, water regulation, wildfire risk reduction, and community well-being.^{lxv} However, workshop discussions consistently stressed that NbS complement, rather than replace, the need for rapid reductions in human-caused greenhouse gas emissions.

Workshop participants discussed NbS across a continuum of ecosystem condition and intervention, including:

- Protecting ecosystems, which aims to prevent new disturbances in intact areas.
- Managing ecosystems, which involves targeted interventions to maintain or restore ecosystem balance where disturbance is occurring.
- Restoring ecosystems, which seeks to return degraded areas as close as possible to their pre-disturbance condition.

The effectiveness of NbS will depend on ecosystem type, local conditions, and the pace of climate change. Participants emphasized that as warming accelerates, some ecosystems may lose their capacity to store carbon effectively, increasing the urgency of both mitigation and adaptation efforts.

Workshop participants also emphasized that NbS should not be viewed as stand-alone interventions, but as part of an integrated response. NbS were discussed as a necessary complement to engineered approaches, particularly in northern regions where the scale, remoteness, and interconnectedness of ecosystems limit the feasibility of site-specific technical solutions alone.

Peatlands solutions

Peatlands are a form of wetland, which may also be forested and are typically surrounded by forest, but in all cases are characterized by substantial deposits of peat that has accumulated over long periods of time. Many peatlands in NWT are also underlain by permafrost, as the peat surface promotes ground cooling that can sustain permafrost which otherwise would thaw under current climate conditions.

Workshop discussions focused on three main types of peatland solutions: protective, restorative, and managing and mitigating.

Protective approaches

Workshop participants emphasized that intact peatlands play an important role in storing carbon and supporting ecosystem functions such as water regulation, biodiversity, and wildfire resilience. Given the long timescales required for peat formation, and recovery once lost,^{lxvi} participants discussed the importance of understanding peatland carbon values during land-use planning, stewardship, infrastructure development, and resource management decisions. Discussions focused on identifying opportunities to avoid, minimize, mitigate, and restore impacts where peatlands may be affected by climate change or human activities.

Key approaches discussed included:

- Indigenous Protected and Conserved Areas (IPCAs) were discussed as one approach that may support Indigenous stewardship, conservation objectives, and the long-term management of carbon-rich peatland landscapes (explored further in Section 5)
- Incorporating information on peatland condition, function, and carbon storage into land-use planning and policy developments
- Considering peatland assessments during planning and regulatory processes for major infrastructure to better understand potential impacts and mitigation opportunities.

Participants noted that information on peatland extent, condition, hydrology, and carbon storage may help support a wide range of planning and management decisions. Examples discussed during the workshop included land-use planning, infrastructure development, resource management, restoration activities, and environmental assessments. Participants emphasized that peatland carbon information should be considered alongside environmental, cultural, social, and economic factors when making decisions about future opportunities.

Restorative approaches

Workshop discussions showed that restoration may help recover ecosystem functions, reduce ongoing carbon emissions, and support long-term landscape resilience, especially where disturbance has occurred. Emerging research presented during the workshop suggests that some degraded peatlands can begin to recover in as little as 3 to 5 years,^{lxvii lxviii} and suggests that if well designed, peatland restoration can accelerate their recovery.^{lxix}

Participants discussed a range of restoration techniques aimed at re-establishing peatland function and reducing carbon emissions from degraded sites. These included:^{lxx}

- Restoring natural moisture and soil conditions at disturbed sites, for example by replacing removed organic or mineral soils, removing wellpad materials where soils have dried, or blocking drainage where sites have become too wet.
- Re-introducing vegetation through planting, or transplanting plant species from nearby natural areas, including fire-resistant or moisture retaining vegetation such as sphagnum moss.
- Developing restoration plans for new development and infrastructure projects that account for carbon loss, with the aim of maintaining or restoring carbon storage over the life of the project.

Managing and mitigating approaches

Workshop participants emphasized that where industrial development occurs in peatland regions, early consideration of peatland conditions, hydrology, and carbon storage can help support project planning and reduce long-term environmental risks. Discussions focused on approaches that avoid, minimize, mitigate, and restore impacts where feasible, while recognizing the importance of

balancing environmental, cultural, social, and economic objectives. Workshop discussions highlighted the following management approaches:

- Using information on soil carbon, peatland conditions, and permafrost to inform project siting, design, mitigation measures, and abatement planning
- Some participants discussed the potential role of mitigation measures, restoration requirements, offsets, or other approaches to address impacts where development occurs in peatland regions.

Participants noted that while these approaches show promise, their effectiveness in the medium to long-term remains uncertain because the impact of climate change will continue to become stronger. More research is needed.^{lxxi} Meanwhile, there is an increasing need for pairing peatland solutions with long-term monitoring and adaptive management approaches that can respond to changing environmental conditions and improve understanding of long-term outcomes.

Permafrost solutions

Since NWT was deglaciated, permafrost formation has trapped soil organic carbon throughout the NWT, and not just in peatlands. Workshop presenters emphasized that the primary driver of widespread permafrost degradation is global warming, meaning that the long-term preservation of carbon stored in permafrost depends largely on limiting GHG emissions.^{lxxii} At the same time, participants noted that local land-use and management practices may influence how permafrost responds to warming in some locations. Disturbances such as vegetation removal, changes to surface organic layers, altered drainage or snow conditions, and increased wildfire severity can affect ground temperatures and, in some cases, accelerate permafrost thaw releasing stored carbon.

Workshop discussions highlighted that nature-based solutions (NbS) are unlikely to prevent permafrost degradation at broad scales. However, some approaches may help maintain ecosystem functions, reduce additional pressures on permafrost, and reduce risks to communities, infrastructure, and carbon-rich landscapes.

Participants emphasized the importance of place-specific approaches that reflect local terrain, vegetation, hydrology, and permafrost conditions. Improved understanding of permafrost dynamics was also identified as important for supporting land-use planning, infrastructure development, resource management, and restoration activities.

NbS for permafrost remains an emerging field. While several approaches were discussed during the workshop, participants noted that additional research is needed to assess their effectiveness, scalability, and applicability in northern environments.

Land-use and management measures

Workshop participants discussed how management decisions can influence permafrost conditions at local scales. Rather than focusing solely on carbon storage, these considerations were also linked

to infrastructure resilience, ecosystem health, wildfire management, and long-term stewardship. Examples discussed during the workshop included:

- Considering how roads, infrastructure, and other activities may alter natural drainage patterns and water movement, as well as considering how permafrost thaw can impact infrastructure.
- Maintaining vegetation cover and surface organic layers where feasible, as these can help insulate underlying soils.
- Considering how vegetation management, snow accumulation, and surface disturbance may influence ground temperatures.
- Integrating knowledge of permafrost conditions into planning, restoration, monitoring, and development decisions.

Participants emphasized that these approaches are intended to reduce additional pressures on permafrost and support informed decision-making rather than prevent all landscape change.

Examples of ecosystem-based approaches and emerging concepts discussed during the workshop include:

- **Rewilding and herbivore management**, inspired by Siberia’s Pleistocene Park, where large herbivores, such as bison, caribou, or moose, compact snow, and shrub cover, slowing thaw, and improving ground insulation. Observations from Sweden’s Holmon Island suggests that reindeer activity reducing snow depth by 17% can lower permafrost temperatures by approximately 0.5°C.^{lxxiii}
- **Beaver dam restoration**, which may help maintain natural hydrology and prevent excessive drainage and drying of wetlands, supporting natural hydrology in ways that may influence permafrost conditions (though this example was not widely received by participants).
- **Vegetation management**, by increasing surface cover with light-coloured or reflective plants, such as caribou lichen (as shown in **Figure 9**), can enhance the albedo effect, reducing heat absorption by the ground.
- **Integrating peatland solutions**, recognizing that the surface organic layer is a key factor that protects underlying permafrost from thawing.
- **Fire management**, including controlled burns to reduce surface fuel loads, facilitating the growth of moisture-retaining vegetation (such as sphagnum moss), noting that wet sphagnum has relatively low albedo^{lxxiv} and benefits are primarily hydrological/insulating rather than reflective, or targeted fire suppression where forests interface with high-risk peat stocks or ice-rich soils.



Figure 9. Image showing lichen growth on peatland in the NWT. Photo by Ryan Connon.

Participants emphasized that some of these approaches remain largely experimental and require further research to assess their effectiveness and scalability in the NWT.

Case Study: Pleistocene Park (Siberia) - Experimental ecosystem restoration research

Pleistocene Park is an experimental research project in northeastern Siberia that explores how grazing animals may influence vegetation, snow conditions, and ground temperatures in permafrost regions. The project was cited as an example of ecosystem-process restoration, but its applicability to other northern regions remains uncertain.

Large grazing animals were introduced to study whether reduced shrub cover and compacted snow can influence soil temperatures and permafrost conditions. While some results suggest localized cooling effects, the approach remains experimental and has not been demonstrated as a scalable solution for reducing permafrost thaw across northern landscapes.

Workshop participants discussed Pleistocene Park as an example of how ecosystem processes may influence permafrost dynamics. Participants also noted that additional research would be required to assess whether similar approaches could be effective, practical, or appropriate in the NWT.

Workshop discussions emphasized that nature-based approaches to slowing permafrost thaw are best understood as risk-reduction strategies rather than permanent solutions. Participants noted that reducing avoidable disturbance, improving understanding of permafrost conditions, maintaining ecosystem functions, and incorporating permafrost considerations into planning processes may help support community resilience, infrastructure planning, and stewardship objectives. However, long-term permafrost degradation remains closely linked to global climate warming.

Wildfire solutions

Wildfires are a natural part of the northern landscape, shaping ecosystems and influencing carbon dynamics. However, workshop presenters emphasized that climate-driven increases in wildfire frequency and intensity are releasing large amounts of carbon and threatening carbon-rich soils such as peat and permafrost.^{lxxv}

Presenters and participants discussed a range of wildfire management strategies that could help reduce the impacts of large, intense wildfires on communities, infrastructure, ecosystems, and landscape carbon. These strategies were described as complementary, with the choice of approach depending on local conditions, including vegetation type, permafrost presence, community priorities, and cultural values. For instance, a presentation on modelling of the Yukon Flats National Wildlife Refuge in Alaska suggested using different fire management strategies to reduce wildfire-related emissions and risks in different areas of the park.^{lxxvi} The presentation suggested that fire suppression could work well in permafrost areas, whereas forest thinning and/or prescribed controlled burns would be more effective in non-permafrost areas.

Workshop participants mainly discussed prescribed burns and fire suppression as wildfire management strategies.

Prescribed fires or controlled burns and cultural burns

Prescribed or controlled burns are intentional fires conducted under carefully managed conditions. They mimic natural fire cycles but are ignited when moisture and wind are optimal for a manageable, slow burn that consumes fuel, such as deadwood and leaves, while leaving larger trees intact. Participants discussed how these burns can reduce fuel loads, improve habitat diversity, and restore natural fire cycles.^{lxxvii}

Indigenous participants emphasized that cultural burning has long been used as a land stewardship practice in the NWT. It was also noted that these practices were largely restricted in the 1960s when federal policies prioritized fire suppression over traditional management, likely leading to fuel build-up in boreal forests, and potentially contributing to larger, more severe wildfires.

Participants identified several barriers to carrying out prescribed burns and/or cultural burns.

- Loss of traditional knowledge about fire stewardship practices.
- Limited inclusion of Indigenous fire practices into territorial fire management.

- Operational challenges, as prescribed burns depend heavily on weather, fuel conditions, and wind strength and direction.
- Public perception, as communities may view intentional fires with concern or fear.

Participants emphasized that communication, education, and Indigenous-led co-management will be essential to overcoming these barriers.

Case Studies

During the workshop, Indigenous knowledge holder Danny Beaulieu from Deninu Kue First Nation shared his knowledge on traditional fire stewardship. He explained how controlled burns historically supported ecosystem balance and wildlife, noting that prescribed burns conducted in the 1990s led to a significant increase in bison populations within five years.³

The Pollination Foundation also presented lessons from Australia, where Indigenous Rangers combined traditional fire knowledge with modern technology to “fight fire with fire.” These practices have reduced large, uncontrolled wildfires, protected biodiversity, and helped mitigate carbon release.^{lxxviii}

In landscapes with peat-rich soils and/or permafrost, participants discussed fire suppression as an important complementary measure. In addition to protecting communities and infrastructure, suppression efforts may help reduce severe burns that damage organic soils, accelerate permafrost degradation, and contribute to long-term carbon emissions.^{lxxix} Participants noted that information on landscape carbon conditions could help support wildfire planning and risk assessment by identifying areas where severe fire may result in greater ecological, infrastructure, or climate-related impacts.

It was also noted that successful fire management seeks to maintain fire within ranges appropriate for local ecosystems while balancing ecological, social, cultural, and operational objectives.

Additional NbS wildfire management approaches discussed during the workshop included:

- Forest thinning and fuel management activities to reduce fuel buildup, support wildfire resilience, and potentially generate economic value through wood products and biomass utilization.
- Fire breaks to reduce the spread of large fires
- Peatland restoration to support natural hydrological conditions, reduce vulnerability to deep burning, and improve ecosystem resilience

³ The teachings cannot be shared in this report without the appropriate protocol in place for sharing Indigenous knowledge.

- Lightning suppression and redirection technologies
- The use of artificial intelligence (AI) for fire prediction and early warning.
- Reforestation with native fire-resistant species such as black spruce and mountain alder
- Producing biochar from wildfire or fuel-reduction biomass, which can reduce fuel loads while converting a portion of above-ground carbon into a more stable form.^{lxxx} Evidence presented indicated that biochar can be generated through controlled or cultural burn scenarios (where carbon is stabilized in soils) as well as through engineered pyrolysis systems using harvested or post-fire biomass. In both cases, biochar was discussed as a way to link wildfire management, biomass utilization, and potential carbon storage benefits while also supporting soil enhancement and land restoration objectives.

Workshop discussions

Participants emphasized that NbS should be viewed as one tool within a broader suite of land management, stewardship, adaptation, conservation, restoration, and development planning approaches.

Across all discussions dedicated to NbS, participants repeatedly returned to the role of Indigenous stewardship, governance, and place-based knowledge as enabling conditions rather than optional co-benefits. Participants also emphasized that effective NbS in the North would require approaches that reflect the unique characteristics of peatlands, permafrost, boreal forests, and the communities who live within them.

Regarding Indigenous knowledge, stewardship, and co-development, a consistent message throughout the workshop was that effective NbS in the NWT must be grounded in Indigenous knowledge, leadership, and governance. Participants emphasized that Indigenous knowledge may provide long-term, place-based insights into landscape change, including shifts in hydrology, vegetation, wildlife, permafrost, and fire behaviour that are not always captured in scientific datasets.

Indigenous-led stewardship practices, including cultural burning, guardianship programs, community monitoring, and on-the-land education, were repeatedly described as existing NbS that support healthy, carbon-rich landscapes. While these practices do not always align neatly with technical carbon accounting frameworks, participants stressed their importance for long-term ecosystem function and resilience.

Indigenous Protected and Conserved Areas (IPCAs) were discussed in depth as one example of a governance mechanism that can support active management of carbon-rich landscapes.

Some participants suggested that stewardship or protected area approaches aligned with Indigenous land stewardship could help sustain peatlands, boreal forests, and ice-rich soils while supporting broader ecological, cultural, and community objectives.

Case Study: NWT's conservation network Indigenous Protected and Conserved Areas (IPCAs)

The NWT's vast landscape provides a rare chance to proactively plan for a healthy future for the land, water, wildlife, and people.

The NWT's conservation network is a collection of inter-connected protected, conservation, and heritage areas. It is built in close collaboration between territorial, federal and Indigenous governments, Indigenous organizations, and stakeholders to protect the territory's ecological, social, cultural, and economic vibrance over the long-term. In 2024, the conservation network covered 17.6% of NWT land and fresh water.

The conservation network in the NWT consists of different types of areas including Indigenous Protected and Conserved Areas (IPCAs).

IPCAs are lands and waters where Indigenous governments and Indigenous organizations have the primary role in protecting and conserving ecosystems through Indigenous laws, governance, and knowledge systems. Culture and language are fundamental to these areas. On public land an IPCA designation, on its own, does not provide legal protection to an area; however, if co-designated with a territorial, provincial, or federal protected area or conservation area designation, it does. On Indigenous owned land, an IPCA designation may, on its own, provide legal protection.

Sources: GNWT, 2024. Northwest Territories State of the Conservation Network. Available at: <https://www.gov.nt.ca/ecc/en/content/nwt-state-conservation-network-report-2016> and [website](#)

Key Takeaways

Workshop discussions highlighted NbS as a key opportunity to help manage landscape carbon in the NWT. Key messages from this section include:

- **NbS were identified as one potential approach for supporting ecosystem resilience, stewardship, and landscape carbon management in the NWT.** Participants explored a range of approaches that could help support ecosystem resilience and landscape carbon management across interconnected ecosystems, while also delivering benefits for communities, and biodiversity.
- **Fire management was identified as one of the most applicable and promising NbS approaches for the NWT.** Participants were interested in learning more about

how to integrate controlled and cultural burns, fire breaks, reforestation, and forest thinning into NWT-wide stewardship practices. Participants also noted that improved understanding of landscape carbon and permafrost conditions could support wildfire planning, risk assessment, and restoration decisions.

- **Indigenous knowledge, leadership, and participation were emphasized as essential to identifying and implementing NbS.** Participants stressed that any solution needs to involve Indigenous communities, governments, and organizations, from the outset, as well as respect Indigenous rights, culture, and knowledge.
- **NbS has the potential to deliver many co-benefits.** In addition to helping reduce carbon loss, NbS can support biodiversity, maintain hydrology, reduce wildfire risk near communities, strengthen cultural connections to the land, enhance community well-being, and, in some areas, support infrastructure resilience and planning. Participants emphasized that these benefits should be valued even where carbon outcomes are difficult to quantify.
- **More research is needed to demonstrate the effectiveness of NbS in northern ecosystems.** Some participants perceived NbS as “*band-aid solutions*”, whereas others perceived that they could make a meaningful difference if scaled up and implemented widely. More carbon monitoring and research will help improve understanding of landscape change, evaluate the effectiveness of NbS,^{lxxxi} and support informed planning, stewardship, infrastructure, and resource management decisions.

Key barriers to implementation include limited long-term funding, technical capacity, monitoring, and coordination. Several participants also noted that policy and regulatory tools, alongside sustained financial and technical support, may be among the most efficient ways to enable NbS at scale in the NWT.

Finance and policy pathways for nature-based solutions in the NWT

Participants discussed how policy frameworks, financing mechanisms, and institutional support can influence the implementation of NbS at scale. Access to finance, as well as gaps in policy frameworks and greenhouse gas (GHG) inventories, were identified as major barriers to advancing NbS.

The section synthesizes some policy changes and promising finance mechanisms identified by presenters and participants. It also summarizes barriers and challenges discussed during the workshop, including why northern conditions create practical and equity-related constraints.

Developing landscape carbon accounting frameworks and protocols

A recurring point across workshop presentations was that policy and accounting frameworks do not currently capture many landscape-driven emissions, even when undisturbed ecosystems are rapidly losing carbon due to climate change.

Presenters noted that Canada's National Inventory Report (NIR) follows UN reporting rules and mainly captures land-sector emissions in contexts tied to managed land and direct human-driven land-use change.^{lxxxii} Workshop participants noted that this approach may not fully capture some climate-driven emissions from intact northern ecosystems, such as wildfire emissions and emissions from permafrost thaw and resulting peatland degradation, less visible in policy, planning, and financing decisions.

Participants emphasized two implications:

1. Under-counting and under-prioritization: National estimates likely understate both current emissions and the vulnerability of northern carbon stocks to abrupt release.
2. Limited incentive to act: Without a framework to measure and recognize these dynamics, there are fewer policy, financial, and regulatory levers to advance NbS targeting landscape carbon.

Participants also stressed that the burden of quantifying and responding to these emissions should not fall solely on the jurisdictions experiencing them. They emphasized the need for coordinated intergovernmental collaboration on methods, monitoring, and policy recognition.

Workshop discussions highlighted that developing northern-relevant frameworks and protocols would require:

- coverage of multiple ecosystem types (peatlands, permafrost soils, boreal forests, wetlands);
- representation of interactions among wildfire, thaw, hydrology, and vegetation change;
- improved treatment of winter emissions and methane releases;

- inclusion of Indigenous knowledge into monitoring and interpretation;
- baseline datasets and long-term monitoring networks; and
- Measurement, Reporting, Verification (MRV) approaches adapted to remote and cold-region realities.

Participants emphasized that advancing landscape carbon accounting frameworks will depend on addressing the data and knowledge gaps identified in Section 5, particularly gaps related to baseline conditions, winter emissions, methane dynamics, and the use of Indigenous knowledge into monitoring and interpretation. Speakers noted that such frameworks would support internal planning and governance and could also enable the future development of protocols that recognize the value of maintaining ecosystem functions that support long-term carbon storage.

Two potential pathways to access financing

Presentations introduced two broad, complementary pathways that presented opportunities to access financial resources and enable the implementation of NbS, including:

- Carbon finance, including Carbon Offset Credits, which monetize verified greenhouse gas (GHG) reductions or removals; and
- Nature finance, including Nature Stewardship Credits (NSCs), which monetize broader stewardship outcomes (e.g., biodiversity, cultural stewardship, water protection, resilience), not carbon outcomes alone.

- ***Carbon finance*** refers to financial mechanisms focused on the reduction of greenhouse gas emissions. Its purpose is to promote the development of a low-carbon economy through financial means. Key elements include carbon taxes, carbon credits, green funds and climate investment funds, carbon offset projects, carbon disclosure requirements, and policy support and incentives through government subsidies, tax incentives, and low-interest loans.^{lxxxiii}
- ***Nature finance*** refers to financial mechanisms aimed at investing in the protection, restoration, and sustainable use of natural ecosystems, delivering biodiversity, resilience, and community benefits as a core, not just carbon storage.

Carbon Offset Credits: An opportunity with practical and equity barriers

The workshop provided an overview of how Carbon Offset Credits can finance certain types of NbS through both compliance and voluntary markets.

A **Carbon Market** is a trading system where carbon credits (like Carbon Offset Credits), representing greenhouse gas (GHG) emissions reductions or removals, are bought and sold to allow companies, governments, or individuals to offset or compensate for their own emissions.^{lxxxiv} One carbon credit represents one tonne of carbon dioxide equivalent (CO₂e) reduced, avoided, or captured.

Markets can be **compliance-based**, created by laws or regulations, or **voluntary**, driven by corporate or philanthropic commitments:

- **Compliance markets**, such as the federal Output-Based Pricing System (OBPS), where regulated industrial emitters may purchase offset credits to meet mandatory emissions requirements.
- **Voluntary markets**, which operate independently of governments and allow corporations or philanthropies to buy credits to meet self-set climate goals, support environmental stewardship, or demonstrate leadership.

A **Carbon Offset Credit** (also called carbon credits) is a government-recognized certificate that shows one tonne of carbon dioxide equivalent was reduced or removed from the atmosphere. Credits can be generated from project types such as forest management, peatland restoration, agricultural soil practices, renewable energy, or landfill methane capture, depending on the rules of the system.

Presenters from Environment and Climate Change Canada (ECCC) emphasized that credits can only be issued after a project follows strict official protocols, meets eligibility rules, carefully measures results, and undergoes a third-party verification. They provided a clear overview of these requirements, which help explain both the value of offsets and their constraints in northern contexts, including:

- **Additionality:** Projects must demonstrate that carbon reduction or removal would not have happened under normal circumstances (beyond a business-as-usual scenario). Participants noted this can be difficult to demonstrate in the North, where large carbon stores are “undisturbed” by industrial activity but are increasingly affected by climate-driven change (e.g., shifting fire regimes, thaw, hydrology changes). Demonstrating additionality often requires strong baseline data and counterfactual modelling, which are challenging in dynamic ecosystems.
- **Permanence:** Carbon storage must be maintained for the period relevant to the project. For instance, the standard crediting period for forestry-related sequestration projects is typically 30 years, but regulations may require proponents of sequestration projects to monitor and report GHG removals for 100 years. Participants emphasized that increasing wildfire severity and permafrost thaw create elevated reversal risks. For some interventions (e.g., prescribed burning), demonstrating long-term net benefits may require credible evidence that the intervention reduces overall emissions over long time horizons compared to a no-intervention scenario.

- **Leakage:** Projects must demonstrate that carbon reductions do not cause emissions to rise elsewhere. For example, protecting one area of forest should not cause increased harvesting in another place. If this happens, the project must account for it.
- **Real and Measurable Benefits:** Projects must show that they lead to actual reductions or removals of greenhouse gases. They need to provide clear data and follow approved methods to measure how much carbon they reduce or store.
- **Monitoring, Reporting, and Verification (MRV):** Projects must follow strict protocols to quantify the amount of carbon they will store (compared to a business-as-usual scenario) and undergo third-party verification. Workshop participants noted MRV can be expensive and logistically difficult in remote, cold regions, especially for winter processes and methane.
- **Avoiding Double Counting:** Credits can only be issued and claimed once within one system. This prevents over-reporting of climate benefits and protects the markets credibility.

Nature Stewardship Credits: An emerging opportunity

Presenters explored **Nature Stewardship Credits (NSCs)** as an emerging nature finance mechanism focused on ecological and social outcomes alongside carbon storage.

An NSC, certifies positive ecological and social outcomes, such as biodiversity protection, cultural stewardship, fire resilience, or watershed restoration, rather than tonnes of carbon.

NSCs are used in voluntary global markets and are typically purchased by corporations, philanthropies, or governments seeking to support nature protection and community wellbeing. They cannot currently be used as Carbon Offset Credits in compliance systems.

Presenters described NSC systems as typically emphasizing outcomes, governance, and transparency, and systems that do not rely on traditional carbon market frameworks. Key elements discussed included:

- Ecological outcomes, like habitat condition, peatland/wetland health, connectivity, and ecosystem function (including resilience).
- Social and cultural outcomes, such as cultural use of the land, on-the-land programs, language and knowledge transfer, community safety, and local employment.
- Governance and rights, with potential to be designed to recognize Indigenous land rights and governance responsibilities, positioning Indigenous nations as primary decision-makers.
- Transparency and verification, as NSCs still require clear methodologies, transparent pricing, and credible documentation of outcomes so that buyers understand what is being supported.

Presenters highlighted that NSC approaches do not necessarily mirror the Carbon Offset Credit approach (e.g., rigid additionality/permanence requirements). Instead, they can be designed to recognize and resource stewardship in landscapes that already provide global climate and biodiversity benefits.

Presenters explained that NSCs are being developed by organizations such as the Pollination Foundation and First 30×30 Canada in partnership with Indigenous nations. Buyers may include corporations, philanthropic foundations, and other actors seeking to demonstrate positive contributions to nature and communities.

Workshop discussions

Opportunities

Overall, several participants viewed NSCs as a potentially promising approach. First because there are currently no carbon finance protocols for undisturbed landscapes. Second, and most importantly, because NSCs, by recognizing co-benefits, seem more aligned with Indigenous values and holistic approach of land stewardship.

In the context of carbon finance, workshop discussions acknowledged that these could provide access to financing for some NbS activities, particularly where methods are established and monitoring is feasible. Speakers noted that existing (or emerging) protocols in Canada tend to focus on project types such as improved forest management, landfill methane capture, and agricultural soil management. In response, presenters suggested that protocols could expand over time to include additional nature-based or northern-relevant methodologies.

Voluntary markets were also discussed as a possible entry point because they can attract a wider set of buyers and may place higher value on co-benefits (cultural, ecological, community resilience), provided integrity and verification expectations can still be met. At the same time, participants emphasized that voluntary markets still require clear methods, quantification, and monitoring capacity, which remain significant barriers in much of the NWT.

When participants discussed NSCs, Indigenous participants were particularly interested in Indigenous-led initiatives and case studies. NSCs were seen as promising to secure financing for activities that are difficult to fit within conventional offset protocols, such as:

- Protection and stewardship of peatlands, wetlands, and intact landscapes
- Restoration and resilience efforts in fire-affected regions
- Community safety and resilience near wildland–urban interfaces
- Guardianship and long-term stewardship programs.

Participants also discussed the possibility of “stacking” in some cases (e.g., carbon credits for quantified carbon outcomes, with NSCs recognizing additional ecological and social outcomes), although this would require careful design to avoid double counting and to ensure integrity.

Barriers and concerns

Participants raised three broad categories of constraints associated with Carbon Offset Credits and NSCs: fit offset credits with northern landscape dynamics, transaction costs/capacity, and alignment with Indigenous governance and values.

Presenters and participants discussed the applicability of these two approaches to northern landscape dynamics. As a participant pointed out *“proving additionality is difficult when the landscape is already doing the work”*. Participants noted that many NWT ecosystems are already large carbon stores without industrial disturbance, but climate change is now shifting baselines and increasing carbon emissions.

Establishing robust counterfactual baselines, quantifying avoided emissions, and attributing outcomes to a project can be difficult when fire regimes, hydrology, and thaw are changing rapidly. Workshop breakout group participants emphasized that landscape-scale modelling can help address this challenge by simulating what would happen under natural trajectories and comparing these projections to scenarios where NbS measures are implemented. Using multiple models is important, as different approaches will inevitably produce varying outcomes; however, areas of convergence across models can provide higher confidence in the estimated additionality and mitigation impact.

Participants also discussed the challenges around permanence. They highlighted increasing wildfire severity, peat drying, and accelerating thaw as threats that could raise the likelihood that stored carbon will be released, complicating long-duration permanence expectations under conventional carbon rules even with buffers applied to crediting. It was however noted that monitoring with Eddy Covariance methods and/or chamber methods could be a definitive way to monitor carbon cycling and storage/emission.

High transaction costs and the technical capacity required by these two approaches were also identified as barriers. Participants noted that carbon offset projects often require multi-year development timelines, specialized modelling, ongoing monitoring, and third-party verification. These requirements can be prohibitive without dedicated, long-term support, particularly for Indigenous governments and Indigenous organizations, and communities.

Participants emphasized that monitoring, reporting and verification of both Carbon Offset Credits and NSC approaches may not be well suited to northern conditions, including winter emissions and methane dynamics, and are difficult and costly to implement in remote settings. It was, however noted by presenters within discussion groups that this is also true for projects in the south, however, these systems can be supported if there are finances in place, and hopefully these finances can start coming from Carbon Offset Credits.

While NSCs may reduce some burdens associated with carbon modelling, participants stressed that NSCs still require capacity for documentation, governance, contracting, and relationships with buyers, activities that must be realistically resourced. Despite the enthusiasm around NSCs, the workshop discussions also acknowledged NSC as an emerging market with important uncertainties. Participants noted uncertainties around:

- how pricing is determined and how stable buyer demand will be;
- whether standards will be consistent and credible as markets scale; and
- concerns about the risk of misalignment with Indigenous governance and values.

Most concerns were shared for Carbon Offset Credits. Indigenous participants emphasized that carbon-only approaches can undervalue holistic stewardship outcomes and may not align with Indigenous governance systems or land relationships. Concerns were raised that projects can be designed in ways that externalize control and concentrate benefits away from communities, especially when carbon rights, decision-making authority, or project rules are not community-led. Several participants suggested that alternative market models, such as nature finance, may be better suited to Indigenous governance and may be needed to reflect the full range of stewardship activities underway in northern regions.

Despite the enthusiasm on the holistic approach of NSCs, participants shared some concerns on whether governance structures would genuinely protect Indigenous authority and benefit-sharing. Participants emphasized that NSCs must be developed for northern ecosystems and implemented with strong ethical safeguards, transparency, and community-driven governance to avoid reproducing power imbalances.

Indigenous perspectives

Participants emphasized that if advanced, financing mechanisms must be co-developed with Indigenous governments and Indigenous organizations from the outset, in order to ensure transparent benefit-sharing, and respect for Indigenous timelines, knowledge systems, and decision-making authority. They raised important concerns about how existing carbon finance systems can conflict with Indigenous governance and land relationships, and projects funded through these mechanisms can sometimes reproduce power imbalances, with external developers retaining control over carbon rights, project design, and long-term commitments.

Additionality and permanence requirements were also discussed as potential points of misalignment, particularly where Indigenous stewardship has long maintained healthy landscapes. Participants emphasized that MRV systems rooted primarily in Western scientific frameworks can undervalue Indigenous knowledge and may not reflect what communities consider meaningful evidence of stewardship outcomes.

Carbon offset projects were described as centering heavily on carbon accounting and external protocols, whereas some participants perceived NSCs as having a greater potential to align with Indigenous governance because of their holistic approach centred on stewardship and relationships with the land and their recognition of co-benefits.

Participants also noted that NSCs could support guardian programs, fire stewardship, restoration of fire-affected areas, youth training, and intergenerational knowledge transfer, activities vital for climate resilience but difficult to quantify in tonnes of CO₂. In this way, NSCs were viewed as a mechanism capable of supporting the full breadth of Indigenous-led conservation.

At the same time, participants underscored that NSCs will only fulfill this potential if implemented with transparent pricing, direct relationships with buyers, and clear safeguards to prevent exploitation. They stressed the importance of Indigenous leadership in shaping NSC standards from

the outset so that the system reflects local priorities and governance structures rather than imposing an external model.

Case Study: Restoration and Land Care Case Studies

The following principles, as shared by presenters referencing Mi'kmaq experience, reinforce the need to view carbon not merely as a commodity but as part of a living relationship with the land. Workshop speakers and participants described several guiding concepts that inform Indigenous approaches to land and carbon stewardship:

- Etuaptmumk (Two-Eyed Seeing): understanding the world through both Indigenous and Western scientific perspectives, drawing strength from each.
- Netukulimk: using natural resources in a way that sustains the environment for future generations.

Msit no'kmaq (All My Relations): recognizing the interconnectedness of all living beings and systems.

Case Study: Mi'kmaw-Led NbS in Unama'ki

The Unama'ki Institute of Natural Resources provides an example of how Indigenous-led governance can integrate culture, science, and conservation finance to advance climate and community goals. Supporting Mi'kmaw First Nations in Unama'ki (Cape Breton), the Institute established the Sespité'mnej Kmitkinu Conservancy in 2021 to implement conservation at a land- and seascape scale. Their strategic plan identifies NbS grounded in Mi'kmaw stewardship principles and uses 139 culturally significant biocultural indicator species to guide monitoring and measure effectiveness. Presenters emphasized that, for Mi'kmaw communities, NbS reflect longstanding responsibilities to restore balance among land, air, and water, demonstrating how Indigenous governance can anchor carbon and biodiversity outcomes within enduring stewardship systems.^{lxxxv}

Case Study: Aligning Natural Systems Carbon with Indigenous-Led Stewardship

Workshop presenters highlighted examples demonstrating how NSC approaches can align with Indigenous-led conservation initiatives in the NWT.

The Indigenous Led Partnerships in Conservation (First 30x30 Initiative)^{lxxxvi} showcased how Indigenous Nations are leading large-scale conservation planning grounded in Indigenous governance, stewardship, and long-term land protection. These landscape-scale initiatives include carbon-rich ecosystems such as peatlands, boreal forests, and permafrost regions, aligning closely with NSC objectives. Discussions also explored future opportunities through the Indigenous-led Thaidene Nene initiative. Participants noted that an NSC framework could complement Indigenous governance systems by supporting durable conservation outcomes while creating opportunities for high-integrity carbon finance. Key considerations include respecting Indigenous authority, ensuring long-term stewardship funding, and recognizing the biodiversity and cultural co-benefits associated with conservation.

Key Takeaways

Workshop discussions emphasized that advancing NbS in the NWT will require both fit-for-purpose financing mechanisms and enabling policy and accounting frameworks. Key messages from this section include:

- **Participants consistently highlighted the need for policy changes to better account for landscape carbon emissions.** Current greenhouse gas inventories do not capture emissions from intact ecosystems losing carbon due to wildfires and permafrost and peatland degradation, leaving these emissions largely invisible in policy and financing decisions.
- Participants discussed two complementary financing pathways for NbS, including carbon finance (including Carbon Offset Credits that monetize verified GHG outcomes) and nature finance (including Nature Stewardship Credits that recognize broader stewardship outcomes beyond carbon).
- **Carbon Offset Credits can unlock financing for some NbS, but northern conditions could create practical constraints.** Participants highlighted that core eligibility requirements such as additionality, permanence, and MRV might be difficult to meet in peatlands, permafrost, and boreal forests in undisturbed lands, but are increasingly impacted by climate change and with reversal risks that are high.
- **High technical and financial barriers could further constrain participation.** Workshop participants emphasized that offset projects often require specialized modelling, long development timelines, sustained monitoring, and third-party verification, which can be challenging to resource in remote and cold-region contexts.
- **Indigenous participants raised significant concerns about the compatibility of Carbon Offset Credits systems with Indigenous governance and stewardship.** Discussions highlighted risks of external control over carbon rights. In addition, it

was unclear whether carbon-focused frameworks risk undervaluing cultural, ecological, and social dimensions of land care.

- **Nature Stewardship Credits (NSCs) were viewed as a potentially more flexible and culturally aligned financing pathway.** Participants noted NSCs may better recognize co-benefits such as biodiversity, cultural stewardship, water regulation, fire resilience, and community safety.
- However, participants noted that **NSCs remain an emerging approach.** Their relevance to the NWT will depend on how standards are developed and implemented, with success depending on transparent pricing, durable buyer demand, and governance structures that ensure Indigenous authority and equitable benefit-sharing.

Participants emphasized the potential value of improving landscape carbon accounting approaches for climate-driven emissions from intact or undisturbed ecosystems. Many noted that the responsibility for understanding and responding to these emissions should not fall solely on the jurisdictions experiencing them, but could benefit from coordinated intergovernmental collaboration on research, monitoring, methods, and policy development.

Data and knowledge gaps

This section summarizes the key knowledge gaps identified during the Landscape Carbon Workshop to understand and manage landscape carbon, with a focus on issues most relevant to decision-making in the NWT context.

Reliable, accessible, and locally relevant monitoring data are important for improving understanding of landscape carbon and supporting modelling, policy development, planning, and other decision-making processes in the NWT. Discussions focused on how governments, Indigenous partners, and communities can make informed decisions about land use, stewardship, and participation in the carbon economy.

Monitoring network: Technologies and methods

Workshop presentations highlighted some technologies currently used to measure landscape carbon in the NWT. While complementary, their geographic coverage remains limited. Examples discussed included:

- Eddy covariance flux towers (shown in **Figure 10**), which monitor atmospheric carbon exchange at select research sites.
- Satellite imagery and artificial intelligence, which help detect transitions in vegetation, permafrost, and hydrology
- Drones (shown in **Figure 10**), increasingly being used to map thaw slumps, peatland changes, and other disturbances
- Chronosequencing or field soil sampling, to measure how soils change over time; and
- Winter carbon emission measurements, highlighting the importance of cold-season carbon cycling, an often underrepresented component of northern carbon budgets.



Figure 10. Images showing an eddy covariance flux tower (left); and a drone (right). Source adapted by Garfield Giff, (2025), Landscape Carbon Workshop, Yellowknife, NT [Workshop presentation].

Participants agreed that these tools together provide valuable insight but currently cover only a small fraction of the territory. There was broad consensus that expanded, coordinated monitoring networks, designed specifically for northern conditions and seasonal variability, represent a major opportunity for improving understanding and decision-making.

Understanding and modelling landscape carbon dynamics

Workshop discussions showed that current understanding of northern landscape carbon dynamics remains limited.

Participants noted that wide regional differences in permafrost depth, peatland extent, and organic soil characteristics, combined with sparse monitoring and sampling coverage, limit the ability to accurately estimate the magnitude and distribution of carbon stocks across the NWT. For instance, Polar Knowledge Canada highlighted that there are only about 104 soil organic carbon sampling sites in permafrost regions in Canada, limiting the precision of national and territorial estimates.

Participants also emphasized limitations in historical datasets used to establish baseline conditions and understand how carbon cycles have changed over time. For example, wildfire records in the NWT extend back only to the 1960s, making it difficult to characterize long-term fire cycles and boreal carbon dynamics before recent warming and disturbance. However, tree ring analysis has been used effectively to extend the fire record at specific locations.

Finally, participants highlighted the limited understanding of how wildfire severity, permafrost thaw, hydrological change, vegetation transitions, and methane production interact. As these interactions remain poorly understood, especially at the scale required for accurate modelling, there are a lot of uncertainties to assess disturbance processes.

As a result, current datasets are insufficient to track ongoing changes. Limited carbon monitoring of permafrost thaw, peatland drying, and hydrological shifts makes it difficult to determine when and where ecosystems are transitioning from carbon sinks to carbon sources, and to quantify the rate at which emissions are increasing.

These limitations also make it difficult to model how northern landscapes contribute to climate change today and how they will behave in future decades. While some models acknowledge that landscape carbon emissions accelerate climate change, participants expressed uncertainty about whether these emissions are accurately captured or are grossly underestimated due to gaps in current data.

Knowledge gaps linked to key threats

Presentations on wildfire, peatland degradation, and permafrost thaw revealed several specific gaps in knowledge that limit the ability to estimate emissions and predict long-term landscape change.

Wildfire

Speakers highlighted uncertainties related to the depth of burn into organic soils and peat, as a major limitation in estimating wildfire-related carbon emissions. Knowledge gaps also remain regarding overwintering fire behaviour, including how smouldering fires persist under drought conditions and how much carbon they release. Post-fire regeneration rates were described as poorly documented, especially in areas experiencing repeated burns. Participants also noted limited understanding of how recurring fire alters long-term carbon storage in boreal forests and peatlands.

Peatland degradation

Workshop discussions highlighted incomplete mapping of peatland depth, soil moisture, and ice content, all of which strongly influence carbon storage. Participants also identified limited datasets on peatland drying, hydrological change, and structural collapse of peat plateaus. Climate warming has made permafrost recovery in peatlands in the southern NWT very unlikely, at least in the near term, and permanent alteration may be possible. ^{lxxxvii}

Permafrost thaw

Participants noted insufficient measurements of carbon and methane released during permafrost thaw, especially across different landscape types. There is limited understanding of which regions are approaching irreversible tipping points, where thaw may accelerate abruptly, and other areas where management actions may help reduce additional pressures on permafrost systems. Sparse monitoring of thermokarst formation and progression also limits the ability to track how thaw-induced changes shift carbon emissions over time. Many participants agreed that permafrost carbon emissions, particularly methane, are likely underestimated.

Indigenous knowledge and community-led monitoring

Throughout the workshop, Indigenous governments and Indigenous organizations and community participants highlighted the essential role Indigenous knowledge plays in increasing the understanding landscape change. It was noted that Indigenous knowledge can contribute important long-term observations and context for understanding landscape change.

For instance, participants noted that Indigenous knowledge can help interpret remote sensing data and identify landscape transitions that may not be obvious in satellite images. Site-specific observations from knowledge holders can provide critical insight into thaw progression, water movement, vegetation change, wildlife patterns, and other indicators of shifting carbon cycles. Participants referred to the guardians program for carbon monitoring, and to support year-round monitoring, local decision-making, and rapid detection of changes in landscape conditions.

Finally, knowledge co-production and co-development of research priorities were highlighted as necessary for ethical and effective monitoring practices. Participants stressed that Indigenous

knowledge was essential for understanding landscape change and supporting stewardship, monitoring, and decision-making.

Priority research areas raised in the workshop

The following research priority areas, identified during presentations and breakout group discussions, aim to improve scientific understanding and modelling of landscape carbon, while supporting planning, stewardship, adaptation, infrastructure management, and future policy development in the NWT:

- **Improved mapping of peatlands and permafrost**, to better capture stores variation with soil composition and permafrost depth. Even small measurement inaccuracies, such as a ten-centimetre error in peat depth, can lead to substantial misestimations of carbon stocks. They also noted the need for **standardized field methods**, as inconsistencies in carbon density measurements across sampling sites limit comparability and weaken model inputs.
- **Territory-wide monitoring of all landscape emissions, including methane**. Current systems do not capture methane or interactions with permafrost layers consistently, and participants highlighted the need for an expanded network of atmospheric and ground-based monitoring systems. Presenters also emphasized the importance of winter monitoring, citing evidence that winter warming is a major driver of soil carbon loss.
- **Enhanced permafrost monitoring** to better track carbon content, thaw progression, hydrological shifts, and landscape degradation. **Improved quantification of carbon fluxes and storage** was seen as essential to refine emissions estimates and support future modelling work. **Research on soil moisture regimes** was identified as a need for understanding boreal forest responses to changing precipitation patterns and water flows within the Mackenzie River Basin.
- **Establishing observational benchmarks** to validate models and track long-term landscape change. Reconstructing historical carbon cycles prior to recent warming was considered important for establishing baselines, and **integrating more empirical field data into existing models** was identified as essential for capturing variability in carbon density and ecosystem processes.

Table 1. Summary of Key Research and Monitoring Gaps Identified in the Landscape Carbon Workshop.

Theme	Research and Monitoring Gaps
Carbon Stocks and Baselines	Large uncertainty in the amount of carbon stored in NWT landscapes due to limited sampling of permafrost, peatlands, and organic soils
	Lack of baseline data describing natural carbon cycles prior to rapid climate change, including limited historical wildfire records

Carbon Fluxes and Emissions	Insufficient data on current rates of carbon release from permafrost thaw, peatland drying, and hydrological change
	Methane emissions, particularly from thawing permafrost and wetlands, are poorly quantified and likely underestimated
Disturbance Interactions	Limited understanding of how wildfire severity, peatland degradation, permafrost thaw, vegetation change, and hydrology interact to influence carbon emissions
	Uncertainty around cumulative and compounding effects of repeated disturbances on long-term carbon storage
Monitoring Coverage and Methods	Existing monitoring technologies (flux towers, satellites, drones, field sampling) cover only a small portion of the territory
	Monitoring systems are not well adapted to northern conditions, especially winter processes and remote locations
Threat-Specific Knowledge Gaps	Peatlands: Incomplete mapping of peat depth and moisture regimes, limited data on permafrost thaw, drying and collapse, and insufficient understanding of recovery conditions
	Permafrost: Sparse measurements of carbon and methane release, limited identification of tipping points, and inadequate tracking of thermokarst development
	Wildfire: Uncertainty around depth of burn into organic soils, overwintering fire behaviour, post-fire regeneration, and long-term carbon impacts of repeated burns.
Indigenous knowledge and Co-Development	Indigenous knowledge is not consistently reflected in carbon monitoring and modelling approaches despite its potential in understanding landscape change
	Greater support is needed for Indigenous-led, community-based monitoring and guardianship
Modelling and Decision Support	Current models struggle to capture northern carbon dynamics due to limited empirical data and weak integration of field observations
	Lack of observational benchmarks limits model validation and confidence in long-term projections

Together, these gaps explain why uncertainty remains high in estimating landscape carbon emissions and underscore the importance of collaborative, adaptive, and Indigenous-led approaches to monitoring and decision-making.

Key Takeaways

Workshop participants consistently emphasized that data, monitoring, and knowledge gaps are a central barrier to managing landscape carbon in the NWT. Key messages from this section include:

- Data, monitoring, and knowledge gaps affect the ability to quantify carbon stocks, understand emissions, interpret feedback loops, assess ecosystem interactions, and apply carbon finance or modelling tools effectively.
- Participants noted that **uncertainty remains high due to gaps in baseline data, limited monitoring of key processes such as soil temperature and permafrost thaw, and incomplete understanding of the natural carbon cycles that govern northern landscapes**. This includes uncertainty around methane emissions and the cumulative interactions among wildfire, hydrology, peatland drying, and thaw-related carbon release. These gaps contribute to uncertainty in the scale of landscape carbon emissions, including the potential for positive feedback loops that may accelerate climate change.
- Given this uncertainty, participants emphasized the **importance of decision-making approaches that can account for incomplete knowledge and adapt as new information becomes available**. Pilot projects, continued monitoring, and adaptive management were discussed as ways to improve understanding while responding to changing conditions.
- Participants also highlighted that **addressing monitoring and data gaps will require stronger inclusion of Indigenous knowledge, long-term northern-specific monitoring systems, and expanded data collection across seasons**. Improved mapping and modelling tools, greater collaboration among governments, researchers, and communities, and co-development of carbon accounting frameworks were also seen as essential. Support for Indigenous-led stewardship and guardianship was repeatedly emphasized as a foundation for effective long-term monitoring and for interpreting changes across carbon-rich landscapes.

Next steps

The Landscape Carbon Workshop was a unique learning opportunity to understand the role and scale of landscape carbon in Canada and in the NWT in the context of a changing climate, as well as to identify potential opportunities associated with understanding, monitoring, and responding to landscape carbon emissions in a changing climate. Indigenous partners, communities, researchers, practitioners, and policymakers from the NWT and other Canadian jurisdictions shared their knowledge through presentations and panels, highlighted inspiring case studies, and discussed their perspectives through breakout sessions and plenary discussions.

Key takeaways include:

- Landscape carbon in Canada, and particularly in the NWT, is globally significant. However, emerging evidence suggests that some areas may be shifting from long-term carbon sinks to carbon sources under changing climate conditions.
- Peatland degradation, permafrost thaw, and wildfires are the dominant and interconnected drivers of landscape carbon emissions in the NWT, and these emissions in turn accelerate climate change.
- NbS offer real potential to address landscape carbon emissions, but approaches must be designed for northern realities. Fire management and stewardship-based approaches were identified as potential options for the NWT. These approaches may help inform land-use planning and development decisions while reducing climate-related risks and supporting ecosystem resilience.
- Indigenous knowledge, governance, and stewardship were consistently identified as essential components of effective landscape carbon work. Participants consistently emphasized that initiatives must be Indigenous-led or co-developed, respect data sovereignty, and build on existing stewardship practices.
- Current carbon finance tools were viewed by many participants as having limitations in northern contexts. Carbon offsets were discussed as facing significant practical challenges, while emerging nature finance approaches may better align with some Indigenous stewardship priorities but remain exploratory at this time.
- Addressing landscape carbon in northern regions requires collaboration and coordinated action across all levels of government, including Indigenous governments and Indigenous organizations, as well as academia, the private sector, industry, and non-profit organizations.

Participants generally viewed landscape carbon information as one source of information that can support decision-making by helping governments, Indigenous governments and Indigenous organizations, communities, and industry better understand climate-related risks and opportunities associated with the environment, infrastructure, and resource development activities. Participants highlighted that significant data and monitoring gaps currently limit decision-making, finance, and

policy action. In particular, they stressed the need to improve understanding of:

- Carbon stocks and baselines across peatlands, permafrost, and boreal forests;
- Interactions among wildfire, permafrost thaw, peatland degradation, hydrology, and vegetation change;
- Thresholds and tipping points that may lead to irreversible carbon loss;
- The cumulative effects of repeated disturbances over time; and
- Methane emissions and winter processes, which are currently underrepresented due to sparse baseline data and limited monitoring coverage.

Improved quantification and monitoring of landscape carbon emissions was identified as important for improving understanding of emissions from intact ecosystems and informing greenhouse gas inventories, policy discussions, and carbon management approaches.

Based on these discussions, participants identified the following areas for future consideration:

- Strengthen collaboration and capacity building among Indigenous governments and Indigenous organizations, communities, researchers, practitioners, private sector actors, and decision-makers, particularly to co-develop research agendas, monitoring networks, shared learning platforms, and pilot projects.
- Advance targeted research, development, and place-based pilot studies to test and refine NbS approaches in northern contexts, with particular focus on fire management and stewardship-based approaches.
- Expand and better coordinate landscape carbon and methane monitoring networks across northern regions and ensure that collected data are accessible and usable for multiple decision-making contexts.
- Monitor developments in carbon and nature finance and assess their potential applicability in the NWT, while carefully considering ecological relevance, equity, and alignment with Indigenous governance and stewardship values.

Overall, participants emphasized the importance of continuing research, monitoring, collaboration, and adaptive decision-making as understanding of landscape carbon continues to evolve.

The landscape carbon workshop established a shared foundation for ongoing dialogue, research, and collaboration. Its insights can inform future discussions, partnerships, and consideration of landscape carbon in the NWT. Collaboration among Indigenous governments and Indigenous organizations, communities, researchers, industry, and others was consistently identified as essential for advancing understanding and exploring northern opportunities.

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Appendices

Glossary

Carbon Sink refers to an ecosystem, such as a forest, peatland, or wetland, which absorbs more carbon dioxide (CO₂) and methane (CH₄) from the atmosphere than it emits, thereby helping to **reduce atmospheric greenhouse gas (GHG) concentrations and contribute to climate regulation**.

Carbon Store/Stock is the amount of carbon, in the form of organic matter (soils, vegetation, peat, permafrost) or inorganic reservoirs, held within a landscape at a given time, and which has the potential to remain sequestered unless released by natural or human-caused processes.

Cultural burning is an important Indigenous cultural practice that enhances ecosystem biodiversity, assists with the management of complex resources, and reduces wildfire risk by reducing vegetation.

Fire refugia refers to areas that remain unburned after a wildfire. The characterization of an area as a fire refugia depends on “bottom-up” drivers (place specific characteristics) including:

- terrain features (e.g., elevation, slopes, water bodies) which can provide fire skips;
- the presence of peatlands (which retain moisture and have standing waters); and
- the type and patterns of vegetation, which can provide more or less combustible fuels.
- The characterization of an area as fire refugia also depends on “top-down” drivers including weather (e.g. precipitation, relative humidity, etc.) and climate (e.g., mean annual temperature).

Landscape carbon refers to the carbon stored and exchanged within ecosystems such as forests, wetlands, vegetation, and soils. Carbon is mostly stored in vegetation or as partially degraded organic matter in soils, also known as soil organic carbon (SOC), especially in permafrost soils.

Nature Stewardship Credit (NSC), a form of Nature Finance, certifies positive ecological and social outcomes, such as biodiversity protection, cultural stewardship, fire resilience, or watershed restoration, rather than tonnes of carbon.

NSCs are used in voluntary global markets and are typically purchased by corporations, philanthropies, or governments seeking to support nature protection and community wellbeing. They cannot currently be used as Carbon Offset Credits in compliance systems

Peatlands are unique wetland ecosystems that store massive amounts of carbon, built up slowly over thousands of years. When these areas are disturbed or degraded, they can release significant greenhouse gases into the atmosphere. In cool climates, peatland vegetation is mostly made up of Sphagnum mosses, sedges and shrubs, which then become primary builders of peat when the vegetation dies.

Permafrost is soil, sediment, or rock that remains below 0°C for two or more years. Some of the oldest permafrost in Canada (especially in Yukon) is over 700,000 years old, and permafrost overall stores very large amounts of carbon.

Prescribed fire is a carefully planned and managed fire ignited by trained fire specialists. These fires reduce accumulated vegetation and surface fuel loads, limit the risk of high-severity wildfires, and help maintain ecosystems.

Appendix A: Workshop overview

The Landscape Carbon Workshop was held in Yellowknife, Northwest Territories (NWT) from February 4–6, 2025. The workshop was hosted by the Government of the Northwest Territories (Department of Environment and Climate Change) and Polar Knowledge Canada, bringing together researchers, Indigenous governments and Indigenous organizations, practitioners, policymakers, and community representatives to build a shared understanding and to enhance collaboration around landscape carbon in the NWT. The workshop was financially supported by Polar Knowledge Canada, Environment and Climate Change Canada, C-CORE, and the GNWT.

Main objectives

The main objectives of the workshop were to:

- Bring together landscape carbon proponents to strengthen collaboration and knowledge exchange
- Identify opportunities and barriers to landscape carbon management
- Identify scientific, policy, monitoring and knowledge gaps related to landscape carbon.

Across all sessions, participants emphasized the urgency of addressing climate-driven changes in permafrost, peatlands, hydrology, and wildfire regimes, and the need for collaborative, Indigenous-led approaches to land stewardship and carbon management.

Who participated

The Landscape Carbon Workshop brought together a large and diverse group of people working on climate, land, and stewardship issues across northern Canada. More than 175 participants attended, reflecting strong interest in how landscape carbon is changing and what this means for northern regions. Over the three-day workshop, 38 speakers shared scientific research, community knowledge, monitoring approaches, policy perspectives, and on-the-ground stewardship experiences relevant to the NWT and similar northern landscapes.

Geographic representation

Participants joined the workshop from across Canada, with a strong northern focus. Just over half of all participants (approximately 54%) were based in the NWT with a strong Indigenous component, underscoring the workshop's grounding in NWT priorities and lived experience. The remaining participants came from across the country, including Alberta, British Columbia, Newfoundland and Labrador, Nova Scotia, Nunavut, Ontario, Quebec, Saskatchewan, and Yukon. There was also international participation, from the United States, the United Kingdom, and Australia, bringing additional perspectives from outside Canada.

This geographic mix ensured that discussions were rooted in northern realities while also benefiting from broader national and international expertise. **Figure 11** presents a breakdown of participants by geography.

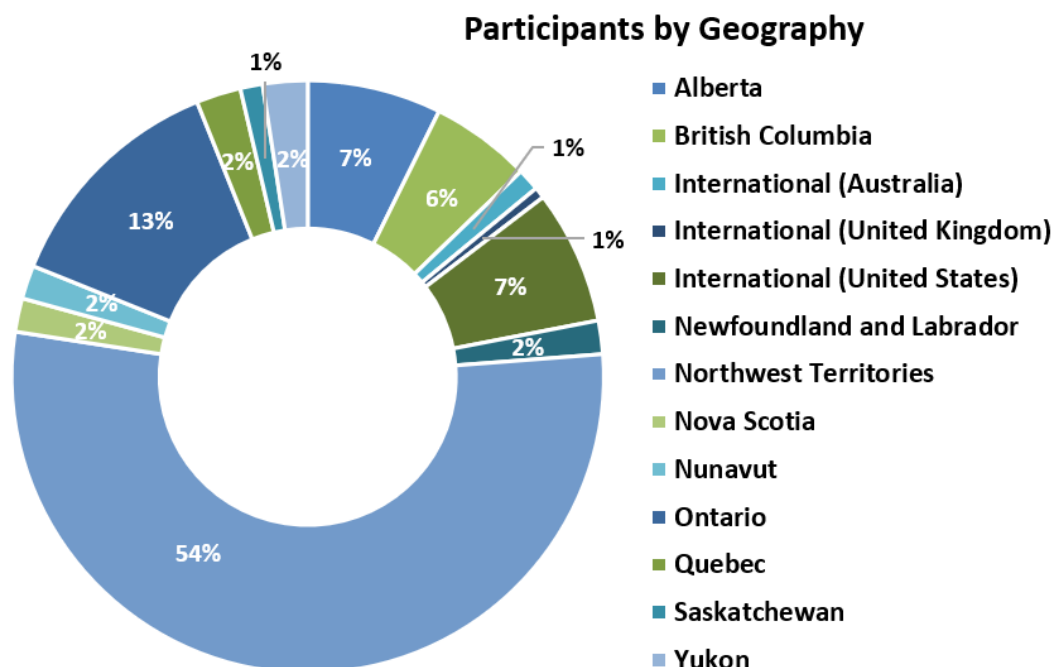


Figure 11 Breakdown of participants by geography.

Sector representation

Participants represented a wide range of sectors, highlighting the cross-cutting nature of landscape carbon issues. The largest share of participants came from provincial and territorial governments (approximately 28%), reflecting the key role governments play in land management, climate policy, and monitoring. Indigenous governments and Indigenous organizations (around 19%) were also strongly represented, ensuring that Indigenous knowledge, stewardship priorities, and governance perspectives were central to workshop discussions.

Other participants included those from non-profit organizations (about 18%), academia and research institutes (13%), and the federal government and agencies (13%), alongside private sector and professional services, and municipal and international governments. This mix brought together people working in research, policy, community stewardship, conservation, and implementation. **Figure 12** presents a breakdown of participants by sector.

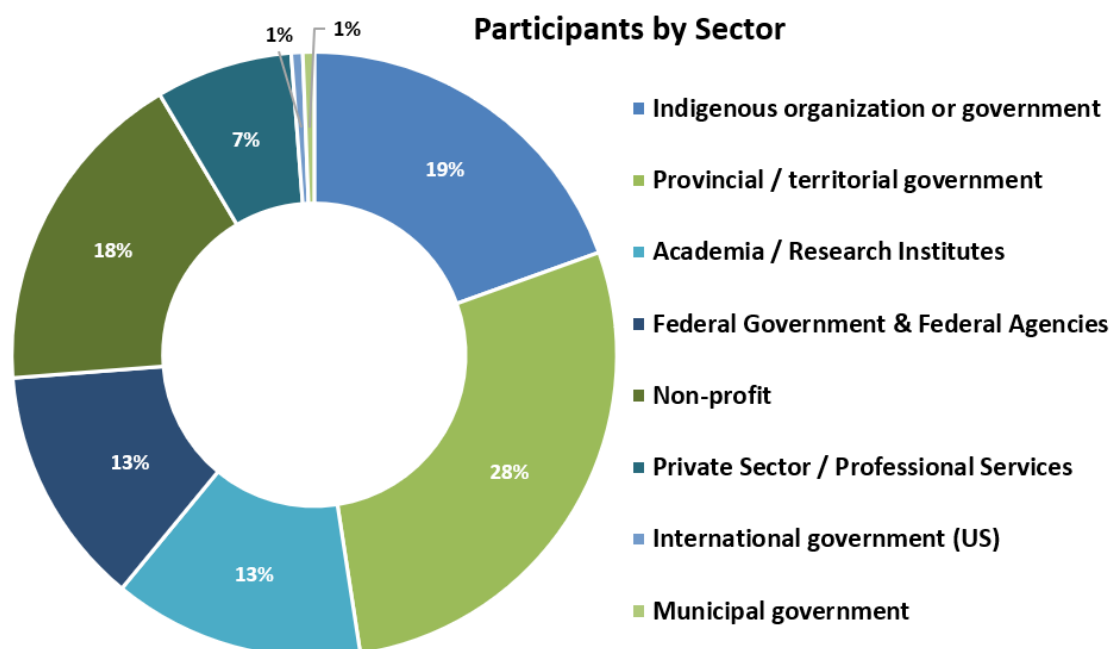


Figure 12. Breakdown of participants by sector.

Collaborative and interactive format

The workshop was designed to encourage conversation and shared learning, combining presentations with breakout discussions and plenary reflections. To support this, illustrator Alison McCreesh provided live graphic recording throughout the event, visually capturing key ideas, connections, and questions as they emerged. While these images do not necessarily represent the views of all organizations participating, they were helpful for participants to see how different perspectives and themes fit together and supported ongoing dialogue during and after the workshop.

Overall, participation reflected the interdisciplinary and collaborative nature of landscape carbon work, bringing together those who study, manage, steward, and are directly affected by changes in northern landscapes.

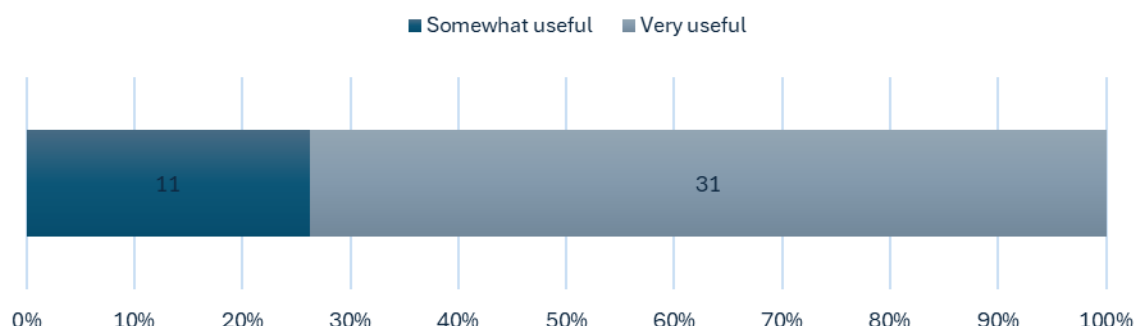
Workshop experience

Survey results indicate that the Landscape Carbon Workshop was highly effective in meeting its objectives, delivering relevant research content, and creating space for meaningful discussion. Across all evaluation questions, responses cluster strongly toward the most positive categories, suggesting a well-designed and well-facilitated event that resonated with its diverse audience of governments, Indigenous partners, researchers, and practitioners.

Usefulness of research content

Most participants found the research presented to be valuable. The majority rated the content as “very useful,” with the remainder indicating it was “somewhat useful.” There were no responses indicating that the research was not useful. This suggests that the workshop successfully aligned technical presentations with participant interests and information needs, and that the state-of-knowledge framing was appropriate for a mixed audience.

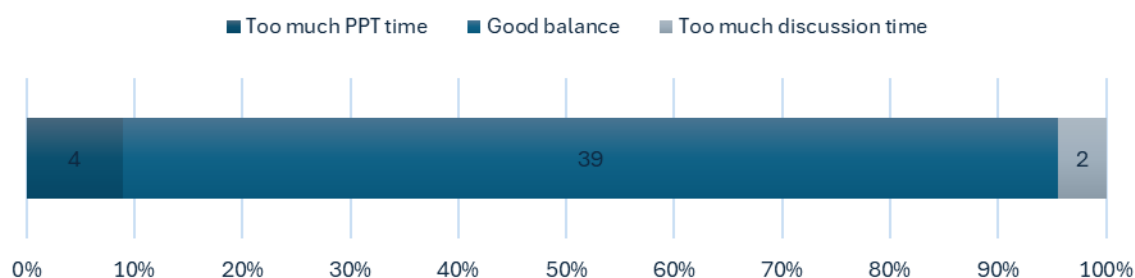
Did you find the research results presented useful?



Balance between presentation and discussion

Feedback shows a strong consensus that the workshop struck a good balance between presentations and discussion. Only a very small number of respondents felt there was too much presentation time or too much discussion time. This balance appears to have supported both knowledge transfer and interactive learning, reinforcing the workshop’s dual purpose of education and exploration of opportunities.

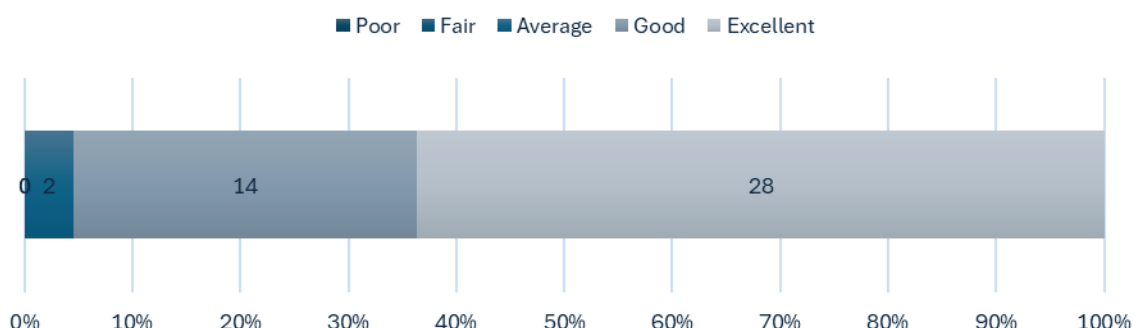
Was there a good balance between presentation and discussion?



Facilitation quality

Facilitation was rated extremely positively. Most respondents assessed the facilitation and overall workshop experience as “excellent,” with the remainder rating it as “good” or “average.” There were no ratings of “poor” or “fair.” This indicates that the workshop structure, pacing, and moderation supported inclusive participation and productive dialogue across disciplines and perspectives.

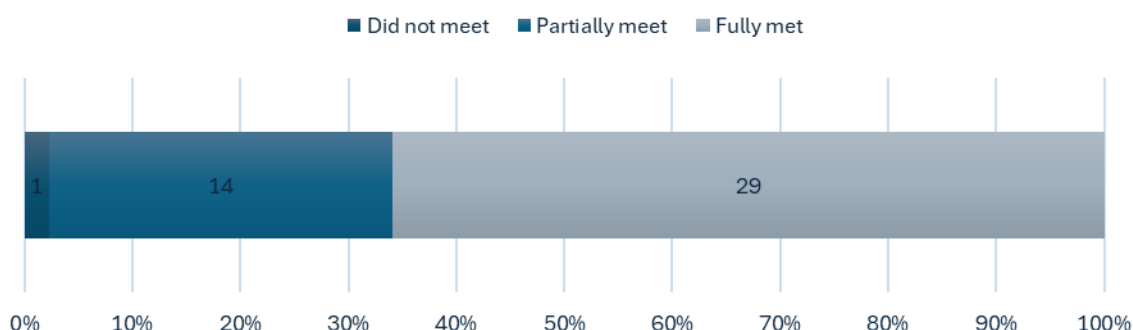
How would you rate the facilitation and workshop?



Achievement of workshop objectives

Participants largely agreed that the workshop fully met its stated objectives, with a smaller number indicating that objectives were partially met, and only a single response suggesting objectives were not met. This result aligns with earlier feedback on research usefulness and discussion balance, reinforcing that the workshop design successfully delivered on its intended outcomes.

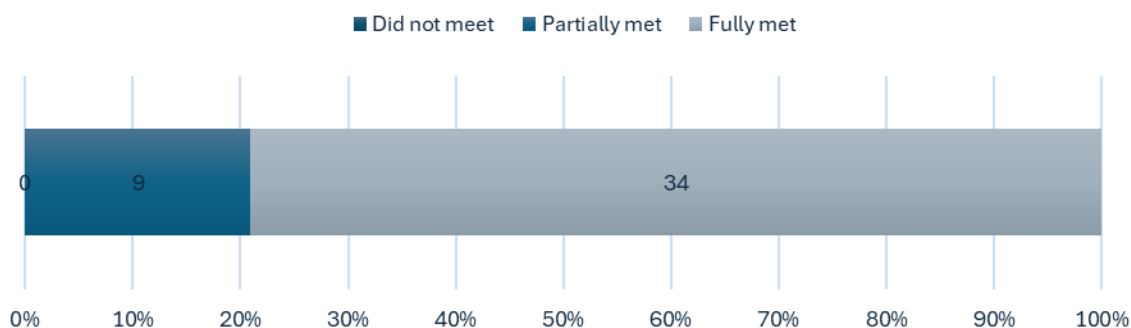
Did the workshop meet the objectives?



Providing a forum for discussion

One of the strongest signals from the survey relates to the workshop's role as a forum for discussion. Most participants indicated that this objective was fully met, with the remainder stating it was partially met. This highlights the importance of the workshop as a convening space for cross-jurisdictional and cross-disciplinary exchange on landscape carbon, an outcome repeatedly emphasized during discussions.

Providing a forum for discussion



Key takeaway

Overall, the survey results demonstrate that the Landscape Carbon Workshop was well received, effective, and impactful. Participants valued both the scientific content and the opportunity to engage with others working on landscape carbon across northern contexts. The strong ratings across all categories suggest that the workshop format provides a solid foundation for continued dialogue, shared learning, and future collaborative work on landscape carbon research, policy, and practice.

Appendix B: Workshop presentations

All presentation slides from the workshop have been combined into a single document and can be downloaded here:

https://www.gov.nt.ca/ecc/sites/ecc/files/resources/lcw_presentations_combined.pdf or here:

<https://gnwt.ca/resources/landscape-carbon-workshop-presentations>

Theme / Presentation Title	Presenter	Recording links
Landscape Carbon 101, An Introduction Intro-session A: Landscape Carbon 101	Andrew Tanentzap, Trent University, and Elyn Humpheys, Carleton University	https://youtu.be/TKcXzM5uh94
Introduction to the NWT Landscape Carbon and Major Threats Permafrost Carbon Feedbacks: What we need to learn about how thawing permafrost creates greenhouse gas emissions that can accelerate global climate change	Scott Dallimore, Polar Knowledge Canada (virtual), and Peter Morse, Geological Survey of Canada	https://youtu.be/xiQdrPvVIHQ
Introduction to the NWT Landscape Carbon and Major Threats Threats to land carbon in NWT – a focus on industry disturbances to peatlands	Lorna Harris, Wildlife Conservation Society	
Introduction to the NWT Landscape Carbon and Major Threats Wildfire – threats to landscape carbon stocks	Jenn Baltzer, Wilfrid Laurier University	https://youtu.be/Jlac6I-oUI0
Wildfires and Feedback Loops Across the Boreal Ecosystem Wildfire in the Boreal: The Role of Peatlands	Sophie Wilkinson, Simon Fraser University	https://youtu.be/9Fn0i2M0vBI
Wildfires and Feedback Loops Across the Boreal Ecosystem Wildfires, Carbon, and Monitoring	Kyle Arndt, Woodwell Climate Research Centre, and Brendan Rogers, Woodwell Climate Research Centre	https://youtu.be/HmkEk3yeK-A

Wildfires and Feedback Loops Across the Boreal Ecosystem Fire refugia in the Northwest Territories: Bottom-up vs. top-down controls	Diana Stralberg, Canadian Forest Service, (virtual)	https://youtu.be/9KgWS1dnW5c
Mapping Carbon in the NWT Ecosystem Carbon in Forests of Canada's National Parks	Chelsea Chisholm, Parks Canada	https://youtu.be/Swsz1Y3xKj8
ROUND ROBIN: The Future of NWT Carbon Stocks Spatio-Temporal Trends of Soil Organic Carbon in the Northwest Territories Under Future Climate Scenarios	Daorui Han, McMaster University,	
ROUND ROBIN: The Future of NWT Carbon Stocks The Future of NWT Carbon Stocks: Winter Carbon Cycling	Fereidoun Rezanezhad, University of Waterloo	
Protecting, Storing and Enhancing Carbon in and Above the Ground Introducing Nature based Solutions	Khizr Tajammul, GNWT	https://youtu.be/uh-XTk6xoBE
Protecting, Storing and Enhancing Carbon in and Above the Ground Protecting carbon and permafrost with boreal fire management	Kayla Mathes & Brendan Rogers, Woodwell Climate Research Centre	https://youtu.be/MKO4VarpfIU
Nature-Based Solutions for the NWT Nature-Based Solutions for the NWT	Jane Hutchinson	https://youtu.be/EvcfCojUQqI
Nature-Based Solutions for the NWT	Steven Nitah, Nature for Justice Robin Barr, First 30x30	https://youtu.be/FyhtolmBx8Y

Harnessing Nature-based Solutions as a Catalyst for Indigenous-Led Conservation		
Nature-Based Solutions: Success Stories Nature Stewardship Credits	Michael Davies	https://youtu.be/PuCwGoESccI
Nature-Based Solutions: Success Stories Indigenous Titan Project: Empowering Indigenous leadership in carbon removals and renewable fuels	AJ Bird, Bird and McCrimmon	https://youtu.be/ijFLY9tgpF0
What did we learn about Landscape Carbon from NASA ABoVE What did we learn about Landscape Carbon from NASA ABoVE	Laura Bourgeau-Chavez	
PANEL DISCUSSION: Quantifying Carbon and Biodiversity for Various Markets Aurora Research Institute's Carbon Emission Project: Methane Detection	Garfield Giff, Aurora Research Institute	
PANEL DISCUSSION: Quantifying Carbon and Biodiversity for Various Markets	<u>Paul Adlakha</u>	
ROUND ROBIN: Introduction to Federal and Voluntary Offset Markets CANADA'S GREENHOUSE GAS OFFSET CREDIT SYSTEM AND PROTOCOLS	Megan Baskerville, Environment and Climate Change Canada	https://youtu.be/-RN_wFHBovM
ROUND ROBIN: Introduction to Federal and Voluntary Offset Markets Indigenous Carbon Credits: Rare, Valuable, and Impactful	AJ Bird, Bird and McCrimmon	https://youtu.be/dglbvAgYxnM

Potential NWT Policy and Governance Needs Policy gaps and solutions for land carbon in NWT - a focus on peatlands	Lorna Harris, Wildlife Conservation Society	
Potential NWT Policy and Governance Needs LAYING THE FOUNDATION Policy and Governance Considerations for A Carbon Management Program	Trevor Fulton, Government of Alaska (virtual)	
Potential NWT Policy and Governance Needs Potential NWT Policy and Governance Needs	Ariadne Gorrington, Pollination Foundation	
Where do we go from here? Arctic and Northern Warming - Climate Change	Lynda Orman and Andrew Applejohn, Polar Knowledge Canada	

Appendix C: Workshop Agenda



Day 1 - February 4, 2025

<u>Time</u>	<u>Agenda Item</u>	<u>Who</u>
8:00-8:45 AM	Breakfast	
8:45-9:10 AM	Welcome and Arrival - Facilitator Introduction, Housekeeping and Land Acknowledgement - Opening Prayer - Government of the NWT Opening Remarks - Polar Knowledge Canada Opening Remarks - Overview of Workshop Objectives	Brie O'Keefe Elder Deputy Minister Robert Jenkins Lynda Orman Brie O'Keefe
9:10-10:00 AM	Landscape Carbon 101, An Introduction	Andrew Tanentzap, Trent University Elyn Humpheys, Carleton University Alison McCreesh, Graphic Recorder
10:00 - 10:15 AM	Introduction to Facilitation Methodology/Interactivity - House Rules - Round-Robin Style Sessions - Survey Questions - Prizes - Breakout Groups - Live-analysis of key findings	Brie O'Keefe
10:15 - 10:30 AM	BREAK	
10:30-11:45 AM	Introduction to the NWT Landscape Carbon and Major Threats	Scott Dallimore, Polar Knowledge Canada (virtual) Peter Morse, Geological Survey of Canada Lorna Harris, Wildlife Conservation Society Jenn Baltzer, Wilfrid Laurier University
11:45-12:15 PM	Breakout Groups: <i>What are the key knowledge gaps that stood out to you in understanding the NWT's carbon dynamics?</i> <i>What are the most significant Industrial and Natural Disturbances we need to be concerned about?</i>	Breakout Group Leads
12:15 - 1:15 PM	LUNCH	

<u>Time</u>	<u>Agenda Item</u>	<u>Who</u>
1:15 - 2:15 PM	Wildfires and Feedback Loops Across the Boreal Ecosystem	Sophie Wilkinson, Simon Fraser University Kyle Arndt/Brendan Rogers, Woodwell Climate Research Centre Diana Stralberg, Canadian Forest Service, (virtual) Marc-Andre Parisien, Canadian Forest Service (virtual)
2:15 - 2:30 PM	BREAK	
2:30 - 2:45 PM	Permafrost Land Systems	Steve Kokelj, NWT Geological Survey Niels Weiss, NWT Geological Survey
2:45 - 3:00 PM	Mapping Carbon in the NWT	Chelsea Chisholm, Parks Canada
3:00 - 3:50 PM	Breakout Groups: - What does the historical trend of wildfires across the NWT tell us about the future of fires? - What information do you want to see about wildfire and carbon emissions going forward? - Compared to other types of emissions, how concerned are you about wildfire emissions in the NWT? - What do you know about traditional prescribed fire activities in your culture/region?	Breakout Group Leads
3:50 - 4:30 PM	ROUND ROBIN: The Future of NWT Carbon Stocks	Daorui Han, McMaster University Fereidoun Rezanezhad, University of Waterloo

Day 2 - February 5, 2025

<u>Time</u>	<u>Agenda Item</u>	<u>Who</u>
8:00-9:00 AM	Breakfast	
9:00-9:15 AM	Recap of Day 1 and Preview of Day 2	Alison McCreesh Brie O'Keefe
9:15 - 10:30 AM	Protecting, Storing and Enhancing Carbon in and Above the Ground	Khizr Tajammul, GNWT Kayla Mathes & Brendan Rogers, Woodwell Climate Research Centre Melanie Bird, University of Waterloo
10:30 - 10:45 AM	BREAK	
10:45 - 12:00 PM	Breakout Groups What Nature-based solutions are most applicable to the NWT landscape?	Breakout Group Leads
12:00 - 1:00 PM	LUNCH	
1:00 - 2:00 PM	Nature-Based Solutions for the NWT	Steven Nitah, Nature for Justice Robin Barr, First 30x30 Ariadne Gorrington, Pollination Foundation
2:00 - 2:15 PM	BREAK	
2:15 - 3:15 PM	Nature-Based Solutions: Success Stories	Trish Nash - Unama'ki Institute of Natural Resources (UINR) Matthew Hillier, Caldwell First Nation (virtual) AJ Bird, Bird & McCrimmon

<u>Time</u>	<u>Agenda Item</u>	<u>Who</u>
3:15 - 4:15 PM	Breakout Groups <i>What is the best way to integrate Indigenous and Traditional Knowledge into Nature-based Solutions designed for the NWT?</i> <i>What success stories did you hear about that you think have potential for the NWT context?</i>	Facilitators: Steven Nitah, Nature for Justice Robin Barr, First 30x30 Ariadne Gorrington, Pollination Foundation

Day 3 - February 6, 2025

<u>Time</u>	<u>Agenda Item</u>	<u>Who</u>
8:00-9:00 AM	Breakfast	
9:00-9:15 AM	Recap of Day 2 and Preview of Day 3	Alison McCreesh Brie O'Keefe
9:15-9:40 AM	What did we learn about Landscape Carbon from Nasa ABoVE?	Laura Chavez, NASA/Michigan Technological University
9:40 - 10:50 AM	PANEL DISCUSSION: Quantifying Carbon and Biodiversity for Various Markets	Masoud Mahdianpari, C-Core Paul Adlakha, C-Core Oliver Sonnentag, University of Montreal Garfield Giff, Aurora Research Institute Melisandre Teng, University of Montreal
10:50 - 11:05 AM	BREAK	
11:05 - 12:00 PM	ROUND ROBIN: Introduction to Federal and Voluntary Offset Markets	Megan Baskerville, Environment and Climate Change Canada AJ Bird, Bird and McCrimmon
12:00 - 1:00 PM	LUNCH	
1:00 - 1:30 PM	Potential NWT Policy and Governance Needs	Lorna Harris, Wildlife Conservation Society Trevor Fulton, Government of Alaska (virtual) Ariadne Gorrington, Pollination Foundation
1:30 - 2:15 PM	Breakout Groups <i>How can NWT prepare for the evolving carbon and biodiversity market? What innovations, policies and legislation can be introduced to ensure lasting carbon sequestration?</i>	Breakout Group Leads
2:15 - 2:30 PM	BREAK	
2:30 - 2:45 PM	Where do we go from here?	Lynda Orman and Andrew Applejohn, Polar Knowledge Canada
2:45 - 3:45 PM	Breakout Group Priorities & Visual Summary	Dan Ritchie, Planit North Alison McCressh, Graphic Recorder
3:45 - 3:50 PM	Closing Prayer	Elder

Appendix D: Landscape Carbon in the NWT – What is it and why does it matter?



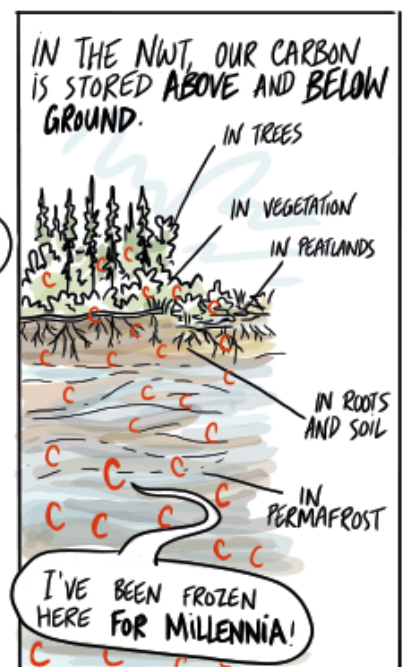
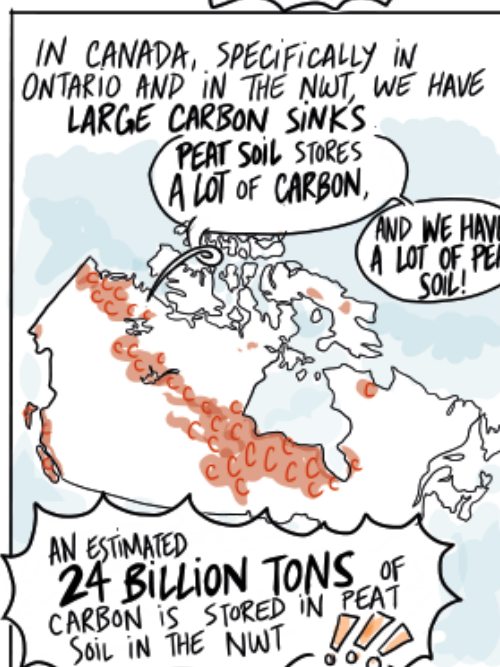
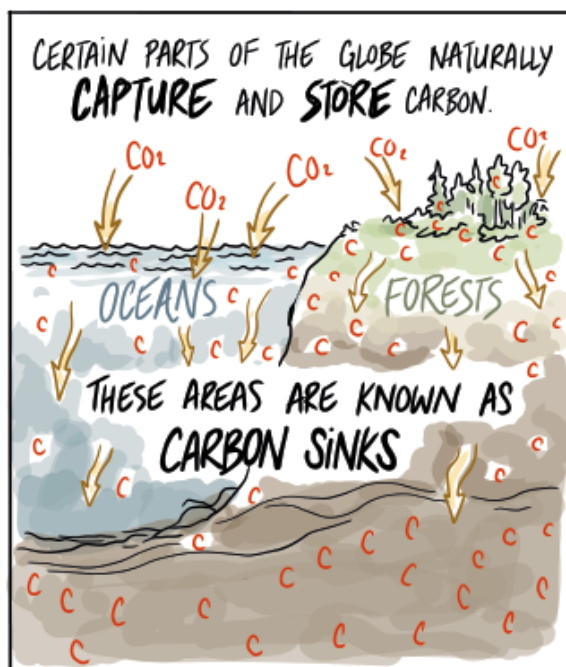
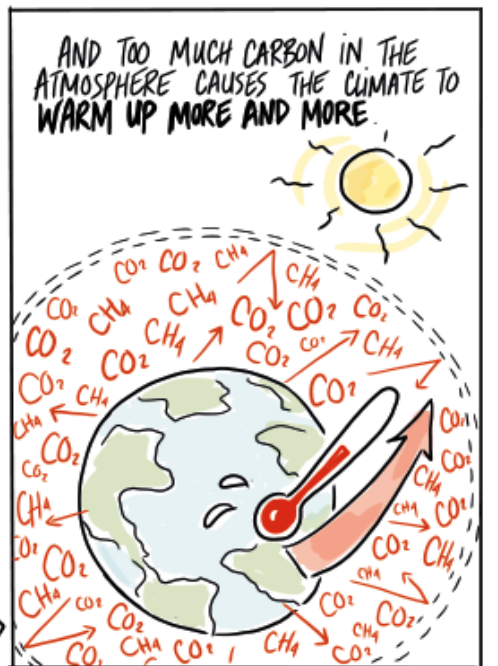
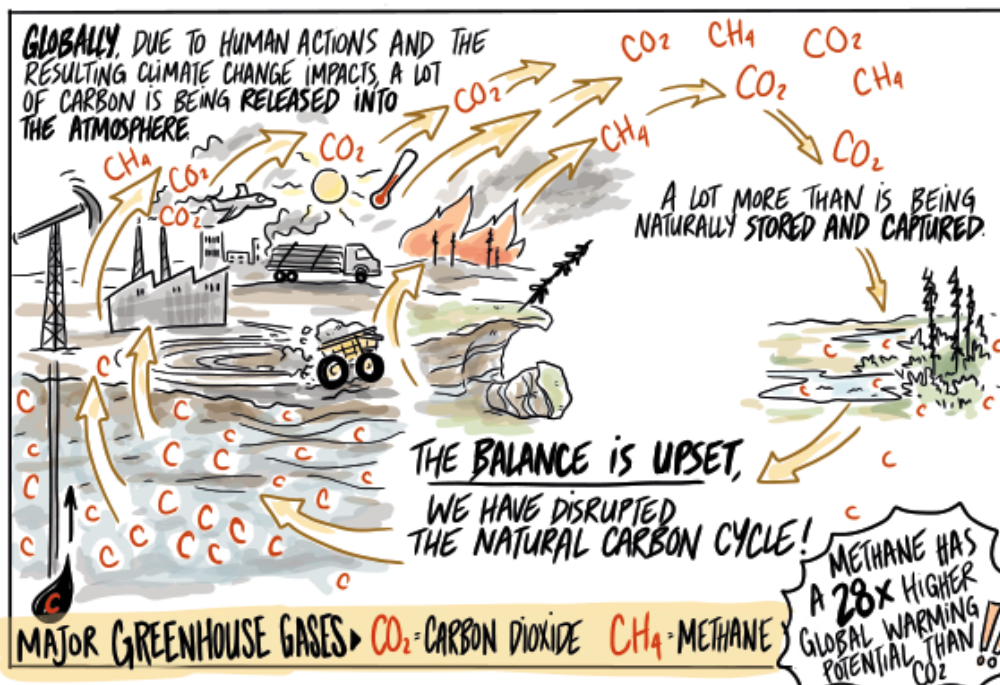
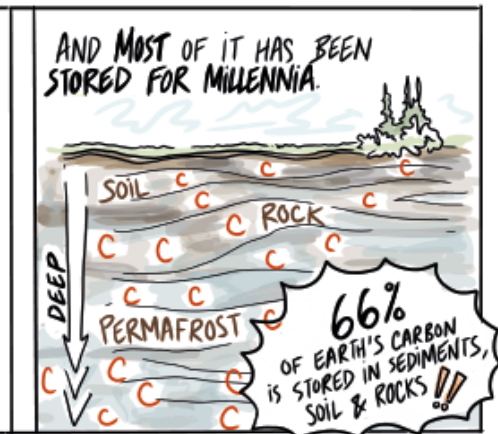
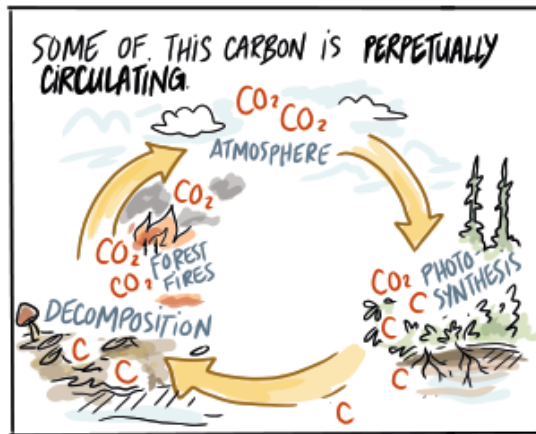
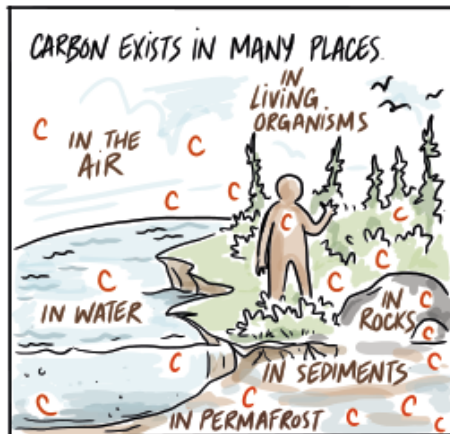
LANDSCAPE CARBON : A SHORT STORY

HOSTED BY
THE GOVERNMENT OF THE NORTHWEST TERRITORIES
IN YELLOWKNIFE, NWT • FEB 4-5-6, 2025

© ALISON MCCREESH 02/2025

LANDSCAPE CARBON IN THE NWT

WHAT IS IT AND WHY DOES IT MATTER?



UNFORTUNATELY, THERE ARE MORE AND MORE **DISTURBANCES** TO THE FRAGILE ECOSYSTEMS WHERE ALL THIS CARBON IS STORED.

INDUSTRIAL

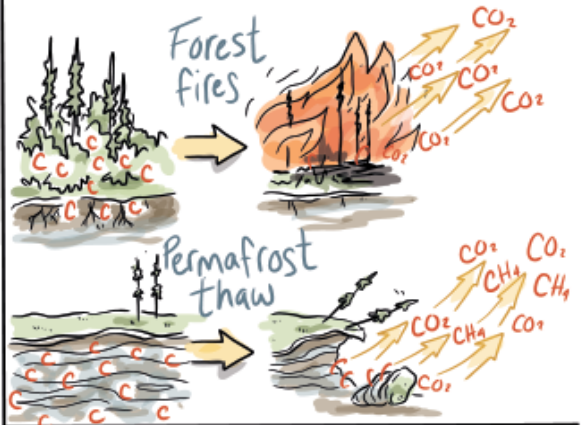


NATURAL

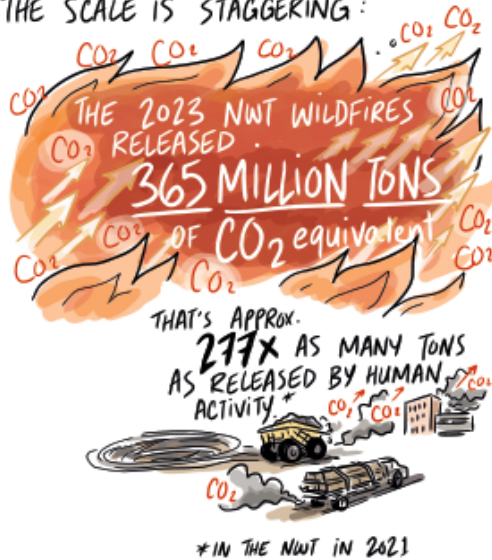
(AMPLIFIED BY CLIMATE CHANGE)



THESE CHANGES TO THE LANDSCAPE CAUSE **A LOT OF CARBON** TO BE RELEASED INTO THE **ATMOSPHERE**.



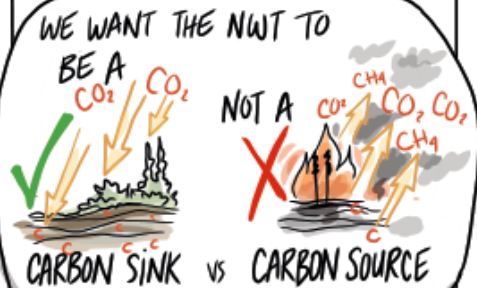
THE SCALE IS STAGGERING:



THIS RELEASE OF CO_2 AND CH_4 CONTRIBUTES TO MORE CLIMATE CHANGE.



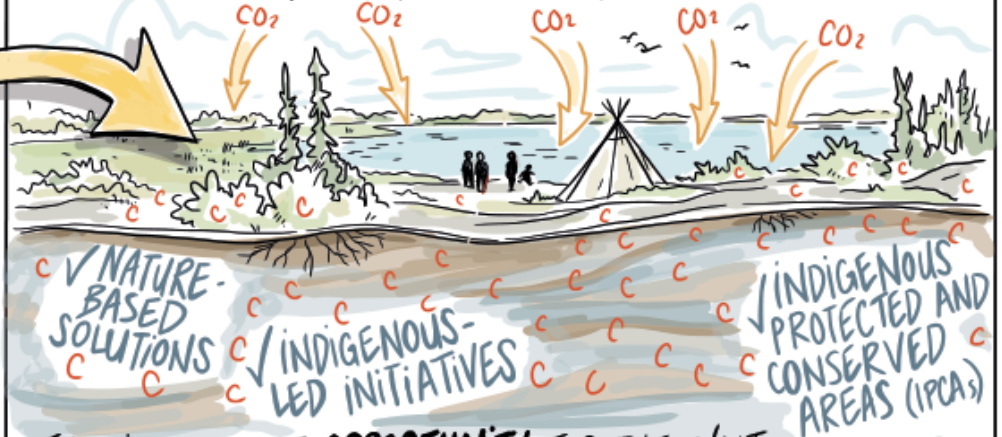
IT IS IMPORTANT TO **TAKE ACTION** AND **BREAK THIS CYCLE**.



WE NEED TO CLEARLY IDENTIFY WHERE THE MOST CARBON IS STORED IN THE NWT...



... THEN WORK TO **PROTECT, MANAGE & RESTORE** THESE AREAS.

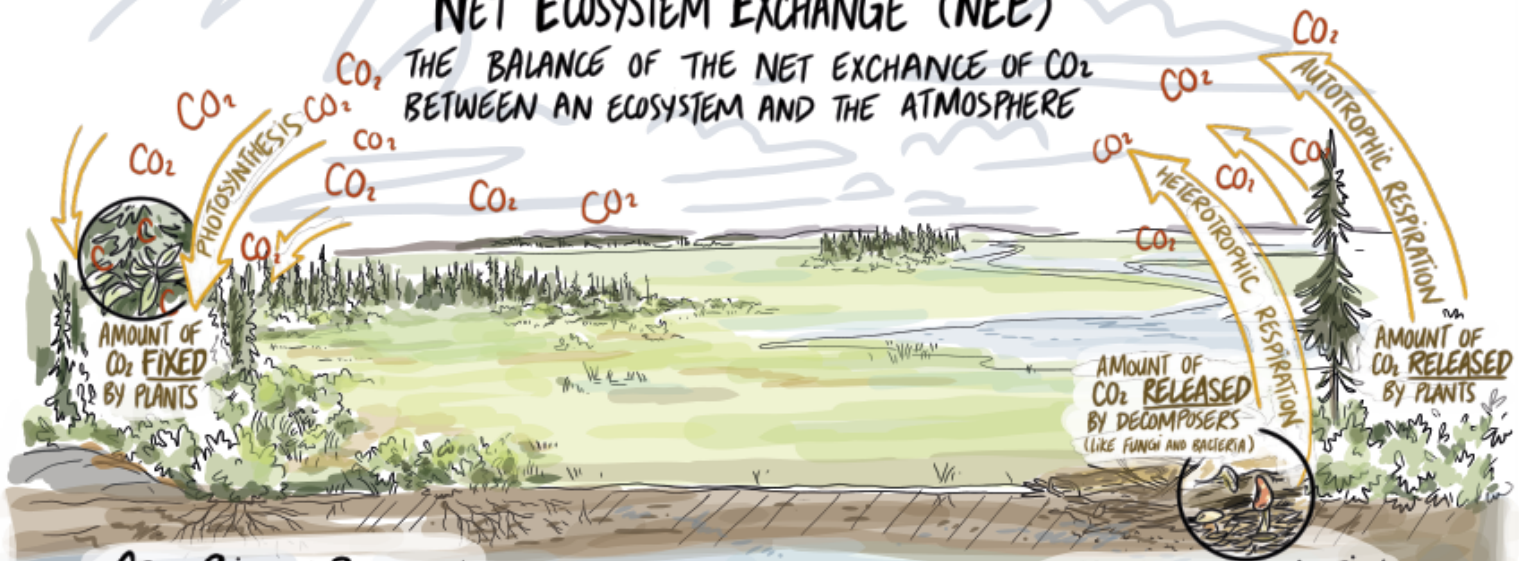


THIS IS A GREAT **OPPORTUNITY** FOR THE NWT...
... AND FOR THE ENTIRE WORLD!

KEY TERMS

NET ECOSYSTEM EXCHANGE (NEE)

THE BALANCE OF THE NET EXCHANGE OF CO₂ BETWEEN AN ECOSYSTEM AND THE ATMOSPHERE



GROSS PRIMARY PRODUCTION (GPP)

ECOSYSTEM RESPIRATION (RECO)

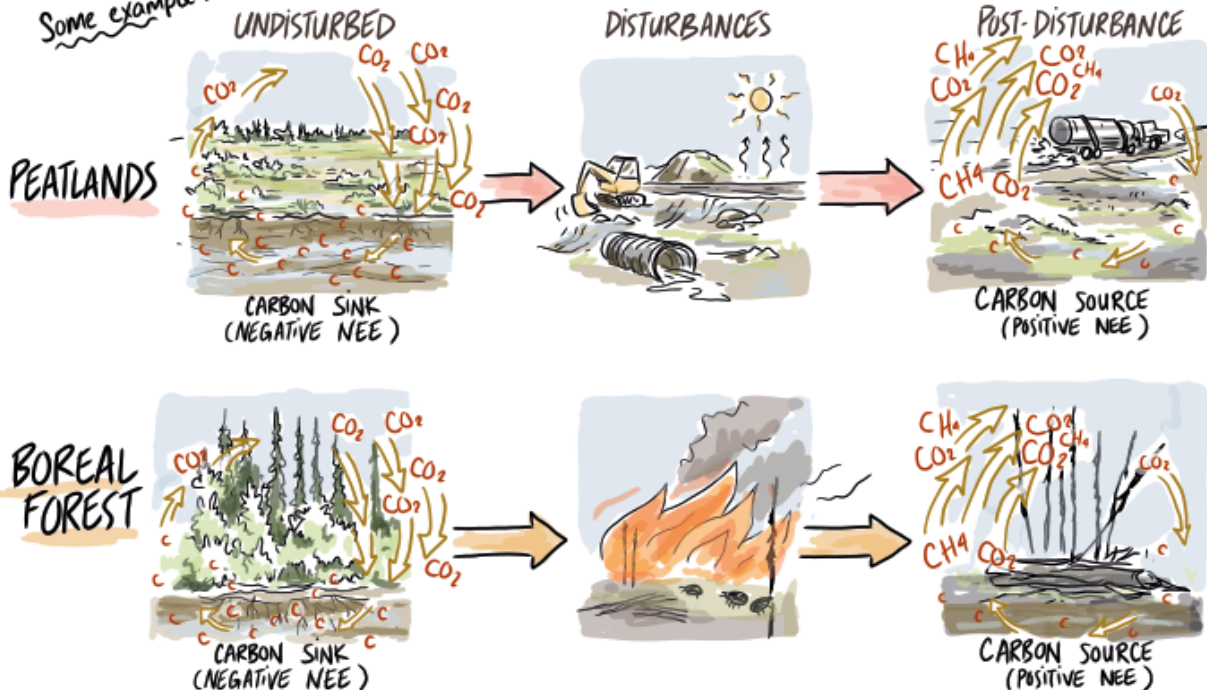
WE CAN USE THIS FORMULA TO DETERMINE IF AN ECOSYSTEM IS A CARBON SINK OR A CARBON SOURCE.

$$\text{GROSS PRIMARY PRODUCTION (GPP)} - \text{ECOSYSTEM RESPIRATION (RECO)} = + \text{ (POSITIVE)} \Rightarrow \text{CARBON SOURCE}$$

$$\text{GROSS PRIMARY PRODUCTION (GPP)} - \text{ECOSYSTEM RESPIRATION (RECO)} = - \text{ (NEGATIVE)} \Rightarrow \text{CARBON SINK}$$



Some examples



MONITORING NEE HELPS ASSESS WHETHER AN ECOSYSTEM IS :

- MITIGATING CLIMATE CHANGE.
- CONTRIBUTING TO CLIMATE CHANGE

THIS CAN INFORM LAND-USE AND CONSERVATION STRATEGIES!

EDDY COVARIANCE (OR EDDY FLUX)

A METHOD OF MEASURING THE EXCHANGE OF GASES AND ENERGY BETWEEN THE EARTH'S SURFACE AND THE ATMOSPHERE AT A SMALL SCALE

FLUX TOWER

EDDIES

SWIRLING
MOTIONS
OF AIR

CARRY:
✓ MOISTURE
✓ HEAT
✓ GASES

TRAVEL
VERTICALLY

MEASURE



HOW FAST IS
THE AIR MOVING
UP OR DOWN?

CO_2
 H_2O
 CH_4

WHAT IS THE
CONCENTRATION
OF GASES?

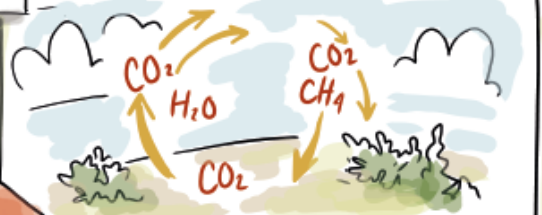


COLLECT
THIS DATA
OVER TIME

HOW DOES $\updownarrow$ CORRELATE WITH CO_2 CH_4 H_2O



CALCULATE
THE FLUX



OBSERVE
THE RATE OF EXCHANGE
OF THE GAS BETWEEN THE
SURFACE & THE ATMOSPHERE.

How is
EDDY COVARIANCE
USEFUL IN
THE NWT?

IT ALLOWS US
TO MONITOR HOW OUR
CARBON RICH ECOSYSTEMS
ARE RESPONDING TO
ENVIRONMENTAL CHANGES
(LIKE DISTURBANCES &
CLIMATE CHANGE)



AND IT HELPS US
TANGIBLY MEASURE*
THE IMPACTS OF OUR
CARBON REDUCING/CAPTURING
INITIATIVES.



* THIS TYPE OF CARBON ACCOUNTING IS
IMPORTANT FOR CARBON MARKETS!



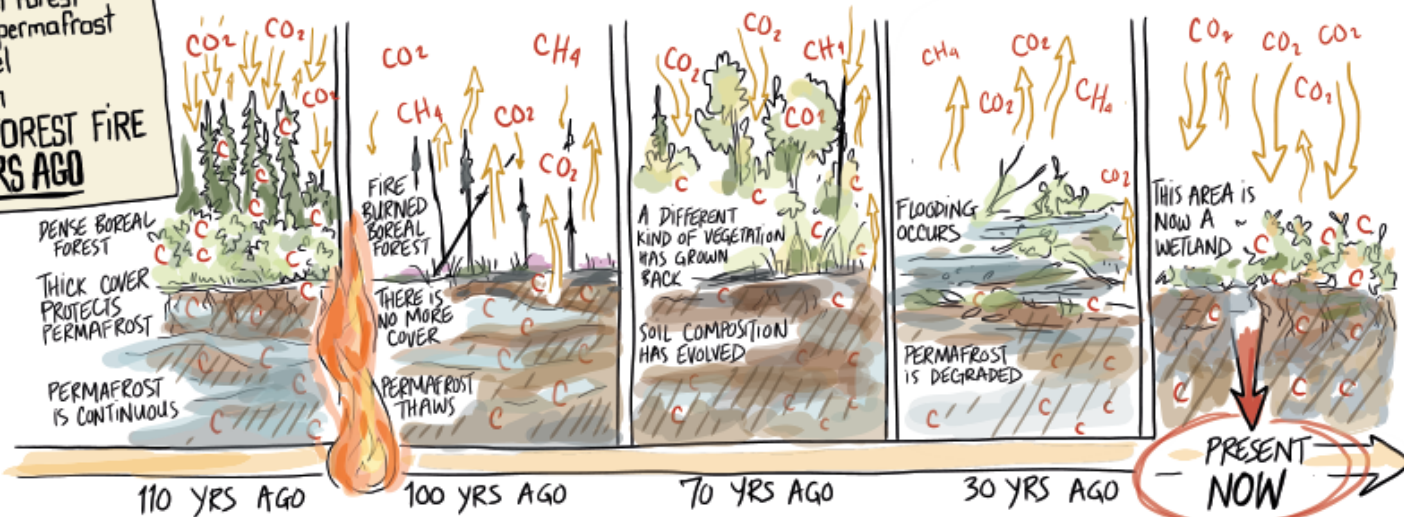
CHRONOSEQUENCING

A METHOD USED TO STUDY HOW ECOSYSTEMS OR SOILS CHANGE OVER TIME BY LOOKING AT SITES THAT ARE SIMILAR IN MOST WAYS BUT DIFFER IN HOW LONG THEY HAVE BEEN DEVELOPING.

An Example:

LOCATION A

- Dense boreal forest
- Continuous permafrost
- 64th parallel
- Flat terrain
- **LARGE FOREST FIRE 110 YEARS AGO**

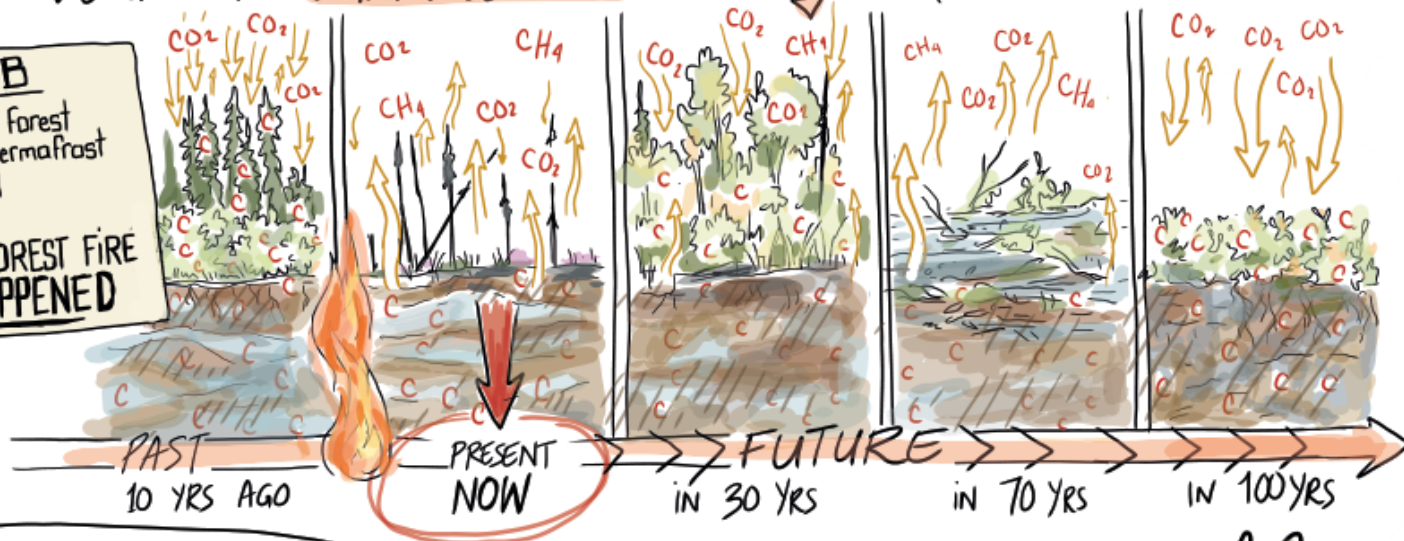


BY OBSERVING WHAT HAPPENED HERE, (In the Past)

WE CAN INFER WHAT WILL HAPPEN HERE. (In the Future)

LOCATION B

- Dense boreal forest
- Continuous permafrost
- 64th parallel
- Flat terrain
- **LARGE FOREST FIRE JUST HAPPENED**



BY STUDYING A CERTAIN LOCATION, SCIENTISTS CAN DETERMINE HOW, FOLLOWING A DISTURBANCE LIKE A WILDFIRE:

- ✓ PLANTS RECOLONIZE THE LAND
- ✓ SOIL DEVELOPS
- ✓ CARBON STORAGE CHANGES OVER TIME.

THIS KNOWLEDGE CAN HELP PREDICT FUTURE IMPACTS OF CLIMATE CHANGE AND INFORM LAND-USE DECISIONS.



PERMAFROST IN THE NWT

PERMAFROST IS GROUND THAT HAS BEEN FROZEN FOR AT LEAST 2 CONSECUTIVE YEARS.

IT CAN OCCUR IN ANY KIND OF TERRAIN OR GROUND,

BEDROCK PEATLANDS MINERAL SEDIMENT etc.

AND IT LOOKS DIFFERENT IN DIFFERENT PLACES!

WE REFER TO SOME AREAS AS ICE-RICH. THIS IS WHEN THERE IS A LOT OF GROUND ICE

PERMAFROST
90-100%
50-90%
10-50%
0-10%

IN THE NWT,
WE HAVE
A LOT OF
PERMAFROST.

IT IS THE
FOUNDATION
OF
OUR LANDSCAPE.

NATURAL DISTURBANCE,
CLIMATE CHANGE &
HUMAN ACTIVITIES ARE
ALL IMPACTING PERMAFROST.

WHEN GROUND ICE THAWS,
IT CAN CAUSE THE GROUND
TO MOVE AND BECOME
UNSTABLE.

THE LANDFORMS CREATED
BY THAWING ICE-RICH
PERMAFROST ARE CALLED
THERMOKARST.

THERMOKARST
LAKES AND PONDS

HUMMOCKY
OR UNEVEN
TERRAIN

SLUMPS AND
LANDSLIDES

DEPRESSIONS
OR SINKHOLES

THERMOKARST POSES RISKS TO
COMMUNITIES, LAND USERS,
ECOSYSTEMS AND INFRASTRUCTURE,

AND CONTRIBUTES
TO THE RELEASE OF
STORED CARBON.*

*NOTE: CARBON IS ALSO
RELEASED BY PERMAFROST
THAW IN TERRAIN WITH
NO THERMOKARST

NATURE FINANCE MARKETS

AN EXAMPLE OF HOW THIS COULD WORK FOR THE NWT.



CARBON EMITTER

THERE ARE REGULATIONS AS TO HOW MUCH **GHG**s COMPANIES OR GOVERNMENTS CAN RELEASE INTO THE ATMOSPHERE.

→ CARBON CREDIT →

IF THEY CAN'T AVOID EXCEEDING THIS AMOUNT, THEY CAN **OFFSET** BY **PURCHASING CARBON CREDITS**.

(ORGANIZATIONS AND INDIVIDUALS WHO WANT TO REDUCE THEIR FOOTPRINT CAN DO THIS TOO.)

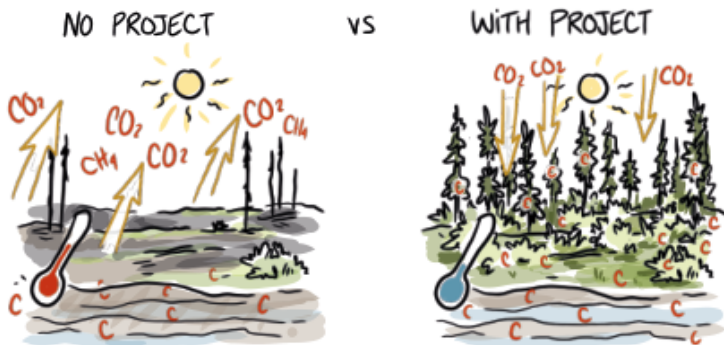
CARBON AVOIDANCE OR SEQUESTRATION

THIS MONEY IS THEN INVESTED IN INITIATIVES THAT WILL:

- ✓ **REDUCE GHG EMISSIONS** ELSEWHERE AND / OR
- ✓ **REMOVE CARBON** FROM THE ATMOSPHERE

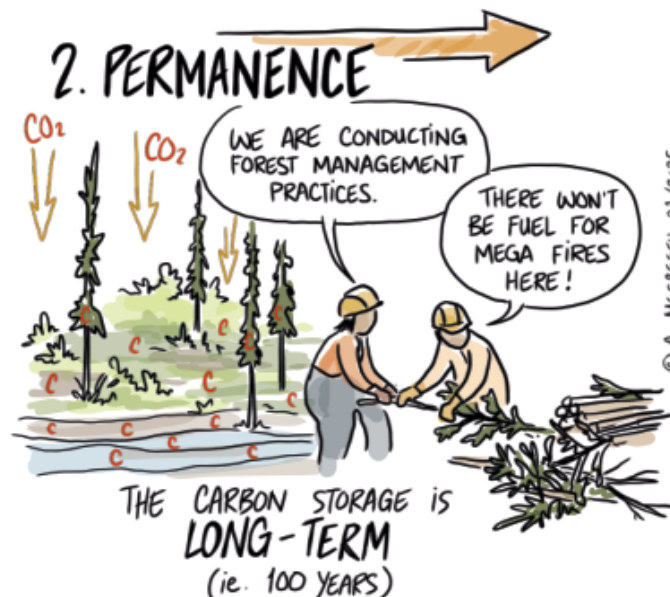
FOR CARBON CREDITS TO BE CREDIBLE, THEY MUST DEMONSTRATE:

1. ADDITIONALITY +

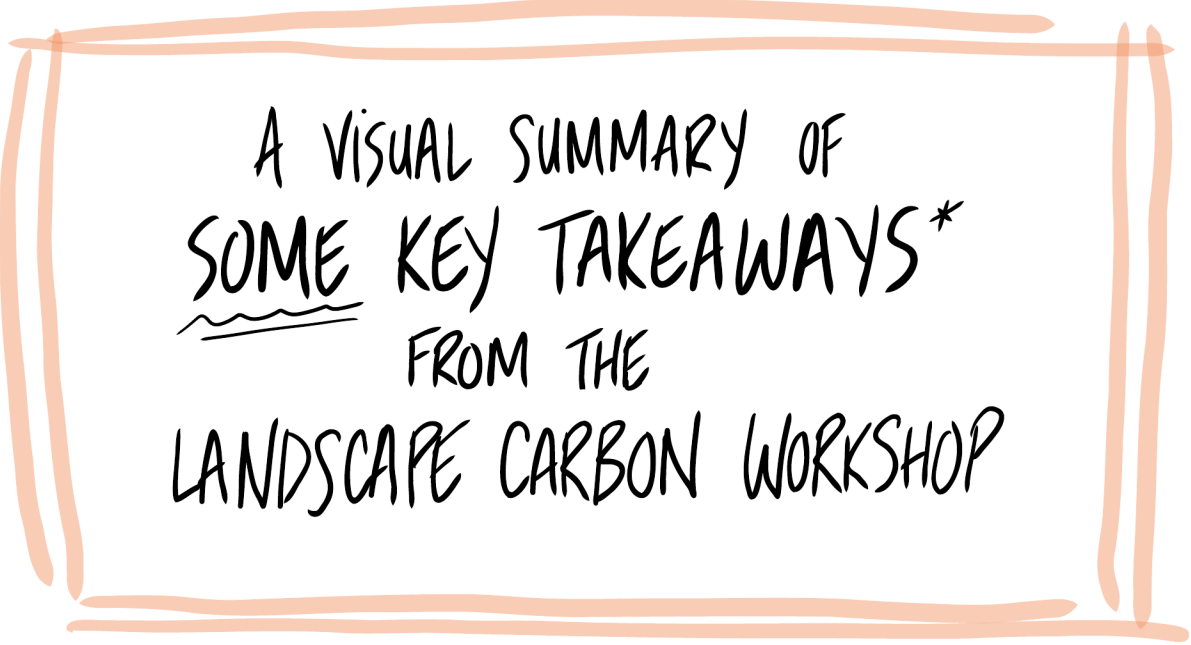


THE CARBON REDUCTIONS OR REMOVALS **WOULDN'T HAVE HAPPENED** WITHOUT THE PROJECT.

2. PERMANENCE →



Appendix E: A visual summary of key takeaways from the Landscape Carbon Workshop



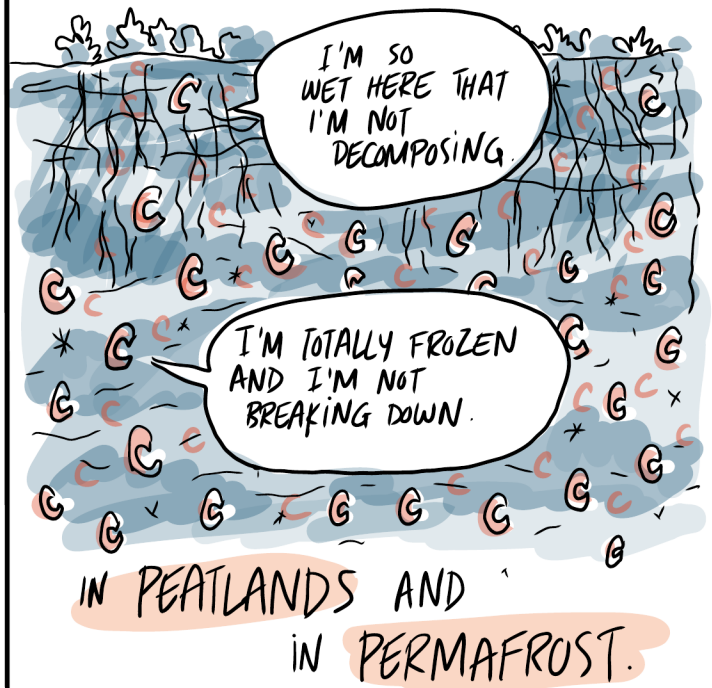
A VISUAL SUMMARY OF
SOME KEY TAKEAWAYS*
FROM THE
LANDSCAPE CARBON WORKSHOP

HOSTED BY
THE GOVERNMENT OF THE NORTHWEST TERRITORIES
IN YELLOWKNIFE, NWT • FEB 4-5-6, 2025

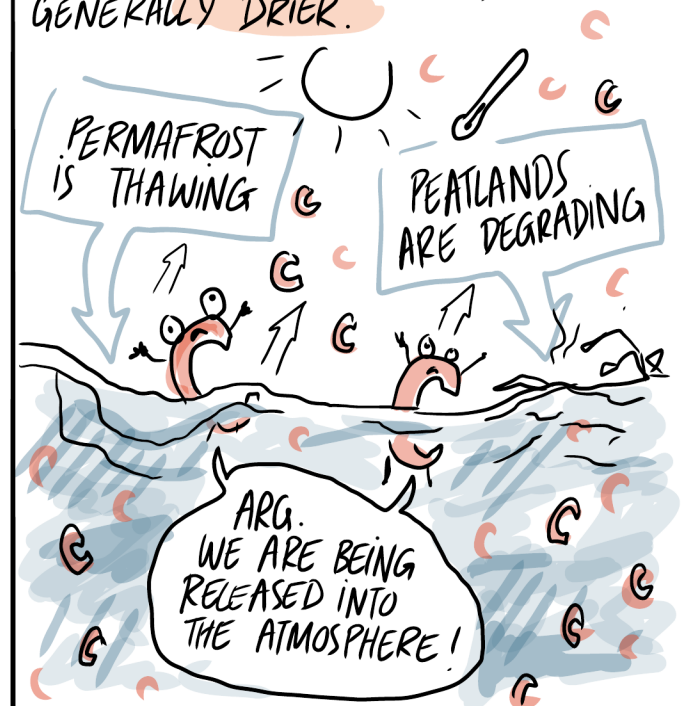
© ALISON MCCREESH 02/2025

DAY 1 - SOME KEY TAKEAWAYS

THERE ARE TREMENDOUS AMOUNTS OF CARBON STORED BELOW GROUND IN THE NWT.



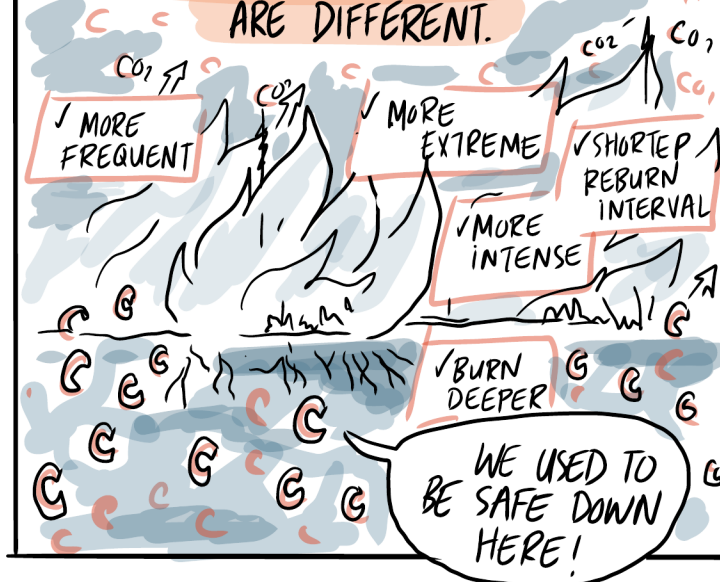
DUE TO CLIMATE CHANGE, THE NORTH IS BECOMING HOTTER (WITH TEMPERATURES RISING UP TO 4X FASTER UP HERE), AND GENERALLY DRIER.



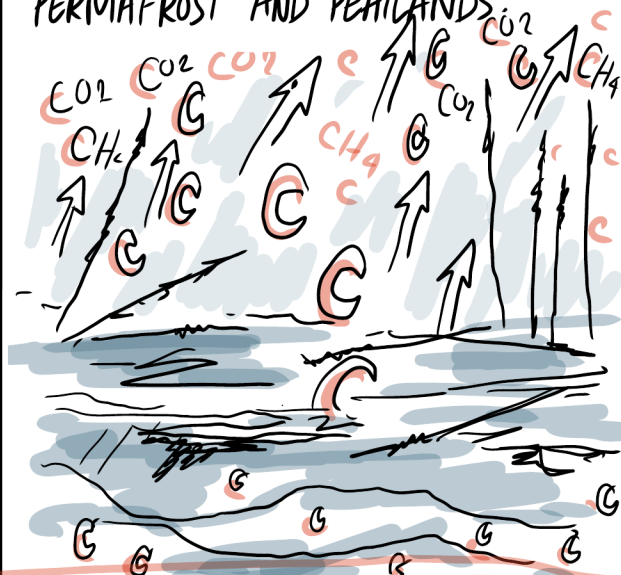
THE INCREASED TEMPERATURES AND DROUGHT MEAN NEW TRENDS IN WILDFIRES.

WILDFIRES HAVE ALWAYS BEEN NATURAL AND IMPORTANT TO THE BOREAL FOREST, BUT

THE FIRES WE SEE NOW ARE DIFFERENT.

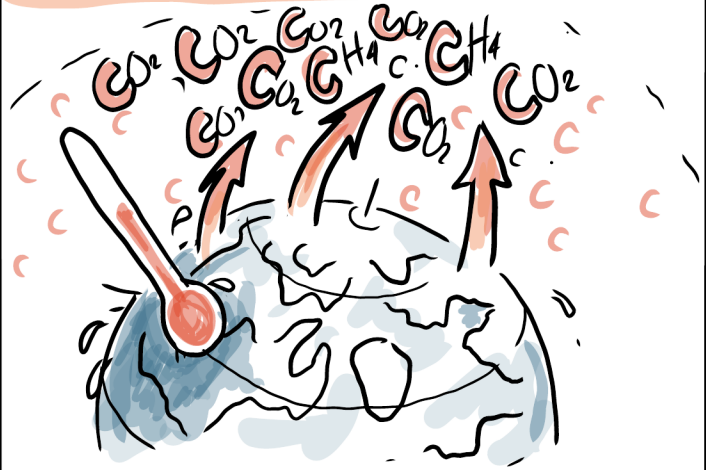


THIS NEW FIRE BEHAVIOUR MEANS MORE CARBON RELEASED, FROM VEGETATION BURNING, BUT ESPECIALLY FROM THE DAMAGE CAUSED TO PERMAFROST AND PEATLANDS.



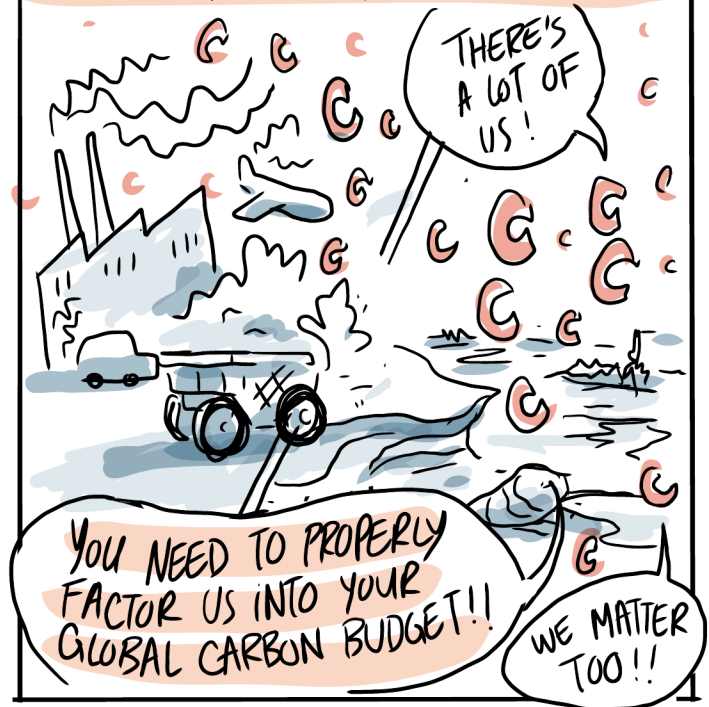
THESE WILDFIRES ARE CAUSING THE NWT TO BECOME A CARBON SOURCE RATHER THAN A CARBON SINK!

ACCORDING TO PROJECTIONS, DUE TO THE TEMPERATURE INCREASE THAT HAS ALREADY OCCURRED (NOT TO MENTION THE INCREASES TO COME IF WE DON'T GLOBALLY REDUCE GHG EMISSIONS), MORE AND MORE CARBON WILL CONTINUE TO BE RELEASED FROM OUR LANDSCAPE.

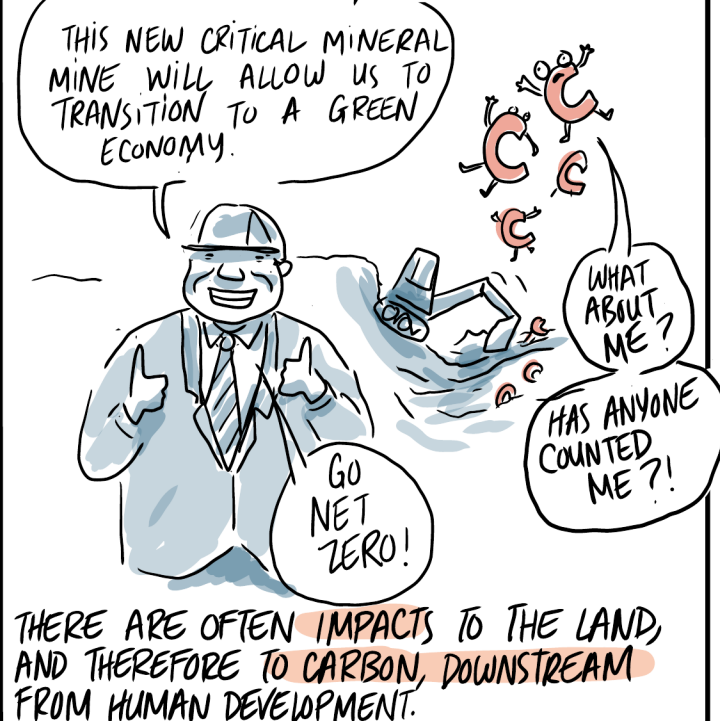


! AND MORE CARBON RELEASE ⇒ MORE GLOBAL WARMING ⇒ MORE CARBON RELEASE ⇒ MORE GLOBAL WARMING ⇒ MORE CARBON RELEASE

THE RELEASE OF GHGS INTO THE ATMOSPHERE IS A GLOBAL ISSUE, BUT UNLIKE EMISSIONS FROM HUMAN ACTIONS, LANDSCAPE CARBON ISN'T WELL ACCOUNTED FOR.



THIS ISSUE OF INCOMPLETE ACCOUNTING FOR LANDSCAPE CARBON EMISSIONS HAPPENS AT MANY LEVELS.



IT IS IMPORTANT THAT BELOW-SURFACE CARBON (WHICH IS WHERE MOST CARBON IS!) NOT BE OVERLOOKED.



WHEN IT COMES TO REDUCING THE RELEASE OF LANDSCAPE CARBON IN THE NWT, THERE IS NO 'ONE SIZE FITS ALL' SOLUTION.

AFTER ALL, THIS IS A VAST AND DIVERSE TERRITORY.

THERE ARE A LOT OF DIFFERENT ECOSYSTEMS

THERE A LOT OF DIFFERENT TYPES OF PERMAFROST

THERE ARE A LOT OF DIFFERENT TYPES OF PEATLANDS.

DIFFERENT PLACES REACT DIFFERENTLY TO DISTURBANCES

AT THE MOLECULAR LEVEL TOO, WHEN IT COMES TO UNDERSTANDING CARBON, THERE IS ALSO A LOT OF NUANCE.

I AM COMPLEX AND UNIQUE!

WE TAKE ON MANY DIFFERENT FORMS

I AM BREAKING DOWN!

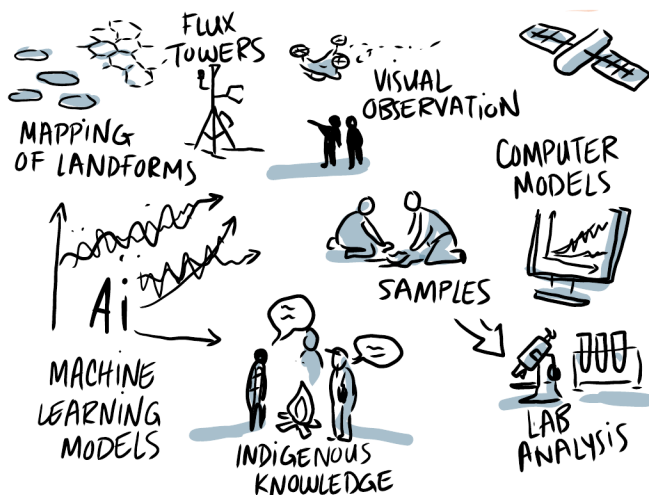
I AM BREAKING DOWN MORE SLOWLY

IT'S NOT JUST ABOUT CARBON QUANTITY,

IT'S ALSO ABOUT CARBON QUALITY

I AM STABLE.

FOR A BROAD UNDERSTANDING, WE WILL NEED TO COMBINE A LOT OF DIFFERENT APPROACHES. (ACROSS ECOSYSTEMS AND ACROSS FIELDS OF EXPERTISE!)



WHEN IT COMES TO UNDERSTANDING AND MANAGING THIS LAND, THERE IS A LOT TO LEARN FROM INDIGENOUS TRADITIONAL KNOWLEDGE.

EXAMPLE:

DANNY BEAULIEU ON PRESCRIBED BURNING.

TRAPPERS, INDIGENOUS PEOPLE, WE ALWAYS BURNED THE GRASS AROUND OUR CABINS.

WE DID THIS IN THE SPRING, WHEN THE LAND WAS WET.

THE GRASS GREW BACK GREEN.

IT ATTRACTED BUFFALO.

THEN THE GOVERNMENT MADE US STOP DOING THIS.

AS OF THE 1980S
IN THE NWT, WE PUT
OUT ALL FIRES WITHIN
A 20KM RADIUS OF
COMMUNITIES.

THIS WAS THE
WRONG THING TO
DO.

WITHOUT SMALL
FIRES, FUEL BUILDS
UP.

UNTIL THE 1950S,
FIRES JUST BURNED.

AFTER A FIRE,
NEW VEGETATION
COMES IN.

THERE IS LESS
UNDERBRUSH.

WE NEED SMALL
FIRES. DON'T
HATE THEM.

THIS IS GOOD
FOR THE ANIMALS,
AND THEREFORE FOR
US TOO.

IN ALASKA, THERE ARE ATTEMPTS
TO SUPPRESS WILDFIRES SPECIFICALLY IN
AREAS WHERE THERE IS CARBON-RICH
PERMAFROST, WHILE LETTING THEM BURN ELSEWHERE.

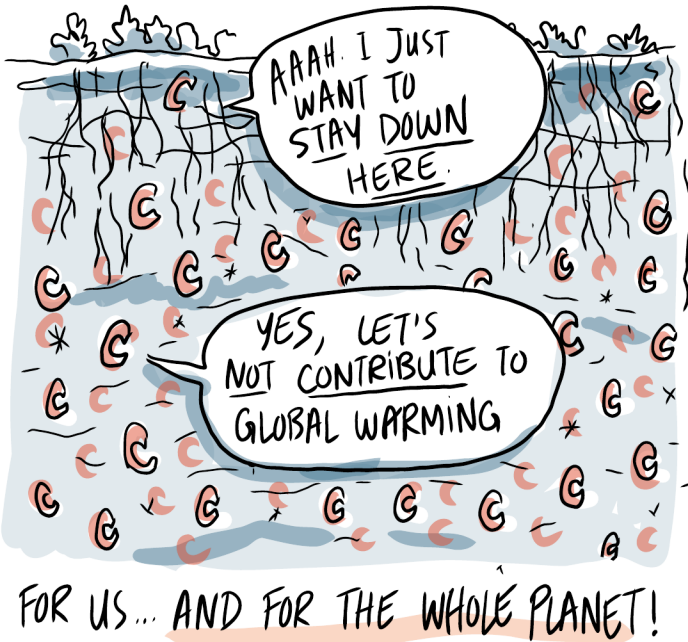
IN AUSTRALIA, THERE ARE INDIGENOUS-
LED 'COLD BURNS' WHICH RELEASE MUCH
LESS CARBON THAN UNCONTROLLED 'HOT
BURNS'.

WE CAN LEARN FROM
SUCCESSSES ELSEWHERE
AND

BRING TOGETHER
WESTERN SCIENCE +
TRADITIONAL KNOWLEDGE
TO HELP GUIDE US
FORWARD.

DAY 2 - SOME KEY TAKEAWAYS

WE WANT TO KEEP CARBON STORES AS UNDISTURBED AS POSSIBLE.
(AND HELP RESTORE THOSE THAT HAVE BEEN)



NATURE-BASED SOLUTIONS PROVIDE WAYS TO PROTECT, MANAGE, RESTORE CARBON-RICH ECOSYSTEMS.



NATURE-BASED SOLUTIONS CAN HAVE A LOT OF CO-BENEFITS.

FOR EXAMPLE: COMMUNITY BIOCHAR MACHINE, FED FROM LOCALLY HARVESTED DEAD WOOD.

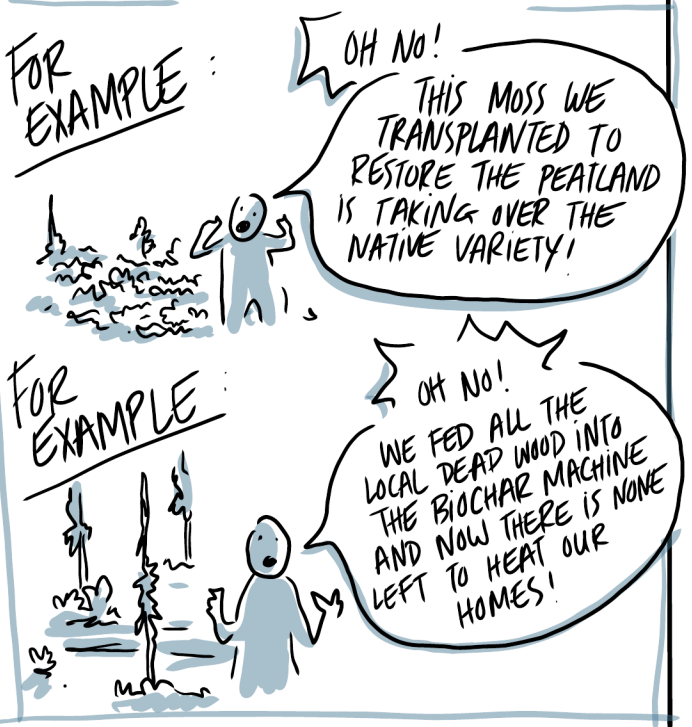
CARBON BENEFITS

1. LESS FUEL IN THE FOREST REDUCES RISKS OF MEGA WILDFIRES.
2. LESS ORGANIC MATTER DECOMPOSING AND RELEASING CO₂.

COMMUNITY BENEFITS

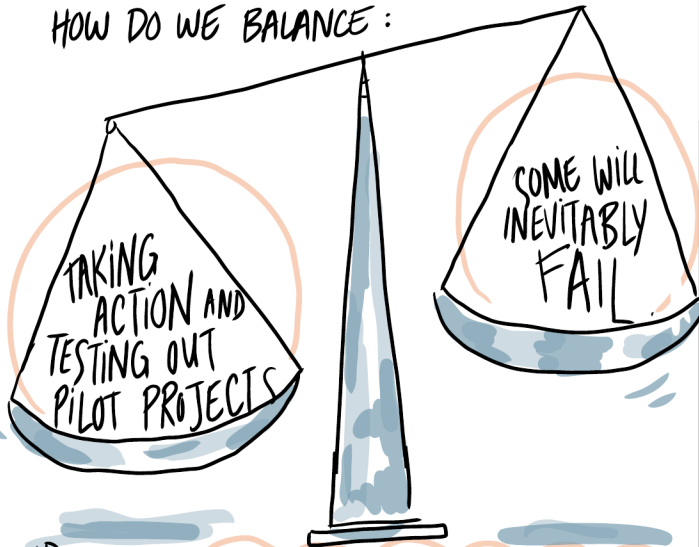
- ✓ EMPLOYMENT HARVESTING DEAD WOOD
- ✓ LESS RISKS OF LARGE FIRES NEAR THE COMMUNITY.
- ✓ BIOCHAR PELLETS FOR WATER PURIFICATION
- ✓ RESIDUAL HEAT FROM MACHINE TO HEAT GREENHOUSE

NATURE-BASED SOLUTIONS CAN ALSO HAVE UNINTENDED CONSEQUENCES.



TAKING ACTION COMES WITH UNCERTAINTY.
RESEARCH CAN HELP, BUT IT ALSO TAKES
TIME... AND THERE IS A SENSE OF
URGENCY

HOW DO WE BALANCE:



AND
WHAT IS OUR LEVEL OF COMFORT WITH UNCERTAINTY?

HERE ARE SOME
QUESTIONS TO ASK ABOUT OUR IDEAS FOR
NATURE-BASED SOLUTIONS:

- ? IF WE ACCOUNT FOR ALL THE FACETS OF THIS PROJECT, IS IT ACTUALLY CARBON NEGATIVE.?
- ? IS IT SUSTAINABLE OVER TIME?
- ? IS THIS PROJECT FEASIBLE IN OUR NWT CONTEXT?
- ? THIS IS A NATURE-BASED SOLUTION, WHAT ARE WE LOOKING FOR A SOLUTION TO?
- ? WHAT ARE THE CUMULATIVE IMPACTS OF THIS SOLUTION?

TO MOVE FORWARD,
THESE PROJECTS REQUIRE INVESTMENT.
THERE ARE SEVERAL OPTIONS LOCALLY,
NATIONALLY AND INTERNATIONALLY.

\$ INTERNATIONAL
CARBON MARKETS/
OFFSETS

\$ BIODIVERSITY
CREDITS

\$ GOVERNMENT

\$ PHILANTHROPY

\$ NEW EMERGING
MARKETS

\$ PRIVATE
BUSINESS



THERE ARE CHALLENGES
THOUGH TO FINDING FUNDING
THAT IS A GOOD FIT.

Will we
BE ABLE TO
MEET THE
REQUIREMENTS?

IS THE STRUCTURE
TOO RIGID?

DOES IT
ALIGN WITH
OUR VALUES?

IS IT
LONG-
TERM?

IS IT
VULNERABLE
TO POLITICAL
CYCLES?

IS IT
PROVEN
TO WORK?



IN THE NWT, NOT ALL FUNDING IS SUITED TO OUR SITUATION.

OUR MAIN GOALS ARE :

1. FOREST MANAGEMENT :

ACTIONS TO REDUCE OUR RISKS OF MEGA WILDFIRES

EX: PRESCRIBED BURNS, TARGETED FIRE SUPPRESSION

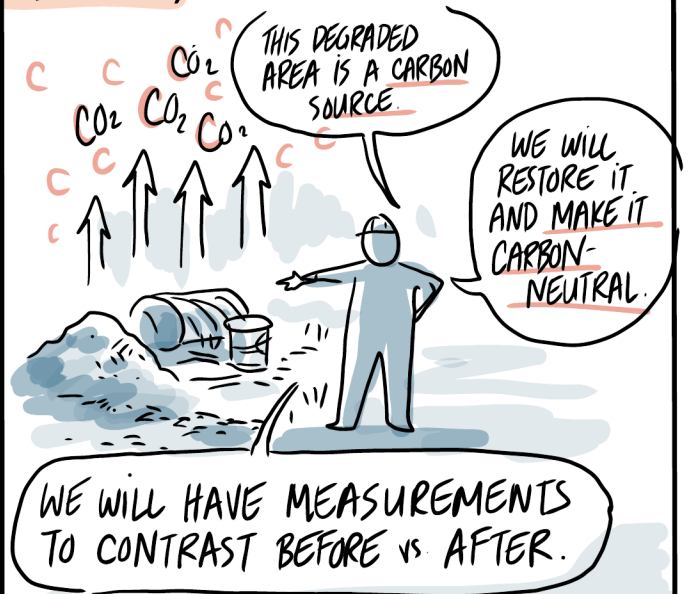
2. CONSERVATION

ACTIONS TO PROTECT AREAS THAT ARE CARBON-RICH LIKE PEATLANDS AND PERMAFROST.

EX: INDIGENOUS PROTECTED AND CONSERVED AREAS, LEGISLATION

WE WANT TO KEEP OUR CARBON IN THE GROUND!

CARBON MARKETS ARE DATA-DRIVEN AND ARE MORE SUITED TO RESTORATION PROJECTS WHERE IT IS EASIER TO DETERMINE A BASELINE AND TO DEMONSTRATE ADDITIONALITY.

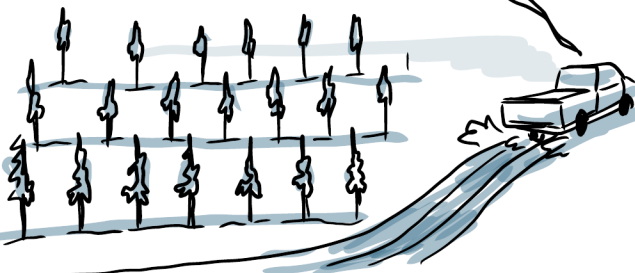


THERE ARE ALSO CONCERNS ABOUT CARBON MARKETS. A FEELING THAT THEY MAY HAVE A HISTORY OF SUPPORTING PROJECTS THAT ARE EXPLOITATIVE OR COLONIAL IN NATURE.

LOOK, WE CAME AND PLANTED THIS MONO-CULTURE FOR YOU.

HOPE YOU LIKE IT!

CIAO!



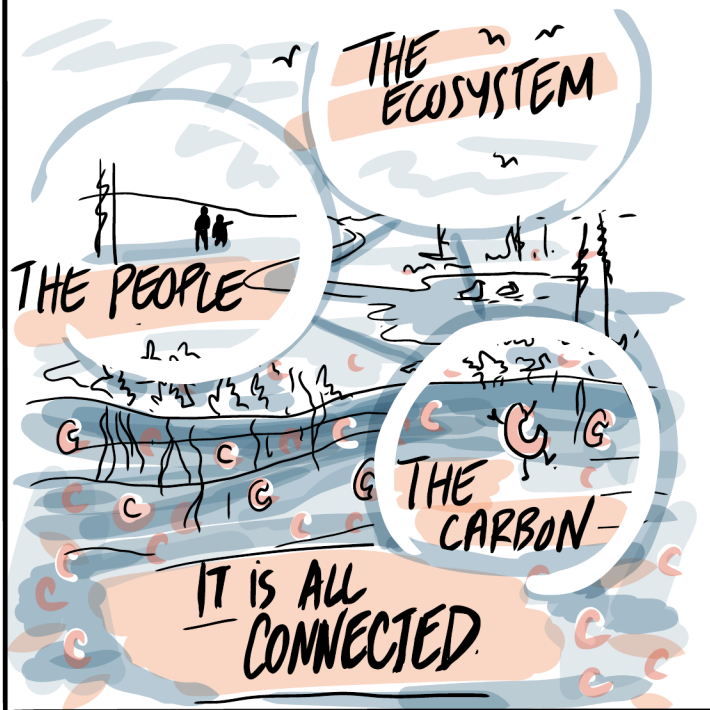
(THESE MARKETS ALSO FEEL INTANGIBLE AND SPECULATIVE - NOT ALIGNED WITH LOCAL VALUES)

THE MAJORITY OF BIODIVERSITY AND CARBON STORES ARE ON LAND STEWARDED BY INDIGENOUS PEOPLE...



THE PEOPLE, AND THEIR PRACTICES, HAVE ALWAYS BEEN PART OF THE ECOSYSTEMS.

WE NEED TO FAVOUR THIS HOLISTIC
APPROACH: FINDING SOLUTIONS THAT
DO NOT VIEW CARBON IN A SILO.



MOVING FORWARD, THERE SHOULD BE
A FOCUS ON PROJECTS THAT ARE

INDIGENOUS-LED,

SOLUTIONS THAT REDUCE CARBON
EMISSIONS AND THAT BENEFIT

COMMUNITIES



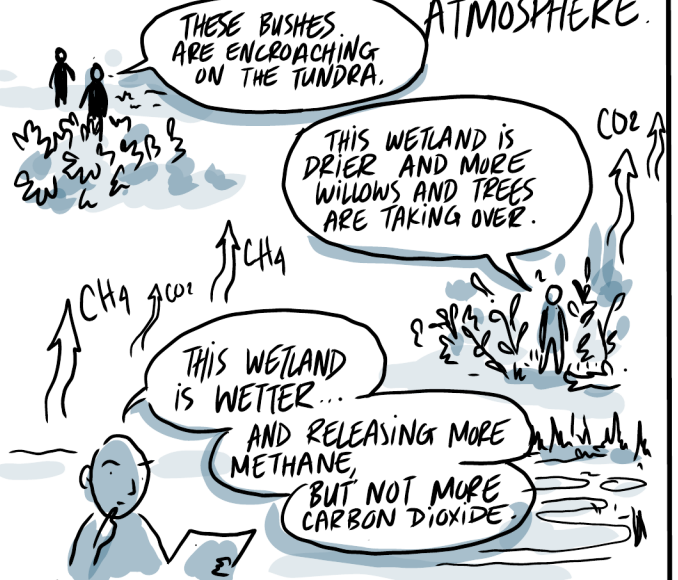
DAY 3 - SOME KEY TAKEAWAYS

THE NWT IS VERY BIG, WHICH MEANS THERE IS LOT OF DIVERSITY IN ITS LANDSCAPES.



THERE IS DIFFERENT TERRAIN, DIFFERENT SOIL COMPOSITION, DIFFERENT VEGETATION, DIFFERENT CLIMATE, ETC.

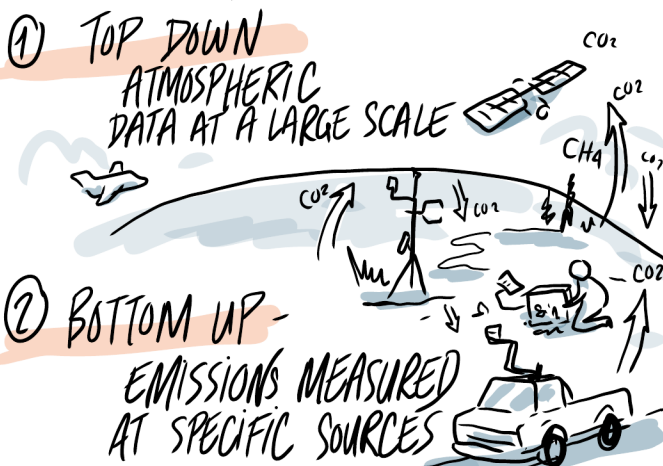
IN RECENT YEARS, WE HAVE BEEN OBSERVING NUMEROUS CHANGES,* SOME OF WHICH ARE IMPACTING THE RELEASE OF CARBON INTO THE ATMOSPHERE.



*WIDESPREAD SHIFTS, IN ADDITION TO LOCALIZED CLIMATE CHANGE CAUSED DISTURBANCES LIKE WILDFIRES

MANY DIFFERENT RESEARCH PROJECTS DO WORK RELATED TO MONITORING CARBON FLUXES - AND TRYING TO UNDERSTAND HOW THEY MAY BE CHANGING.

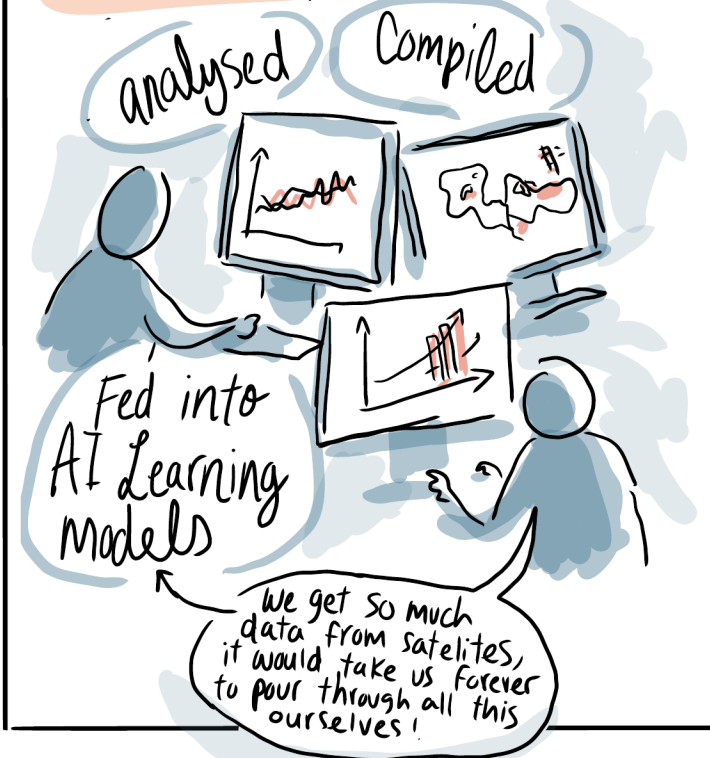
THE DATA IS COLLECTED IN TWO MAIN WAYS.



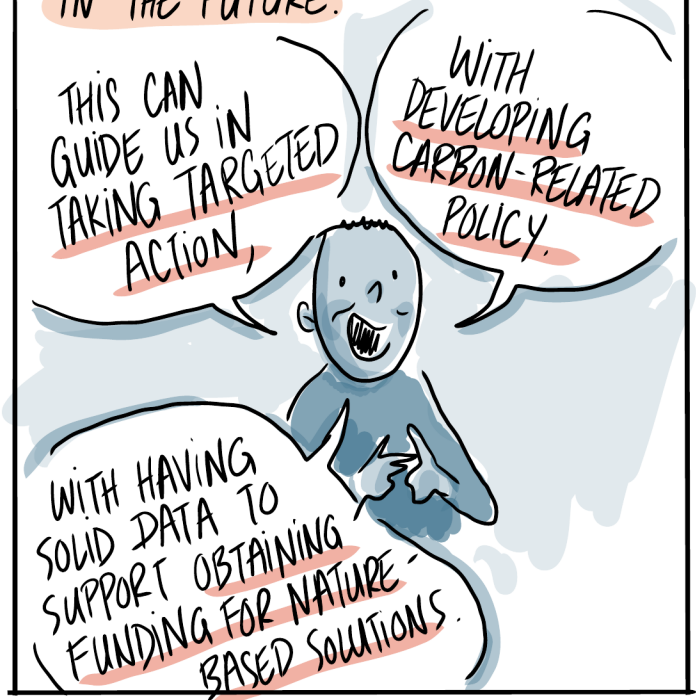
IN MANY CASES, THESE ARE OPPORTUNITIES TO INVOLVE LOCAL RESIDENTS, TO TEACH YOUTH ABOUT SCIENCE, TO BUILD CAPACITY AND TO FOSTER COMMUNITY-CENTERED RESEARCH.



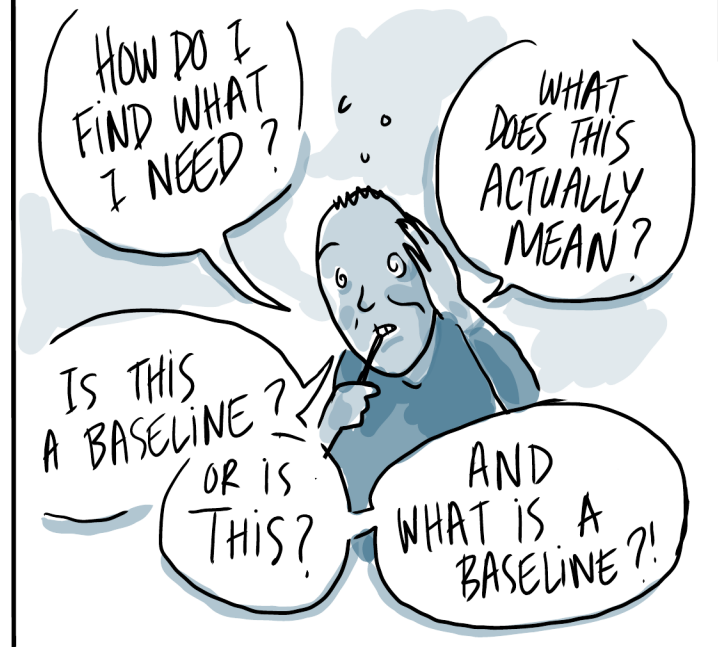
COMBINING TOP DOWN AND BOTTOM UP RESEARCH ALLOWS FOR A MORE COMPLETE PICTURE.



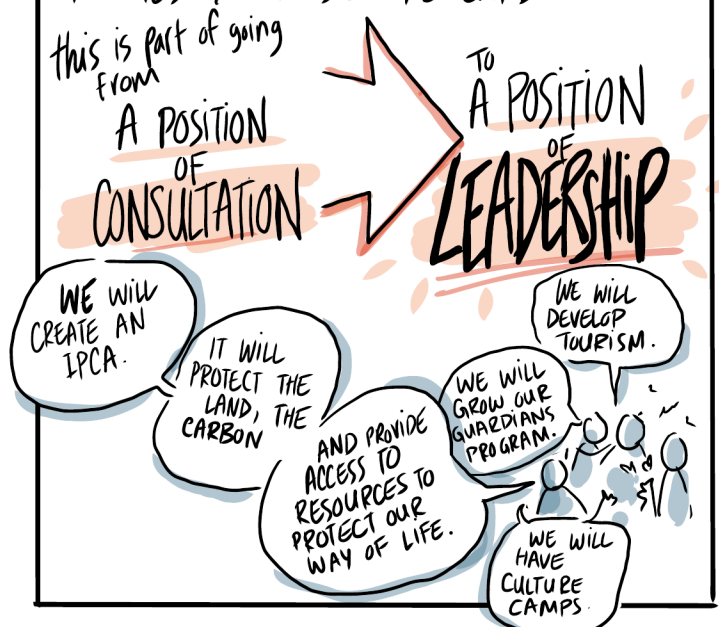
THIS DATA CAN HELP BETTER UNDERSTAND LANDSCAPE CARBON, WHERE IT IS, AND WHAT MAY HAPPEN TO IT IN THE FUTURE.



THERE EXISTS A LOT OF INFORMATION. A SIGNIFICANT CHALLENGE THOUGH, IS MAKING ALL THIS DATA ACCESSIBLE.



AS WELL AS HAVING ACCESS TO DATA, THERE NEEDS TO BE A BROADER UNDERSTANDING, AT THE COMMUNITY LEVEL, OF THE ISSUES AND OPPORTUNITIES RELATED TO LANDSCAPE CARBON.



THIS AWARENESS ALSO NEEDS TO GROW FOR ELECTED OFFICIALS, DECISION-MAKERS AND POLICY-MAKERS (and also for... well... everyone !)

THERE ARE 150 BILLION TONS OF CARBON IN PEAT IN CANADA.

HOW IS THERE NO LEGISLATION TO PROTECT THESE PEATLANDS!?!?

OTHER COUNTRIES WITH MUCH LESS PEAT DO!

LEGISLATION & POLICY ARE IMPORTANT TOOLS

MOVING FORWARD, WE NEED TO WORK TOGETHER

Collaborating

Listening

COMMUNITIES

Indigenous Knowledge

Western Science

SCIENTISTS

POLICY-MAKERS

Communicating

Knowledge sharing

TOGETHER, WE CAN TAKE ACTIONS THAT WORK FOR THOSE LIVING ABOVE,

TO PROTECT ALL THAT CARBON STORED BELOW!

YAY!

THANK YOU!

Appendix F: Important maps

Legend

fireyear



Community

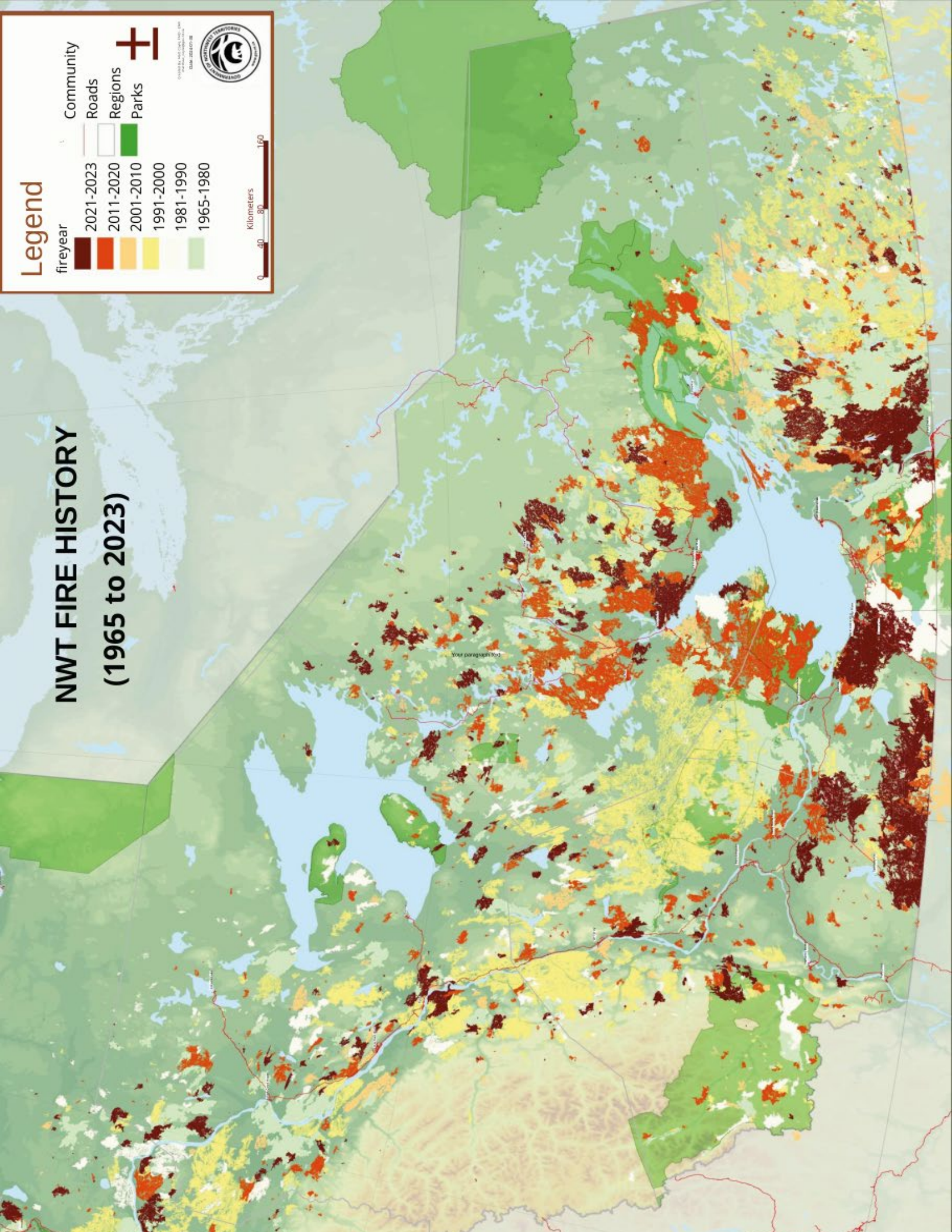
Roads

Regions

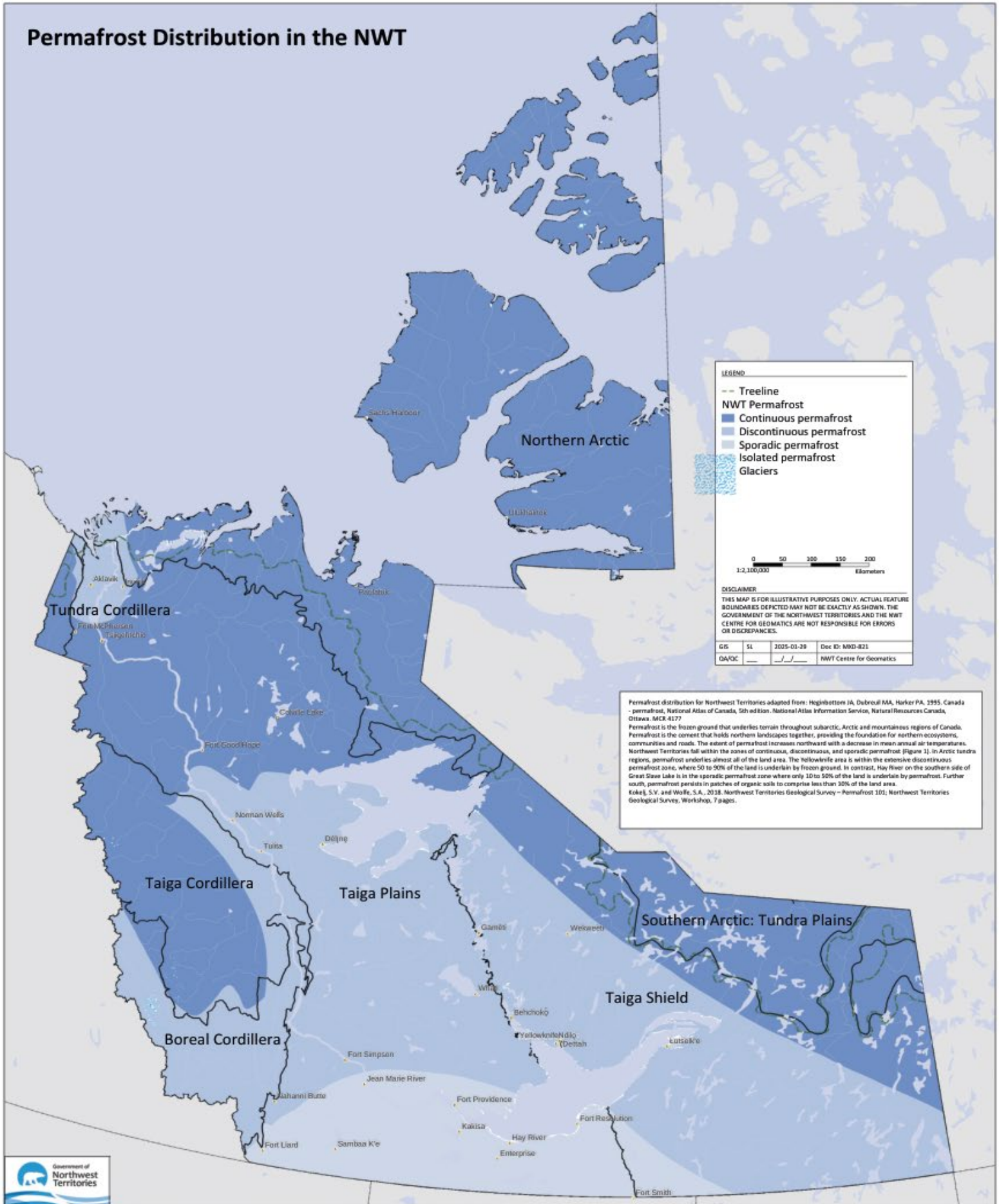
Parks



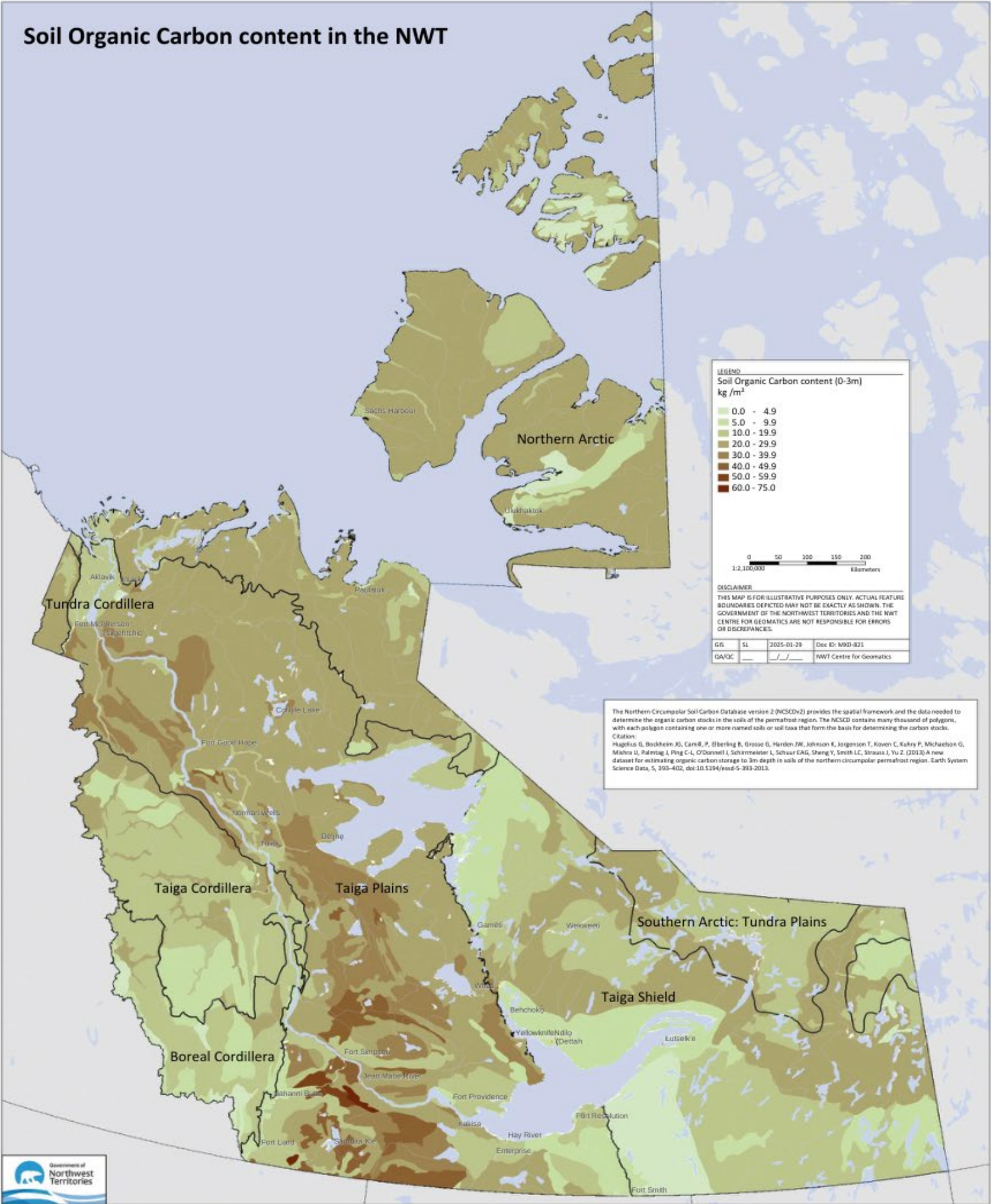
NWT FIRE HISTORY (1965 to 2023)



Permafrost Distribution in the NWT



Soil Organic Carbon content in the NWT



[illegible]

