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CANADIAN COUNCIL ON ECOLOGICAL AREAS
CONSEIL CANADIEN DES AIRES ÉCOLOGIQUES

IMPLEMENTING CONNECTIVITY CONSERVATION IN CANADA

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IMPLEMENTING CONNECTIVITY CONSERVATION IN CANADA

Edited by

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CCEA MISSION STATEMENT

To support the establishment and management of a network of ecological areas that will represent and conserve the natural diversity of Canada's terrestrial, freshwater, and marine ecosystems for the benefit of all Canadians.

ABOUT CCEA

The Canadian Council on Ecological Areas (CCEA) is an independent national organization constituted in 1982 to encourage and to facilitate the selection, protection and stewardship of a comprehensive network of protected areas in Canada. In 1995, the CCEA became a registered charitable organization. The Council draws its following and support from federal, provincial and territorial government agencies, non-governmental organizations, universities, industry, Indigenous Peoples, and private citizens concerned with protected areas.

The mission of the CCEA is to support the establishment and management of a network of ecological areas that will represent and conserve the natural diversity of Canada's terrestrial, freshwater, and marine ecosystems for the benefit of all Canadians. To this end, the work of the CCEA is centred on the following goals:

1. To support the identification, establishment, integration, and reporting on ecological areas in Canada;
2. To support the effective and equitable management and monitoring of ecological areas in Canada;
3. To promote the understanding of the importance of ecological areas in connecting Canadians to nature; and,
4. To collaborate with partners to advance ecological area networks in Canada and globally.

CCEA CCAE

For more information, visit the CCEA website at www.ccea-ccae.org
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Sahtú, Northwest Territories (Photo by Jean Polfus)

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Quttnirpaaq National Park, Nunavut (Photo by Joyce Gould)

Bighorn sheep, (*Ovis canadensis*) above Canmore, Alberta (Photo by Devon Hawkins)

FOREWORD

The Canadian Council on Ecological Areas (CCEA) has taken a leading national and international role in providing evidence-based advice and guidance on global conventions to which Canada is signatory. Between 2010 and 2020, CCEA primarily focused its attentions on the United Nations (UN) *Convention on Biological Diversity* (CBD) and its *Strategic Plan for Biodiversity 2011-2020*, including Aichi Target 11 (reflected in Target 1 of *Canada's Biodiversity Goals and Targets*). These agreements committed Canada and other signatories to expand their systems of protected areas and other effective area-based conservation measures (OECMs) to incorporate at least 17% of their land and inland waters and 10% of their coastal and marine waters by 2020. Other components of Aichi Target 11 compelled Parties to identify and safeguard important biodiversity areas, monitor and implement effective and equitable management, and ensure that protected areas are ecologically representative, well-connected and integrated into wider landscapes and seascapes. Many of these important elements remain engrained, and in some cases heightened, in the draft text of the CBD's *Post-2020 Global Biodiversity Framework* and the 2050 Vision for Biodiversity, which is set to replace the *Strategic Plan for Biodiversity* in May 2021. For instance, in advance of the next negotiation for a global agreement to protect nature, Canada has pledged to protect 30% of its land and ocean by 2030.

The performance of protected areas and OECMs relies on a number of factors, including adequate financing, and effective and equitable governance and management. **The focus of this report is on the need to protect and restore connectivity within Canada's terrestrial ecosystems**. Well-connected ecosystems will be critical for maintaining important ecological and evolutionary processes (including species migration and adaptation), especially in an era of rapid climate and ecological change. While the focus of much of Canada's protected areas establishment over the past two decades has focused on ecosystem representation, a critical and urgent need will be to begin the difficult process of fusing these approaches with connectivity considerations. Without connectivity, protected areas and OECMs will not be able to meet their conservation goals.

The UN 2015 *Paris Agreement* on climate change, and Canada's declaration of a climate emergency in 2019, reinforces the need for countries to commit to the goals and targets of the *Post-2020 Global Biodiversity Framework*. Along with other social and economic functions and ecosystem services that benefit society, protected areas support climate change adaptation and mitigation goals by sequestering carbon from the atmosphere, providing nodes and corridors to assist species' migration, helping to maintain critical environmental functions such as hydrological cycles, and enhancing the resilience and integrity of regional ecosystems. Canada's commitment to curbing climate change under the *Paris Agreement* now presents another opportunity to enhance complementary efforts on biodiversity conservation, protected areas, and connectivity that will help to meet the interrelated goals of these international environmental agreements.

As a member of the International Union for the Conservation of Nature (IUCN) World Commission on Protected Areas (WCPA), the completion of this report by the CCEA builds on priorities from the World Parks Congress (2014) and its *Promise of Sydney*, including the objective to recognize and mainstream protected areas as natural solutions to global challenges, such as climate change and precipitous declines in biodiversity. The report is also aligned with Resolution 038 adopted at the World Conservation Congress (2016), which recognizes the role of protected areas and OECMs as solutions to address the negative effects of climate change through nature-based adaptation and mitigation strategies.

This publication is an important step to enhance governance capacities for Canada's protected areas, Indigenous and Protected Conserved Areas (IPCAs), and OECM systems. The CCEA has played a leading role in identifying and understanding the implications of climate change for protected areas policy, planning and management, including through publishing the first national report synthesizing adaptation options for managers in 2010, and participating in the Canadian Parks Council's Climate Change Working Group. The report builds upon CCEA's recent and on-going efforts to interpret IUCN guidelines for protected areas in a Canadian context, provide evidence-based guidance on the recognition of those conserved lands and waters beyond formally recognized protected areas that contribute to biodiversity conservation, and lead efforts on spatial planning for new protected areas.

Governments, Indigenous Peoples, conservation organizations, the public, and the private sector all have a role to play in the effective implementation of connectivity conservation. This report is intended to be an overview of key aspects related to connectivity among protected areas in Canada, within the context of the Aichi Target 11 and its successor the *Post-2020 Global Biodiversity Framework*. It builds upon discussions of connectivity held at CCEA's 2016 National Workshop *Achieving All Aspects of Aichi Target 11 and Canada's Biodiversity Target 1 – How Will We Know We've Achieved Our Goals?*, which focused on connectivity conservation, along with effective management and integration, and was held in Yellowknife, Northwest Territories. A previous introductory report produced for the connectivity focus of the 2016 National Workshop provided a common basis of understanding for participating representatives of federal, provincial, and territorial government agencies, non-governmental organizations, universities, industry, Indigenous Peoples, and private citizens.

Accordingly, this report integrates and updates the earlier report and discussions on connectivity from the CCEA 2016 National Workshop. For the first time in the Canadian context, this report addresses multiple aspects associated with connectivity conservation implementation,

including sample governance models, legislative and policy contexts, an organizational capacity and needs assessment, and case studies of connectivity conservation in practice in Canada. This work builds on the recent IUCN best practice guidelines report entitled *Guidelines for Conserving Connectivity Through Ecological Networks and Corridors*.

Given the formidable challenges confronting the establishment of effective networks of protected areas, it is inspiring to see positive responses to distinctive regional challenges in the case studies featured in this report. In its own way, each case study demonstrates the application of connectivity science, governance mechanisms, expertise, and resourcing in varied cultural settings, thereby paving the way for wider innovation and application to establish viable networks of protected and conserved areas across Canada.

While there are still more aspects of and perspectives on connectivity and case studies that could be included, it is the hope of the CCEA, the editors, and more than 20 authors from across Canada that this report will stimulate discussion and provide guidance for implementation of connectivity conservation across Canada, and perhaps for all signatories to the *Convention on Biodiversity* working towards achieving the goals of the *Post-2020 Global Biodiversity Framework* and the 2050 Vision for Biodiversity.

Chris Lemieux, Karen Beazley, Tom Beechey, Claudia Haas and Jessica Elliott
Canadian Council on Ecological Areas (CCEA)

Northern Pygmy Owl (*Glaucidium californicum*), Bighorn Country, Alberta (Photo by Brian Starzomski)

AVANT-PROPOS

Le Conseil canadien des aires écologiques (CCAE) a joué un rôle de premier plan à l'échelle nationale et internationale en fournissant des conseils et des orientations fondés sur des données probantes sur les conventions mondiales dont le Canada est signataire. Entre 2010 et 2020, le CCAE a principalement concentré son attention sur la *Convention des Nations Unies (ONU) sur la diversité biologique* (CDB) et son *Plan stratégique pour la biodiversité 2011-2020*, y compris l'objectif 11 d'Aichi (reflété dans l'objectif 1 des *objectifs et cibles du Canada en matière de biodiversité*). Ces accords engageaient le Canada et d'autres signataires à élargir leurs systèmes d'aires protégées et d'autres mesures de conservation efficaces par zone (OECM) pour incorporer au moins 17% de leurs terres et eaux intérieures et 10% de leurs eaux côtières et marines d'ici 2020. D'autrescomposantes de l'Objectif d'Aichi 11 ont obligé les Parties à identifier et à sauvegarder les zones importantes pour la biodiversité, à surveiller et à mettre en œuvre une gestion efficace et équitable, et à garantir que les aires protégées soient écologiquement représentatives, bien connectées et intégrées dans des paysages terrestres et marins plus larges. Beaucoup de ces éléments importants restent enracinés, et dans certains cas renforcés, dans l'ébauche de texte du *Cadre mondial de la biodiversité pour l'après-2020* de la CDB et dans la Vision 2050 pour la biodiversité, qui doit remplacer le Plan stratégique pour la biodiversité en mai 2021. Par exemple , avant la prochaine négociation d'un accord mondial pour protéger la nature, le Canada s'est engagé à protéger 30% de ses terres et de ses océans d'ici 2030.

La performance des aires protégées et des OECM repose sur un certain nombre de facteurs, notamment un financement adéquat et une gouvernance et une gestion efficaces et équitables. **Ce rapport met l'accent sur la nécessité de protéger et de restaurer la connectivité au sein des écosystèmes terrestres du Canada**. Des écosystèmes bien connectés seront essentiels pour maintenir d'importants processus écologiques et évolutifs (y compris la migration et l'adaptation des espèces), en particulier à une époque de changements climatiques et écologiques rapides. Bien que la majeure partie de la création d'aires protégées au Canada au cours des deux dernières décennies se soit concentrée sur la représentation des écosystèmes, un besoin critique et urgent sera d'entamer le processus difficile consistant à fusionner ces approches avec des considérations de connectivité. Sans connectivité, les aires protégées et les OECM ne pourront pas atteindre leurs objectifs de conservation.

L'Accord de Paris de 2015 des Nations Unies sur les changements climatiques et la déclaration d'urgence climatique du Canada en 2019 renforcent la nécessité pour les pays de s'engager à respecter les objectifs et les cibles du *Cadre mondial de la biodiversité pour l'après-2020*. En plus d'autres fonctions sociales et économiques et services écosystémiques qui profitent à la société, les aires protégées soutiennent les objectifs d'adaptation et d'atténuation du changement climatique en séquestrant le carbone de l'atmosphère, en fournissant des nœuds et des couloirs pour faciliter la migration des espèces, en aidant à maintenir des fonctions environnementales critiques telles que les cycles hydrologiques. et améliorer la résilience et l'intégrité des écosystèmes régionaux. L'engagement du Canada à réduire les changements climatiques dans le cadre de *l'Accord de Paris* offre maintenant une autre occasion d'intensifier les efforts complémentaires en matière de conservation de la biodiversité, d'aires protégées et de connectivité qui aideront à atteindre les objectifs interdépendants de ces accords internationaux sur l'environnement.

En tant que membre de la Commission mondiale des aires protégées (CMAP) de l'Union internationale pour la conservation de la nature (UICN), l'achèvement de ce rapport par le CCAE s'appuie sur les priorités du Congrès mondial des parcs (2014) et sa *promesse de Sydney,* notamment l'objectif de reconnaître et d'intégrer les aires protégées en tant que solutions naturelles aux défis mondiaux, tels que le changement climatique et le déclin dramatique de la biodiversité. Le rapport est également aligné sur la Résolution 038 adoptée lors du Congrès mondial de la nature (2016), qui reconnaît le rôle des aires protégées et des OECM en tant que solutions pour faire face aux effets négatifs du changement climatique grâce à des stratégies d'adaptation et d'atténuation fondées sur la nature.

Cette publication est une étape importante pour améliorer les capacités de gouvernance des aires protégées, des aires de conservation autochtones et protégées (IPCA) et des systèmes OECM du Canada. Le CCAE a joué un rôle de premier plan dans l'identification et la compréhension des implications des changements climatiques pour la politique, la planification et la gestion des aires protégées, notamment en publiant le premier rapport national synthétisant les options d'adaptation pour les gestionnaires en 2010, et en participant aux travaux du Conseil canadien des parcs sur les changements climatiques. Groupe. Le rapport s'appuie sur les efforts récents et en cours du CCAE pour interpréter les lignes directrices de l'UICN pour les aires protégées dans un contexte canadien, fournir des conseils factuels sur la reconnaissance des terres et des eaux conservées au-delà des aires protégées officiellement reconnues qui contribuent à la conservation de la biodiversité, et efforts d'aménagement du territoire pour les nouvelles aires protégées.

Les gouvernements, les peuples autochtones, les organisations de conservation, le public et le secteur privé ont tous un rôle à jouer dans la mise en œuvre efficace de la conservation de la connectivité. Le rapport se veut un aperçu des principaux aspects liés à la connectivité entre les aires protégées au Canada, dans le contexte de l'Objectif d'Aichi 11 et de son successeur le *Cadre mondial de la biodiversité pour l'après-2020*. Il s'appuie sur les discussions sur la connectivité tenues lors de l'atelier national 2016 du CCAE «*Atteindre tous les aspects de l'Objectif d'Aichi 11 et de l'Objectif 1 pour la biodiversité du Canada – Comment saurons-*

nous que nous avons atteint nos objectifs? », qui portaient sur la conservation de la connectivité, ainsi que sur la gestion et l'intégration efficaces, et a eu lieu à Yellowknife, dans les Territoires du Nord-Ouest. Un précédent rapport introductif produit pour le thème de la connectivité de l'Atelier national de 2016 a fourni une base de compréhension commune aux représentants participants des organismes gouvernementaux fédéraux, provinciaux et territoriaux, des organisations non gouvernementales, des universités, de l'industrie, des peuples autochtones et des citoyens.

En conséquence, ce rapport intègre et met à jour le rapport précédent et les discussions sur la connectivité de l'atelier national CCEA 2016. Pour la première fois dans le contexte canadien, il comprend plusieurs aspects associés à la mise en œuvre de la conservation de la connectivité, y compris des modèles de gouvernance, des contextes législatifs et politiques, une évaluation de la capacité organisationnelle et des besoins et des études de cas sur la conservation de la connectivité dans la pratique au Canada. Ce travail s'appuie sur le récent rapport sur les lignes directrices des meilleures pratiques de l'UICN intitulé *Lignes directrices pour la conservation de la connectivité à travers les réseaux et corridors écologiques*.

Compte tenu des formidables défis auxquels est confronté l'établissement de réseaux efficaces d'aires protégées, il est encourageant de voir des réponses positives à des défis régionaux particuliers dans les études de cas présentées dans ce rapport. À sa manière, chaque étude de cas démontre l'application de la science de la connectivité, des mécanismes de gouvernance, de l'expertise et des ressources dans des contextes culturels variés, ouvrant ainsi la voie à une innovation et une application plus larges pour établir des réseaux viables d'aires protégées et conservées à travers le Canada.

Bien qu'il y ait encore plus d'aspects et de perspectives sur la connectivité et les études de cas qui pourraient être inclus, le CCAE, les éditeurs et plus de 20 auteurs de partout au Canada espèrent que ce rapport stimulera la discussion et fournira des conseils pour la mise en œuvre de la conservation de la connectivité à travers le Canada, et peut-être pour tous les signataires de la *Convention sur la biodiversité* qui travaillent à la réalisation des objectifs du *Cadre mondial de la biodiversité pour l'après-2020* et de la Vision 2050 pour la biodiversité.

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Woodland caribou (*Rangifer tarandus caribou*), Dease Lake, British Columbia (Photo by Jukka Jantunen)

Athabasca Dunes, Alberta (Photo by Joyce Gould)

CONTENTS

SELECTED LIST OF ACRONYMS

2C1F	Two Countries, One Forest
2C1Forest	Two Countries, *One Forest*
A2A	Algonquin-to-Adirondack
ALUS	Alternative Land Use Services
ANSI	Area of Natural and Scientific Interest
CBD	Convention on Biological Diversity
CCEA	Canadian Council on Ecological Areas
CC-IUCN	Canadian Committee for IUCN
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPCAD	Canadian Protected and Conserved Areas Database
EA	Environmental Assessment
ECCC	Environment and Climate Change Canada
FPT	Federal, Provincial, Territorial
GD-PAME	Global Database on Protected Area Management Effectiveness
GNWT	Government of Northwest Territories
HGNP	Halifax Green Network Plan
IA	Impact Assessment
IBAs	Important Bird Areas
ICE	Indigenous Circle of Experts
IPCAs	Indigenous Protected and Conserved Areas
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for the Conservation of Nature
KBAs	Key Biodiversity Areas
LCCs	Landscape Conservation Cooperatives
LGAG	Local Government Advisory Group
NBSAP	National Biodiversity Strategies and Action Plan
NCC	Nature Conservancy of Canada
NCSs	Natural Climate Solutions
NEGECP	New England Governors and Eastern Canadian Premiers
NGO	Non-government Organization
NMCA	National Marine Conservation Area
NWT	Northwest Territories
NWT-PAS	Northwest Territories Protected Areas Strategy
OECMs	Other Effective Area-Based Conservation Measures
PAME	Protected Area Management Effectiveness
PPAs	Privately Protected Areas
PPS	Provincial Policy Statement
RTCCs	Regional Transboundary Conservation Cooperatives
SCI	Staying Connected Initiative
SDGs	UN Sustainable Development Goals
SEA	Strategic Environmental Assessment
TSM	Towards Sustainable Mining
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
WCEL	World Commission on Environmental Law
WCPA	World Commission on Protected Areas
WWF	World Wildlife Fund
Y2Y	Yellowstone to Yukon Conservation Initiative

EXECUTIVE SUMMARY

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Earth's biological diversity is facing substantial threats and loss due to a host of human activities including, but not limited to, urbanization, land-use and land-cover change, climate change, and pollution (Ceballos et al., 2015; Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2019). A major contribution to these threats is the propensity for people to eliminate or degrade habitats and fragment ecosystems disrupting ecological flows, movement of species, and exchange of genes between populations (Belote, Beier, Creech, Wurtzebach, & Tabor, 2020; Haddad et al., 2015). These threats and losses of biodiversity represent one of the most critical environmental problems facing society, threatening ecosystem services and human health and well-being (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2019; Ripple et al., 2017; Steffen et al., 2015). A recent report by the Swiss Re Institute concluded that a staggering one-fifth of all countries are at risk of economic collapse due to a decline in biodiversity and related ecosystem services (Swiss Re Institute, 2020). The study, which is based on Swiss Re Institute's new Biodiversity and Ecosystem Services Index, emphasizes that neither developing nor advanced economies are immune to these risks.

Two of the most frequently cited recommendations for protecting biodiversity include expanding protected areas networks and **enhancing connectivity** (Heller & Zavaleta, 2009). Ecological connectivity is the unimpeded movement of species and the flow of natural processes that sustain life on Earth (Convention on Migratory Species (CMS), 2020). While important in its own right to maintain species interactions and gene flows, connectivity conservation is also vital to facilitate species movement and adaptation in response to climate-induced ecological changes.

In Canada, and in much of the world, human activities and developments have changed ecosystems in ways that have reduced connectivity for many species, jeopardizing their ability to meet their needs and contributing to population declines and species loss. This problem is not new. Degradation of ecosystems and the loss of species and genetic diversity that result from human activities are the primary reasons why Canada signed and ratified the United Nations (UN) *Convention on Biological Diversity* (CBD) in 1992 (nearly 30 years ago), and most recently agreed to implement the associated goals and targets of *2011-2020 Strategic Plan for Biodiversity* including the 20 Aichi Biodiversity Targets (Convention on Biological Diversity, 2010). In May 2021, Parties to the UN CBD, including Canada, will renew their commitment to averting further biodiversity loss by finalizing the *Post-2020 Global Biodiversity Framework*, which at the time of writing is in draft form (Convention on Biological Diversity (CBD), 2020).

A key strategic action of Aichi Target 11 was calling for the establishment of well-connected networks of protected areas and other effective area-based conservation measures (OECMs). Aichi Target 11 was reflected in Target 1 of the *2020 Biodiversity Goals and Targets for Canada* (Environment and Climate Change Canada (ECCC), 2015). Whereas Aichi Target 11 included terrestrial, freshwater, and marine elements, Canada Target 1 focused exclusively on the terrestrial and freshwater components; implementation of the marine protection component was led by Fisheries and Oceans Canada (DFO).

Global Biodiversity Outlook (GBO), the flagship publication of the UN CBD, recently revealed that at the global level none of the 20 Aichi Targets have been fully achieved (though six targets have been partially achieved: Targets 9, 11, 16, 17, 19 and 20) (Secretariat of the Convention on Biological Diversity, 2020). Despite progress on some aspects of Aichi Target 11 and Canada Target 1 between 2011 and 2020, including expansion of the protected and conserved area footprint in terrestrial ecosystems, landscapes and waterscapes are increasingly disconnected, endangering the viability of ecological networks to achieve their intended objectives, potentially jeopardizing decades of major investments of public and private resources.

The failure of Parties to the UN CBD to meet the goals and targets of the *Strategic Framework on Biodiversity 2011-2020* has necessitated the need for a renewed vision and new set of goals and targets aimed at halting and reversing ongoing biodiversity loss (Maxwell et al., 2020). The *Post-2020 Global Biodiversity Framework* will build on the *Strategic Plan for Biodiversity 2011-2020* and set out a new ambitious plan to implement broad-based action to bring about a transformation in society's relationship with biodiversity and to ensure that, by 2050, the shared vision of 'Living in Harmony with Nature' is fulfilled (Box 1).

In addition to these four long-term goals for 2050, the draft Framework includes eight milestones to assess in 2030 towards progress on the 2050 goals. Goal A.1 specifically recognizes connectivity: ***"The area, connectivity and integrity of natural systems increased by at least [5%].***" The draft Framework currently includes 20 action-oriented targets for 2030 which, if achieved, will contribute to 2030 Milestones and the outcome-oriented goals for 2050. Connectivity is evident in two targets, including:

Box 1. The 2050 Vision for Biodiversity of the UN CBD Zero Draft of the Post-2020 Global Biodiversity Framework (Convention on Biological Diversity (CBD), 2020).

The vision of the framework is a world of living in harmony with nature where: "By 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people."

The four long-term goals related to the 2050 Vision for Biodiversity include:

1. The area, connectivity and integrity of natural ecosystems increased by at least [X%] supporting healthy and resilient populations of all species while reducing the number of species that are threatened by [X%] and maintaining genetic diversity;
2. Nature's contributions to people have been valued, maintained or enhanced through conservation and sustainable use supporting [a] global development agenda for the benefit of all people;
3. The benefits, from the utilization of genetic resources are shared fairly and equitably; and,
4. Means of implementation are available to achieve all goals and targets in the framework (Convention on Biological Diversity (CBD), 2020).

- **Target 1**. By 2030, [50%] of land and sea areas globally are under spatial planning addressing land/sea use change, retaining most of the existing intact and wilderness areas, and allow to restore [X%] of degraded freshwater, marine and terrestrial natural ecosystems and **connectivity** among them.
- **Target 2.** By 2030, protect and conserve through **well connected** and effective system of protected areas and other effective area-based conservation measures at least 30 per cent of the planet with the focus on areas particularly important for biodiversity (Convention on Biological Diversity (CBD), 2020).

The Framework emphasizes that actions to reach these targets should be implemented consistently and in harmony with the UN CBD and its Protocols and other relevant international obligations, taking into account national socioeconomic conditions. In Canada, Prime Minister Justin Trudeau's 2019 Minister of Environment and *Climate Change Mandate Letter* urged the Minister to:

"Work with the Minister of Fisheries, Oceans and the Canadian Coast Guard to introduce a new ambitious plan to conserve 25 per cent of Canada's land and 25 per cent of Canada's oceans by 2025, working toward 30 per cent of each by 2030. This plan should be grounded in science, Indigenous knowledge and local perspectives." (Trudeau, 2019)

Representing Canada at the UN *Nature for Life Event* in September 2020, Prime Minister Trudeau further reiterated his pledge to protect 30 per cent of land and seas by 2030 to stem biodiversity loss and help galvanize support for broader agreement on the target.

While accepting the need to expand protected area coverage and retain connectivity and reconnect Canada where appropriate is a critical first step, the failure of most Parties to the UN CBD in achieving the Goals and Targets of the *2011-2020 Strategic Plan for Biodiversity* tells us that achieving the aspirations outlined in the new *Post-2020 Global Biodiversity Framework* will not be easy. By its very nature, shifting away from the status quo is never easy. But with sound, progressive leadership, such opposition can be overcome for the broader public good.

In light of these grand challenges, this report provides a scan of the current legal, regulatory, policy, planning, governance, knowledge, and implementation landscape to retain and restore terrestrial ecological connectivity in Canada.

By means of fusing a literature review, case studies, and an organizational capacity and needs assessment survey of connectivity practitioners and stakeholders, this report identifies gaps, barriers, successes, and solutions in the efforts to maintain and restore connectivity in Canada. It is organized as follows:

- **Chapter 1:** The Need for a (Re)Connected Canada
- **Chapter 2:** Governance, Law and Policy Dimensions of Connectivity Conservation in Canada
- **Chapter 3:** Case Studies on Connectivity Conservation in Canada
- **Chapter 4:** Connectivity Conservation in Canada Organizational Capacity and Needs Assessment
- **Chapter 5:** (Re)Connecting Canada: Setting the Table for Transformation

Table 1 provides a select summary of the major obstacles and needs associated with the implementation of connectivity conservation in Canada as identified in our pan-Canadian survey of protected areas practitioners. Generally speaking, overall capacity for implementing connectivity conservation among all core protected areas agencies is low to moderate. Protected areas strategies tend to be outdated, focused on completing protected areas systems based on representation, and typically exclude explicit goals and targets for connectivity conservation. Furthermore, few policy frameworks for mainstreaming connectivity

conservation have been created and are generally treated as a secondary priority behind economic development.

Systemic barriers persist, including inadequate human and financial resources in support of research to understand social and scientific issues regarding connectivity, fostering and maintaining collaborative partnerships, and implementing planning and mitigation efforts in support of connectivity. Finally, differing organizational mandates, even within government (e.g., between conservation, transportation, and natural resource departments), lack of provisions within environmental/impact assessment (EA/IA), and lack of mainstreaming of connectivity within public and private sector initiatives, including forestry, mining, transportation and other infrastructure projects, are perceived as major barriers to effectively protecting and restoring connectivity in Canada.

While significant systemic barriers to the effective implementation of connectivity conservation exist, there are many examples of recent successes and further opportunities. First, there is growing evidence that some protected areas have been effective at maintaining, or even enhancing wildlife populations (Geldmann et al., 2013; Pacifici, Di Marco, & Watson, 2020; Venter et al., 2014; Watson, Dudley, Segan, & Hockings, 2014). Further expansion of protected and conserved area networks will therefore be critical to ensuring the long-term persistence of biodiversity in Canada and indeed globally.

Second, it is worth noting that while local governments represent a small part of the focus of this report, it appears that they have been somewhat more effective at implementing connectivity conservation initiatives through integrated regional and urban planning initiatives. Third, as the case studies included in this report show (Chapter 3), relationships between some provincial conservation agencies and private land organizations such as the Nature Conservancy of Canada (NCC) have helped facilitate the implementation of several effective connectivity conservation initiatives.

Fourth, the role of Indigenous Peoples in conservation efforts, and their importance to the success of conservation agreements like the *Post-2020 Global Biodiversity Framework*, has been of heightened discourse and action in Canada (Artelle et al., 2019; Loring & Moola, 2020; Zurba, Beazley, English, & Buchmann-Duck, 2019). In our pan-Canadian survey on capacity to implement connectivity conservation, protected areas practitioners indicated that some organizations struggle with integrating Indigenous Knowledge into connectivity conservation planning. While not revealed in the survey, it is our opinion that it is crucial for protected areas organizations to transition from 'integrating Indigenous Knowledge' to 'mainstreaming' diverse knowledge systems and ways of knowing, such as Two-Eyed Seeing, weaving together both Indigenous and Western-scientific insights, in 'ethical space', for enhanced planning and management (Bartlett, Marshall, & Marshall, 2012; Indigenous Circle of Experts (ICE), 2018; Lemieux, Groulx, Bocking, & Beechey, 2018).

Much work needs to be done to amplify Indigenous-led conservation in Canada, where *"Indigenous governments have the primary role in determining the objectives, boundaries, management plans and governance structures for [Indigenous Protected and Conserved Areas] IPCAs as part of their exercise of self-determination"* (ICE, 2018: 36). The recent establishment of IPCAs in Canada represents positive actions that acknowledge the important roles, responsibilities and contributions that Indigenous Peoples make to the effective in-situ conservation of biodiversity. Continued commitment to and support of Indigenous-led conservation will be needed to effectively achieve desired biodiversity outcomes post-2020.

Finally, our survey also revealed that collaborative partnerships with the broader research community, including universities, have helped offset social and natural science capacity issues related to connectivity conservation, through research that has supported inventorying, monitoring and evaluation.

Based on the results of the literature review, case studies, and the pan-Canadian survey of conservation practitioners, as well as a review of recommendations developed by Lemieux et al. (2020) and consultation with the Pathway to Canada Target 1 Connectivity Working Group, a host of primary and supporting actions to increase the retention and restoration of connectivity in Canada are recommended. Many of these recommendations call for building capacity, responsibility and incentives into the activities of those having the greatest potential impact and influence on connectivity in both positive and negative ways.

Ultimately, the goal is that evidence-based connectivity conservation becomes more mainstreamed, by means of mainstreaming legislation and policy, providing incentives to retain and restore, and implementing disincentives to degrade or ignore connectivity, in decision-making processes.

Recommendations which flow from the broad discussion above are presented below. While some of these timelines may seem ambitious, transformational shifts in priorities, governance systems, institutional function, planning, information management, and capacity building, as noted above, are urgently needed to achieve Canada's national and international conservation goals.

Table 1. Selected organizational barriers and needs associated with the implementation of connectivity conservation initiatives in Canada as identified in a pan-Canadian survey of protected areas practitioners.

Organizational Capacity Theme	Barriers	Needs
Adaptive Governance (Legislation & Policy Frameworks) - 'Mainstreaming'	Many organizations lack policy, legislation, and direction specifically for connectivity conservation. Provincial growth strategies tend to promote sprawl to accommodate population and economic growth without consideration of connectivity. The priorities of other agencies within government, such as those related to transportation, energy and mining, are a perceived barrier to connectivity conservation implementation. There is a lack of incentives or political pressure to develop and implement connectivity policy. Dedicated human and financial resources for connectivity conservation are low.	Effective leadership to coordinate federal-provincial/territorial and local government actions. A transformative recommendation included the establishment of a new agency to coordinate, facilitate and implement a connectivity conservation vision for Canada. Legally established goals and indicators for connectivity could raise 'whole government' attention and, in particular, the ability and willingness to influence land use decision-making outside protected area boundaries to maintain and restore connectivity. Ecosystem protection and connectivity should be integrated outside traditional protected area boundaries, through key planning processes like environmental/impact assessments (EAs and IAs). All major land-use sectors should have staff dedicated to conservation connectivity. This would include transportation, mining, oil and gas, forestry, protected areas, biodiversity/wildlife, Crown land, agriculture and any other relevant agencies.
On-the-ground Planning and Implementation	In many instances, key connectivity areas have been identified, but have not been acquired and/or restored. Provincial and territorial conservation agencies encounter significant challenges working with other departments within their own government. Some jurisdictions do not sponsor incentive programs for the maintenance and/or restoration of connected areas outside of protected areas.	Significant revisions to land-use rules and regulations are required to affect change, including revision to the criteria that define the conditions under which proposed development activities become subject to an EA. Protected areas system plans, other development plans, urban growth plans, and regional land use plans should be updated to include connectivity conservation. There is a need to better understand and recognize ecosystem services provided by protected areas, which could lead to a real and concrete integration of connectivity conservation objectives. Connectivity metrics for monitoring and evaluation are needed. Both qualitative and quantitative tools for assessing connectivity conservation are needed to assess ecological criteria, but to also evaluate needs, responses, and expert and public opinion. Better partnerships with research institutions, such as universities, are required to support social-ecological research and monitoring.
Collaboration & Engagement	Existing collaborative efforts have been largely ad-hoc and informal. For many, collaboration involving partners with significantly different mandates than those of the usual partners responsible for protected areas, wildlife agencies, land trusts and academics is in the early stages, including transportation agencies and municipalities.	There is a need for formal collaboration between municipalities, researchers, universities, and provincial/territorial and federal agencies to share knowledge and lessons learned.
Knowledge Management & Exchange	Training opportunities are limited. Training is not seen as effective or worthwhile if there is no ability to implement it. Decision-makers encounter conflicts of interest, which are primarily political in nature, so a massive investment in science does not necessarily translate into science-guided decisions. A lack of specific goals for connectivity conservation has meant little integration of inventory and monitoring. Many agencies reported a willingness to integrate Indigenous Knowledge into connectivity planning but noted that this has not been done or is in early stages of implementation due to capacity constraints.	Support for staff to attend international conferences on transportation and wildlife, landscape ecology, and other areas relevant to connectivity conservation is required. Dedicated and experienced personnel are needed to gain the trust of communities and ensure that various forms of knowledge (e.g., local; Indigenous) are co-translated into planning outcomes. Data about the effectiveness of mitigation measures is required.

Primary strategic recommendations include:

1. Mainstream connectivity conservation by adapting the legislative, regulatory, and policy landscape to elevate the consideration of connectivity conservation in decision-making, such that those whose activities could degrade it are responsible to prevent, restore, mitigate, and compensate for impacts on connectivity, including the costs of doing so.
2. Prioritize the funding of on-the-ground connectivity conservation retention and restoration undertaken by a broad spectrum of traditional and new connectivity conservation promoters and influencers.
3. Foster collaboration among connectivity conservation promoters and influencers.
4. Invest in social and natural science research to build the evidence-base required for effective implementation of connectivity conservation during all stages of management planning, including monitoring and evaluation, with the goal of optimizing outcomes for biodiversity in Canada.

Primary recommendations, with suggested timelines, include:

Adaptive Governance (Legislation & Policy Frameworks) - 'Mainstreaming'

- By 2021, federal infrastructure funding programs require negative impacts to ecological connectivity be prevented and mitigated with the costs of doing so built into project proposals (e.g., highways, railways, and energy corridors).
- By 2022, federal, provincial, and territorial (FPT) legislation, regulations and/or policies for EAs/IAs are updated to ensure that development activities that may negatively impact connectivity are subject to an EA/IA and require impacts to be prevented, mitigated, and restored as costs of the undertakings.
- By 2023, FPT legislation, regulations and/or policies governing aquatic and terrestrial species and/or land and freshwater management are updated as appropriate to include responsibilities to restore and conserve ecological connectivity. Relevant agencies include, but are not limited to, those responsible for:
    - transportation (including major municipal transportation agencies);
    - protected areas;
    - biodiversity;
    - Crown land administration;
    - municipal government oversight;
    - forestry;
    - agriculture; and,
    - energy and mining.
- By 2022, provincial and territorial legislation governing municipal governments asserts connectivity interests and requires municipal planning to retain and restore connectivity, including requiring the costs of preventing, mitigating, and compensating for impacts to be the responsibility of those undertaking developments.
- By 2021, legislation, regulations, and policies governing activities that influence ecological connectivity are followed and actively enforced and by FPT governments by investing in adequate staffing and resources.
- By 2022, protected areas, OECMs, and other measures to support connectivity conservation are mainstreamed into national and sub-national climate change mitigation and adaptation plans as 'natural climate solutions', in efforts aiming to keep temperatures within a limit of 1.5°C as per the Paris Agreement.
- By 2022, identify potential synergies with other multi-lateral environmental agreements to streamline reporting requirements. The *UN Decade on Ecosystem Restoration* (2021-2030) and the *2030 Agenda for Sustainable Development* provide opportunities in this respect.

Supporting on-the-ground Planning and Implementation of Connectivity Conservation:

- By 2021, focal areas for the retention and restoration of ecological networks and corridors of national, sub-national, and cross-border importance are acknowledged and/or identified and mapped (including using and improving upon existing mapping where possible).
- By 2022, FPT legislation, regulations, and/or policies are established or updated to formally designate and conserve ecological networks and corridors of national, sub-national and cross-border importance.
- By 2023, FPT governments establish or update financial programs for Crown lands and financial incentives for non-Crown lands to conserve areas important for ecological connectivity and advance connectivity conservation, prioritizing areas where ecological networks and corridors of national, sub-national and cross-border importance have been identified.
    - Financial programs exist to buy-out or compensate for rights to Crown lands that are important for connectivity, if the exercising of those rights has the potential to negatively affect ecological connectivity.
    - Financial programs exist to create wildlife crossings and fencing, or other effective mitigation measures, that help to restore ecological connectivity and reduce wildlife-vehicle collisions on Crown lands, making Canada's roads and railways safer for both motorists and wildlife.

- Financial programs exist to remove and/or remediate barriers to native aquatic species passage on Crown and non-Crown land to help restore freshwater ecological connectivity and reduce aquatic species mortality (e.g., turbine mortality at large dams). Incentives may include funding for barrier removal, installation of fishways, or other appropriate mitigation measures.

- Financial incentive programs exist to encourage and support 'on-the-ground' terrestrial ecological connectivity conservation, restoration and mitigation efforts on non-Crown lands. Incentives may be used for land securement, conservation easements, tax shifting, restoring degraded habitat, establishing wildlife crossings and wildlife-friendly or directional fencing.

- By 2023, plans are developed and implemented to ensure the Trans-Canada Highway and other major highways do not impede ecological connectivity and highlight best practices for connectivity conservation.

Collaboration and Engagement:

- By 2021, establish a national connectivity partnership, with additional partners continuing to be onboarded as conditions allow.

- By 2023, 'regional transboundary conservation cooperatives' (RTCCs) are established and resourced throughout Canada and coordinate cross-boundary and inter-agency conservation efforts, especially connectivity conservation efforts.

- By 2022, FPT governments develop a national ecological connectivity conservation strategy in collaboration with and endorsed by partners (e.g., Indigenous governments, communities, organizations and rights holders; industry; non-government organizations (NGOs)), and that outlines how Canada can achieve and maintain ecological connectivity over the long-term. In addition, the strategy should identify the means to implement the connectivity and integration targets in the CBD *Post-2020 Global Biodiversity Framework* and contribute to Canada's next *National Biodiversity Strategies and Action Plan* (NBSAP).

- By 2022, Canadian governments adopt specific connectivity targets for protected and conserved areas as well as for natural ecosystems.

Knowledge Management and Exchange:

- By 2021, all levels of government invest in research (e.g., social and natural science, Indigenous ways of knowing) and associated knowledge mobilization activities to support the effective implementation of connectivity conservation during all stages of management planning, including monitoring and evaluation.

As noted above, effective implementation of the *Post-2020 Global Biodiversity Framework*, which will be agreed upon at the fifteenth Conference of the Parties to the UN CBD in May 2021, may be humanity's last chance to prevent catastrophic loss of global biodiversity. Raising awareness of the costs of negatively impacting connectivity in decision-making, and the benefits of retaining and restoring connectivity, will be a necessary endeavour. Accordingly, adequate financing, adjustments to the legal, regulatory, and policy environments, and to the landscape of deliberate and inadvertent financial incentives that currently result in decisions that degrade connectivity, are urgently required. This can only be achieved through enhanced commitments to not only acquire but to effectively use multiple forms of evidence, inclusive of the natural and social sciences and Indigenous Knowledge, to support decisions aimed at securing conservation outcomes (Lemieux et al., 2018).

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Chignecto Provincial Park, Nova Scotia (Photo by Monique Cormier)

RÉSUMÉ EXÉCUTIF

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La diversité biologique de la Terre est confrontée à des menaces et à des pertes importantes en raison d'une multitude d'activités humaines, notamment, mais sans s'y limiter, l'urbanisation, l'utilisation des terres et le changement de la couverture terrestre, le changement climatique et la pollution (Ceballos et al., 2015; Science intergouvernementale-Plateforme politique sur la biodiversité et les services écosystémiques (IPBES), 2019). Une contribution majeure à ces menaces est la propension des populations à éliminer ou à dégrader les habitats et à fragmenter les écosystèmes en perturbant les flux écologiques, le mouvement des espèces et l'échange de gènes entre les populations (Belote, Beier, Creech, Wurtzebach, & Tabor, 2020; Haddad et al., 2015). Ces menaces et pertes de biodiversité représentent l'un des problèmes environnementaux les plus critiques auxquels la société est confrontée, menaçant les services écosystémiques, la santé et le bien-être humains (Plateforme intergouvernementale scientifique et politique sur la biodiversité et les services écosystémiques (IPBES), 2019; Ripple et al., 2017; Steffen et al., 2015). Un rapport récent du Swiss Re Institute a conclu que plus d'un cinquième de tous les pays sont menacés d'effondrement économique en raison d'un déclin de la biodiversité et des services écosystémiques associés (Swiss Re Institute, 2020). L'étude, qui est basée sur le nouvel indice de la biodiversité et des services écosystémiques du Swiss Re Institute, souligne que ni les économies en développement ni les économies avancées ne sont à l'abri de ces risques.

Deux des recommandations les plus fréquemment citées pour la protection de la biodiversité comprennent l'expansion des réseaux d'aires protégées et **l'amélioration de la connectivité** (Heller et Zavaleta, 2009). La connectivité écologique est le mouvement sans entrave des espèces et le flux des processus naturels qui soutiennent la vie sur Terre (Convention sur les espèces migratrices (CMS), 2020). Bien qu'elle soit importante en soi pour maintenir les interactions entre les espèces et les flux de gènes, la conservation de la connectivité est également vitale pour faciliter le mouvement et l'adaptation des espèces en réponse aux changements écologiques induits par le climat.

Au Canada, et dans une grande partie du monde, les activités humaines et les développements ont modifié les écosystèmes de manière à réduire la connectivité de nombreuses espèces, compromettant leur capacité de répondre à leurs besoins et contribuant au déclin des populations et à la perte d'espèces. Ce problème n'est pas nouveau. La dégradation des écosystèmes et la perte d'espèces et de diversité génétique résultant des activités humaines sont les principales raisons pour lesquelles le Canada a signé et ratifié *la Convention des Nations Unies sur la diversité biologique* (CDB) en 1992 (il y a près de 30 ans), et plus récemment a convenu de mettre en œuvre les objectifs et cibles associés du *Plan stratégique 2011-2020 pour la biodiversité,* y compris les 20 objectifs d'Aichi pour la biodiversité (Convention sur la diversité biologique, 2010). En mai 2021, les Parties à la CDB des Nations Unies, y compris le Canada, renouvelleront leur engagement à éviter une nouvelle perte de biodiversité en finalisant le *Cadre mondial de la biodiversité pour l'après-2020*, qui, au moment de la rédaction, est sous forme de projet (Convention sur la diversité biologique (CBD), 2020).

Une action stratégique clé de l'Objectif d'Aichi 11 appelait à la mise en place de réseaux bien connectés d'aires protégées et à d'autres mesures efficaces de conservation par zone (OECM). La cible 11 d'Aichi était reflétée dans la cible 1 *des objectifs et cibles 2020 en matière de biodiversité pour le Canada* (Environnement et Changement climatique Canada (ECCC), 2015). Alors que l'objectif 11 d'Aichi comprenait des éléments terrestres, d'eau douce et marins, l'objectif 1 du Canada se concentrait exclusivement sur les éléments terrestres et d'eau douce; la mise en œuvre du volet protection marine a été dirigée par Pêches et Océans Canada (MPO).

Global Biodiversity Outlook (GBO), la publication phare de la CDB des Nations Unies, a récemment révélé qu'au niveau mondial aucun des 20 objectifs d'Aichi n'a été pleinement atteint (bien que six objectifs aient été partiellement atteints: les objectifs 9, 11, 16, 17, 19 et 20) (Secrétariat de la Convention sur la diversité biologique, 2020). Malgré les progrès réalisés sur certains aspects de l'objectif 11 d'Aichi et de l'objectif 1 du Canada entre 2011 et 2020, notamment l'expansion de l'empreinte des aires protégées et conservées dans les écosystèmes terrestres, les paysages et les paysages aquatiques sont de plus en plus déconnectés, mettant en danger la viabilité des réseaux écologiques pour atteindre leurs objectifs prévus compromettant potentiellement des décennies d'investissements majeurs de ressources publiques et privées.

L'incapacité des Parties à la CDB des Nations Unies à atteindre les objectifs et les cibles du *Cadre stratégique sur la biodiversité 2011-2020* a rendu nécessaire la nécessité d'une vision renouvelée et d'un nouvel ensemble d'objectifs et de cibles visant à arrêter et inverser la perte de biodiversité en cours (Maxwell et al., 2020). Le *Cadre mondial de la biodiversité pour l'après-2020* s'appuiera sur le Plan stratégique pour la biodiversité 2011-2020 et définira un nouveau plan ambitieux pour mettre en œuvre une action à grande échelle afin de transformer la relation de la société avec la biodiversité et de garantir que, d'ici 2050, le

la vision partagée de «Vivre en harmonie avec la nature» se concrétise (encadré 1).

En plus de ces quatre objectifs à long terme pour 2050, le projet de cadre comprend huit jalons à évaluer en 2030 vers la réalisation des objectifs de 2050. L'objectif A.1 reconnaît spécifiquement la connectivité: **«La superficie, la connectivité et l'intégrité des systèmes naturels ont augmenté d'au moins [5%].»** Le projet de cadre comprend actuellement 20 cibles orientées vers l'action pour 2030 qui, si elles sont atteintes, contribueront aux jalons de 2030 et aux objectifs axés sur les résultats pour 2050. La connectivité est évidente dans deux cibles, notamment:

- **Cible 1.** D'ici à 2030, [50%] des zones terrestres et maritimes dans le monde font l'objet d'une planification spatiale visant à modifier l'utilisation des terres et de la mer, en conservant la plupart des zones intactes et sauvages existantes et en permettant de restaurer [X%] d'eau douce dégradée, les écosystèmes naturels marins et terrestres et la connectivité entre eux.
- **Objectif 2.** D'ici à 2030, protéger et conserver grâce à un système bien connecté et efficace d'aires protégées et d'autres mesures efficaces de conservation par zone au moins 30% de la planète, en mettant l'accent sur les zones particulièrement importantes pour la biodiversité (Convention sur la diversité biologique (CBD), 2020).

Le Cadre souligne que les actions pour atteindre ces objectifs doivent être mises en œuvre de manière cohérente et en harmonie avec la CDB des Nations Unies et ses Protocoles et d'autres obligations internationales pertinentes, en tenant compte des conditions socio-économiques nationales. Au Canada, la lettre de mandat de 2019 du ministre de l'Environnement et du Changement climatique du premier ministre Justin Trudeau a exhorté le ministre à:

«Travailler avec le ministre des Pêches, des Océans et de la Garde côtière canadienne pour présenter un nouveau plan ambitieux de conservation de 25 pour cent des terres du Canada et de 25 pour cent des océans du Canada d'ici 2025, pour atteindre 30 pour cent de chacun d'ici 2030. Ce plan devrait être fondé sur la science, les connaissances autochtones et les perspectives locales. » (Trudeau, 2019)

Représentant le Canada à l'événement « *Nature for Life'* » de l'ONU en septembre 2020, le premier ministre Trudeau a réitéré son engagement de protéger 30% des terres et des mers d'ici 2030 pour endiguer la perte de biodiversité et aider à galvaniser le soutien en faveur d'un accord plus large sur l'objectif.

Tout en acceptant la nécessité d'étendre la couverture des aires protégées et de conserver la connectivité et de reconnecter le Canada, le cas échéant, est une première étape cruciale, l'échec de la plupart des Parties à la CDB des Nations Unies à atteindre les objectifs et les cibles du Plan stratégique 2011-2020 pour la biodiversité nous indique il ne sera pas facile de réaliser les aspirations énoncées dans le nouveau cadre mondial de la biodiversité pour l'après-2020. De par sa nature même, s'éloigner du statu quo n'est jamais facile. Mais avec un leadership solide et progressiste, une telle opposition peut être surmontée pour le bien public au sens large.

À la lumière de ces grands défis, ce rapport fournit une analyse du paysage juridique, réglementaire, politique, de planification, de gouvernance, de connaissances et de mise en œuvre actuel pour maintenir et restaurer la connectivité écologique terrestre au Canada.

En fusionnant une revue de la littérature, des études de cas et une enquête sur la capacité organisationnelle et l'évaluation des besoins des praticiens de la connectivité et des intervenants, ce rapport identifie les lacunes, les obstacles, les réussites et les solutions dans les efforts visant

Encadré 1. La vision 2050 pour la biodiversité *de l'avant-projet de la CDB des Nations Unies du Cadre mondial de la biodiversité* pour l'après-2020 (Convention sur la diversité biologique (CDB), 2020).

La vision du cadre est un monde de vie en harmonie avec la nature où: «D'ici 2050, la biodiversité est valorisée, conservée, restaurée et utilisée à bon escient, en maintenant les services écosystémiques, en soutenant une planète saine et en procurant des avantages essentiels pour tous.»

Les quatre objectifs à long terme liés à la Vision 2050 pour la biodiversité comprennent:

1. La superficie, **la connectivité** et l'intégrité des écosystèmes naturels ont augmenté d'au moins [X%] pour soutenir des populations saines et résilientes de toutes les espèces tout en réduisant le nombre d'espèces menacées par [X%] et en maintenant la diversité génétique;
2. Les contributions de la nature aux êtres humains ont été appréciées, maintenues ou améliorées grâce à la conservation et à l'utilisation durable qui soutiennent [un] programme de développement mondial au bénéfice de tous;
3. Les avantages découlant de l'utilisation des ressources génétiques sont partagés de manière juste et équitable; et,
4. Des moyens de mise en œuvre sont disponibles pour atteindre tous les objectifs et cibles du cadre (Convention sur la diversité biologique (CDB), 2020).

à maintenir et à restaurer la connectivité au Canada. Il est organisé comme suit:

- **Chapitre 1:** Le besoin d'un Canada (re) connecté
- **Chapitre 2:** Gouvernance, droit et dimensions politiques de la conservation de la connectivité au Canada
- **Chapitre 3:** Études de cas sur la conservation de la connectivité au Canada
- **Chapitre 4:** Conservation de la connectivité au Canada Évaluation de la capacité organisationnelle et des besoins
- **Chapitre 5:** (Re) Connecter le Canada: préparer le terrain pour la transformation

Le tableau 1 présente un résumé des principaux obstacles et besoins associés à la mise en œuvre de la conservation de la connectivité au Canada, tels qu'identifiés dans notre enquête pancanadienne auprès des praticiens des aires protégées. D'une manière générale, la capacité globale de mise en œuvre de la conservation de la connectivité parmi toutes les principales agences d'aires protégées est faible à modérée. Les stratégies d'aires protégées ont tendance à être dépassées, axées sur l'achèvement des systèmes d'aires protégées sur la base de la représentation, et excluent généralement les objectifs et cibles explicites pour la conservation de la connectivité. En outre, peu de cadres politiques pour l'intégration de la conservation de la connectivité ont été créés et sont généralement traités comme une priorité secondaire derrière le développement économique.

Des barrières systémiques persistent, notamment des ressources humaines et financières inadéquates pour soutenir la recherche pour comprendre les problèmes sociaux et scientifiques concernant la connectivité, favoriser et maintenir des partenariats de collaboration et mettre en œuvre des efforts de planification et d'atténuation à l'appui de la connectivité. Enfin, des mandats organisationnels différents, même au sein du gouvernement (par exemple, entre les ministères de la conservation, des transports et des ressources naturelles), le manque de dispositions au sein de l'évaluation environnementale / d'impact (EE / AI) et le manque d'intégration de la connectivité dans les initiatives des secteurs public et privé, y compris les projets de foresterie, d'exploitation minière, de transport et d'autres infrastructures, sont perçus comme des obstacles majeurs à la protection et au rétablissement efficaces de la connectivité au Canada.

Des obstacles systémiques importants à la mise en œuvre efficace de la conservation de la connectivité existent, et pourtant il existe de nombreux exemples d'opportunités actuelles et de succès récents. Par exemple, alors que les gouvernements locaux représentent une petite partie de l'objet de ce rapport, il semble qu'ils ont été un peu plus efficaces pour intégrer les initiatives de conservation de la connectivité grâce à des initiatives de planification régionale et urbaine intégrées. De plus, comme le montrent les études de cas incluses dans ce rapport (chapitre 3), les relations entre certaines agences de conservation provinciales et des organisations foncières privées telles que Conservation de la nature Canada (CNC) ont aidé à faciliter la mise en œuvre de plusieurs initiatives efficaces de conservation de la connectivité.

Le rôle des peuples autochtones dans les efforts de conservation et leur importance pour le succès des accords de conservation comme le *Cadre mondial de la biodiversité pour l'après-2020* ont fait l'objet d'un discours et d'une action accrus au Canada (Artelle et al., 2019; Loring et Moola, 2020; Zurba, Beazley, anglais et Buchmann-Duck, 2019). Dans notre enquête pancanadienne sur la capacité de mettre en œuvre la conservation de la connectivité, les praticiens des aires protégées ont indiqué que certaines organisations ont du mal à intégrer les connaissances autochtones dans la planification de la conservation de la connectivité. Bien que cela ne soit pas révélé dans l'enquête, nous sommes d'avis qu'il est essentiel pour les organisations d'aires protégées de passer de `` l'intégration des connaissances autochtones '' à `` l'intégration '' de divers systèmes de connaissances et de modes de savoir, tels que la vision à deux yeux, en tissant ensemble les deux et les connaissances scientifiques occidentales, dans un `` espace éthique '', pour une planification et une gestion améliorées (Bartlett, Marshall et Marshall, 2012; Indigenous Circle of Experts (ICE), 2018; Lemieux, Groulx, Bocking et Beechey, 2018).

Il reste encore beaucoup à faire pour amplifier la conservation dirigée par les Autochtones au Canada, où «les gouvernements autochtones ont le rôle principal dans la *détermination des objectifs, des limites, des plans de gestion et des structures de gouvernance des IPCA [des aires protégées et conservées autochtones] dans le cadre de leur exercice de l'autodétermination»* (ICE, 2018: 36). La création récente d'IPCA au Canada représente des actions positives qui reconnaissent les rôles, responsabilités et contributions importants des peuples autochtones à la conservation in situ efficace de la biodiversité. Un engagement continu et un soutien à la conservation dirigée par les Autochtones seront nécessaires pour atteindre efficacement les résultats souhaités en matière de biodiversité après 2020.

Enfin, notre enquête a également révélé que les partenariats de collaboration avec la communauté de recherche au sens large, y compris les universités, ont aidé à compenser les problèmes de capacité en sciences sociales et naturelles liés à la conservation de la connectivité, grâce à des recherches qui ont soutenu l'inventaire, le suivi et l'évaluation.

Sur la base des résultats de la revue de la littérature, des études de cas et de l'enquête pancanadienne auprès des praticiens de la conservation, ainsi que d'un examen des recommandations élaborées par Lemieux et al. (2020) et la consultation du Groupe de travail sur la connectivité de la voie vers l'objectif 1 du Canada, une série de mesures principales et de soutien visant à accroître le maintien et le rétablissement de la connectivité au Canada sont recommandées. Bon nombre de ces recommandations appellent à renforcer les capacités, la responsabilité et les

Tableau 1. Certains obstacles organisationnels et besoins associés à la mise en œuvre d'initiatives de conservation de la connectivité au Canada, tels qu'identifiés dans une enquête pan-canadienne auprès des praticiens des aires protégées.

Thème de capacité organisationelle	Obstacles	Besoins
Gouvernance adaptive (cadre de politiques et de législation) - "intégration"	De nombreuses organisations manquent de politique, de législation et d'orientation spécifiquement pour la conservation de la connectivité. Les stratégies de croissance provinciales ont tendance à favoriser l'étalement pour s'adapter à la croissance démographique et économique sans tenir compte de la connectivité. Les priorités des autres agences gouvernementales, telles que celles liées aux transports, à l'énergie et aux mines, sont perçues comme un obstacle à la mise en œuvre de la conservation de la connectivité. Il y a un manque d'incitations ou de pressions politiques pour développer et mettre en œuvre une politique de connectivité. Les ressources humaines et financières consacrées à la conservation de la connectivité sont faibles.	Leadership efficace pour coordonner les actions des gouvernements fédéral-provinciaux / territoriaux et locaux. Une recommandation transformatrice comprenait la création d'une nouvelle agence pour coordonner, faciliter et mettre en œuvre une vision de conservation de la connectivité pour le Canada. Des objectifs et des indicateurs de connectivité établis légalement pourraient attirer l'attention de «l'ensemble du gouvernement» et, en particulier, la capacité et la volonté d'influencer la prise de décision sur l'utilisation des terres en dehors des limites des aires protégées pour maintenir et restaurer la connectivité. La protection et la connectivité des écosystèmes devraient être intégrées en dehors des limites des aires protégées traditionnelles, par le biais de processus de planification clés tels que les évaluations environnementales / d'impact (EE et AI). Tous les principaux secteurs d'utilisation des terres devraient avoir du personnel dédié à la connectivité de la conservation. Cela comprend le transport, l'exploitation minière, le pétrole et le gaz, la foresterie, les aires protégées, la biodiversité / faune, les terres de la Couronne, l'agriculture et tout autre organisme pertinent.
Soutenir la planification et la mise en œuvre sur le terrain de la conservation de la connectivité	Dans de nombreux cas, des zones de connectivité clés ont été identifiées, mais n'ont pas été acquises et / ou restaurées. Les agences de conservation provinciales et territoriales doivent relever des défis importants en travaillant avec d'autres ministères au sein de leur propre gouvernement. Certaines juridictions ne parrainent pas de programmes d'incitation pour l'entretien et / ou la restauration des zones connectées en dehors des zones protégées.	Des révisions importantes des règles et des règlements d'utilisation des terres sont nécessaires pour influer sur le changement, y compris la révision des critères qui définissent les conditions dans lesquelles les activités de développement proposées font l'objet d'une EE. Les plans du système d'aires protégées, les autres plans de développement, les plans de croissance urbaine et les plans régionaux d'utilisation des terres devraient être mis à jour pour inclure la conservation de la connectivité. Il est nécessaire de mieux comprendre et reconnaître les services écosystémiques fournis par les aires protégées, ce qui pourrait conduire à une intégration réelle et concrète des objectifs de conservation de la connectivité. Des métriques de connectivité pour le suivi et l'évaluation sont nécessaires. Des outils qualitatifs et quantitatifs pour évaluer la conservation de la connectivité sont nécessaires pour évaluer les critères écologiques, mais aussi pour évaluer les besoins, les réponses et l'opinion des experts et du public. De meilleurs partenariats avec des institutions de recherche, telles que les universités, sont nécessaires pour soutenir la recherche et la surveillance socio-écologiques.
Collaboration et engagement	Les efforts de collaboration existants ont été en grande partie ponctuels et informels. Pour beaucoup, la collaboration impliquant des partenaires aux mandats très différents de ceux des partenaires habituels responsables des aires protégées, des agences de protection de la faune, des fiducies foncières et des universitaires en est à ses débuts, y compris les agences de transport et les municipalités.	Il faut une collaboration officielle entre les municipalités, les chercheurs, les universités et les organismes provinciaux / territoriaux et fédéraux pour partager les connaissances et les leçons apprises.

Thème de capacité organisationelle	Obstacles	Besoins
Gestion et échange des connaissances	Les possibilités de formation sont limitées. La formation n'est pas considérée comme efficace ou utile s'il n'est pas possible de la mettre en œuvre. Les décideurs sont confrontés à des conflits d'intérêts, qui sont principalement de nature politique, de sorte qu'un investissement massif dans la science ne se traduit pas nécessairement par des décisions guidées par la science. L'absence d'objectifs spécifiques pour la conservation de la connectivité a entraîné une faible intégration de l'inventaire et du suivi. De nombreux organismes ont fait état d'une volonté d'intégrer les connaissances autochtones dans la planification de la connectivité, mais ont noté que cela n'a pas été fait ou en est aux premiers stades de mise en œuvre en raison de contraintes de capacité.	Il est nécessaire d'aider le personnel à assister à des conférences internationales sur les transports et la faune, l'écologie du paysage et d'autres domaines pertinents pour la conservation de la connectivité. Un personnel dévoué et expérimenté est nécessaire pour gagner la confiance des communautés et veiller à ce que diverses formes de connaissances (p. Des données sur l'efficacité des mesures d'atténuation sont nécessaires.

incitations dans les activités de ceux qui ont le plus grand impact potentiel et influence sur la connectivité de manière à la fois positive et négative.

En fin de compte, l'objectif est que la conservation de la connectivité fondée sur des preuves soit plus intégrée, au moyen de l'intégration de la législation et des politiques, en fournissant des incitations à conserver et à restaurer et en mettant en œuvre des mesures dissuasives pour dégrader ou ignorer la connectivité, dans les processus de prise de décision.

Les recommandations qui découlent de la large discussion ci-dessus sont présentées ci-dessous. Bien que certains de ces délais puissent sembler ambitieux, des changements transformationnels dans les priorités, les systèmes de gouvernance, la fonction institutionnelle, la planification, la gestion de l'information et le renforcement des capacités, comme indiqué ci-dessus, sont nécessaires de toute urgence pour atteindre les objectifs de conservation nationaux et internationaux du Canada.

Les principales recommandations stratégiques comprennent :

1. Intégration de la conservation de la connectivité en adaptant le paysage législatif, réglementaire et politique pour élever la prise en compte de la conservation de la connectivité dans la prise de décision, de sorte que ceux dont les activités pourraient la dégrader soient responsables de prévenir, restaurer, atténuer et compenser les impacts sur la connectivité, y compris les coûts de cette opération.
2. Accorder la priorité au financement de la conservation et de la restauration de la conservation de la connectivité sur le terrain entrepris par un large éventail de promoteurs et d'influenceurs traditionnels et nouveaux de la conservation de la connectivité.
3. Favoriser la collaboration entre les promoteurs et les influenceurs de la conservation de la connectivité.
4. Investir dans la recherche en sciences sociales et naturelles pour constituer la base de données factuelle nécessaire à la mise en œuvre efficace de la conservation de la connectivité à toutes les étapes de la planification de la gestion, y compris la surveillance et l'évaluation, dans le but d'optimiser les résultats pour la biodiversité au Canada.

LES PRINCIPALES RECOMMANDATIONS, AVEC DES CALENDRIERS SUGGÉRÉS, COMPRENNENT :

Gouvernance adaptive (cadre de politiques et de législation) - "intégration"

- D'ici 2021, les programmes fédéraux de financement des infrastructures exigent que les impacts négatifs sur la connectivité écologique soient évités et atténués, les coûts associés étant intégrés dans les propositions de projet (p. Ex. Autoroutes, chemins de fer et corridors énergétiques).
- D'ici 2022, la législation, la réglementation et / ou les politiques fédérales, provinciales et territoriales (FPT) pour les EE / AI sont mises à jour pour s'assurer que les activités de développement qui peuvent avoir un impact négatif sur la connectivité sont soumises à une EE / AI et nécessitent la prévention des impacts atténués et rétablis en tant que coûts des engagements.
- D'ici 2023, la législation, les règlements et / ou les politiques FPT régissant les espèces aquatiques et

terrestres et / ou la gestion des terres et des eaux douces sont mis à jour au besoin pour inclure les responsabilités de restauration et de conservation de la connectivité écologique. Les agences concernées comprennent, mais sans s'y limiter, les responsables:

  - du transport (y compris les principaux organismes de transport municipaux);
  - des zones protégées;
  - de la biodiversité;
  - en administration des terres de la Couronne;
  - de la surveillance du gouvernement municipal;
  - de foresterie;
  - en agriculture; et,
  - en énergie et mines.

- D'ici 2022, les lois provinciales et territoriales régissant les administrations municipales revendiquent les intérêts en matière de connectivité et exigent que la planification municipale maintienne et rétablisse la connectivité, notamment en exigeant que les coûts de prévention, d'atténuation et de compensation des impacts soient à la charge de ceux qui entreprennent des aménagements.

- D'ici 2021, la législation, les règlements et les politiques régissant les activités qui influencent la connectivité écologique sont suivis et activement appliqués par les gouvernements FPT en investissant dans un personnel et des ressources adéquats.

- D'ici 2022, les aires protégées, les OECM et d'autres mesures de soutien à la conservation de la connectivité seront intégrées dans les plans nationaux et infranationaux d'atténuation et d'adaptation au changement climatique en tant que `` solutions climatiques naturelles '', dans le but de maintenir les températures dans une limite de 1,5 ° C conformément à l'Accord de Paris.

- D'ici 2022, identifier les synergies potentielles avec d'autres accords environnementaux multilatéraux afin de rationaliser les exigences en matière de rapports. La Décennie des Nations Unies pour la restauration des écosystèmes (2021-2030) et le Programme de développement durable à l'horizon 2030 offrent des opportunités à cet égard.

Soutenir la planification et la mise en œuvre sur le terrain de la conservation de la connectivité :

- D'ici 2021, les domaines d'intervention pour la conservation et la restauration des réseaux et corridors écologiques d'importance nationale, infranationale et transfrontalière sont reconnus et / ou identifiés et cartographiés (y compris l'utilisation et l'amélioration de la cartographie existante lorsque cela est possible).

- D'ici 2022, la législation, la réglementation et / ou les politiques FPT sont établies ou mises à jour pour désigner et conserver formellement les réseaux et corridors écologiques d'importance nationale, infranationale et transfrontalière.

- D'ici 2023, les gouvernements FPT établissent ou mettent à jour des programmes financiers pour les terres de la Couronne et des incitatifs financiers pour les terres non publiques afin de conserver les zones importantes pour la connectivité écologique et faire progresser la conservation de la connectivité, en priorisant les zones où les réseaux écologiques et les couloirs de l'importance de la frontière a été identifiée.

  - Des programmes financiers existent pour racheter ou compenser les droits sur les terres de la Couronne qui sont importants pour la connectivité, si l'exercice de ces droits peut avoir des effets négatifs sur la connectivité écologique.

  - Des programmes financiers existent pour créer des passages et des clôtures pour la faune, ou d'autres mesures d'atténuation efficaces, qui aident à rétablir la connectivité écologique et à réduire les collisions entre la faune et les véhicules sur les terres de la Couronne, rendant les routes et les voies ferrées du Canada plus sûres pour les automobilistes et la faune.

  - Des programmes financiers existent pour éliminer et / ou diminuer les obstacles au passage des espèces aquatiques indigènes sur les terres de la Couronne ou non afin d'aider à restaurer la connectivité écologique de l'eau douce et à réduire la mortalité des espèces aquatiques (p. ex., la mortalité due aux turbines dans les grands barrages). Les incitatifs peuvent comprendre le financement de l'élimination des barrières, l'installation de passes à poissons ou d'autres mesures d'atténuation appropriées.

  - Des programmes d'incitation financière existent pour encourager et soutenir les efforts de conservation, de restauration et d'atténuation de la connectivité écologique terrestre «sur le terrain» sur les terres non publiques. Des incitations peuvent être utilisées pour la sécurisation des terres, les servitudes de conservation, le transfert de taxes, la restauration de l'habitat dégradé, l'établissement de passages pour la faune et des clôtures directionnelles ou respectueuses de la faune.

  - D'ici 2023, des plans sont élaborés et mis en œuvre pour s'assurer que la Transcanadienne et les autres autoroutes majeures n'entravent pas la connectivité écologique et mettent en évidence les meilleures pratiques pour la conservation de la connectivité.

Collaboration et engagement :

- D'ici 2021, établir un partenariat national pour la connectivité, avec d'autres partenaires qui

continueront d'être intégrés dans la mesure où les conditions le permettront.

- D'ici 2023, des «coopératives régionales de conservation transfrontalières» (RTCC) sont établies et dotées de ressources partout au Canada et coordonnent les efforts de conservation transfrontaliers et inter-institutions, en particulier les efforts de conservation de la connectivité.

- D'ici 2022, les gouvernements FPT élaborent une stratégie nationale de conservation de la connectivité écologique en collaboration avec des partenaires (p. Ex., Gouvernements autochtones, communautés, organisations et détenteurs de droits; industrie; organisations non gouvernementales (ONG)) et qui décrit comment le Canada peut atteindre et maintenir la connectivité écologique à long terme. En outre, la stratégie devrait identifier les moyens de mettre en œuvre les objectifs de connectivité et d'intégration dans le *Cadre mondial de la biodiversité pour l'après-2020* de la CDB et contribuer aux prochaines *stratégies et plans d'action nationaux pour la biodiversité* (SPANB) du Canada.

- D'ici 2022, les gouvernements canadiens adopteront des objectifs de connectivité spécifiques pour les aires protégées et conservées ainsi que pour les écosystèmes naturels.

Gestion et échange des connaissances :

- D'ici 2021, tous les niveaux de gouvernement investissent dans la recherche (p. Ex. Sciences sociales et naturelles, modes de savoir autochtones) et les activités de mobilisation des connaissances associées pour soutenir la mise en œuvre efficace de la conservation de la connectivité à toutes les étapes de la planification de la gestion, y compris le suivi et l'évaluation.

Comme indiqué ci-dessus, la mise en œuvre effective du *Cadre mondial de la biodiversité pour l'après-2020*, qui sera convenu lors de la quinzième Conférence des Parties à la CDB des Nations Unies en mai 2021, pourrait être la dernière chance pour l'humanité de prévenir une perte catastrophique de la biodiversité mondiale. La sensibilisation aux coûts liés à la connectivité dans la prise de décision et aux avantages de la conservation et de la restauration de la connectivité sera une entreprise nécessaire. En conséquence, un financement adéquat, des ajustements aux environnements juridique, réglementaire et politique, et au paysage des incitations financières délibérées et involontaires qui aboutissent actuellement à des décisions qui dégradent la connectivité, sont nécessaires de toute urgence. Cet objectif ne peut être atteint que grâce à des engagements accrus non seulement pour acquérir, mais aussi pour utiliser efficacement de multiples formes de preuves, y compris les sciences naturelles et sociales et les connaissances autochtones, pour soutenir les décisions visant à obtenir des résultats en matière de conservation (Lemieux et al., 2018).

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American marten (*Martes americana*) (Photo by Paul J Hartley)

CHAPTER 1

The Need for a (Re)Connected Canada

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INTRODUCTION

Canada is the world's second largest country. It encompasses 10 million km^2 of terrestrial and freshwater ecosystems (6.0% of Earth's total), with 9% of Earth's forest, 24% of wetlands, and 20% of freshwater (Federal Provincial and Territorial Governments of Canada, 2010; National Advisory Panel, 2018). From a marine perspective, Canada is responsible for 243,000 km of coastline (39.2% of the Earth's ocean coastline) and 5.6 million km^2 of marine ecosystems (1.6% of Earth's total) (Federal Provincial and Territorial Governments of Canada, 2010; National Advisory Panel, 2018). These ecosystems support 80,000 species (not including viruses and bacteria) (Canadian Endangered Species Conservation Council (CESC), 2015), including 300 that occur nowhere else in the world (Enns et al., 2020).

In recent years, federal, provincial/territorial, and regional/municipal governments, Indigenous Peoples, private landowners, and conservation organizations have made substantial progress in protecting these diverse ecosystems and species. The latest report from the Canadian Protected and Conserved Areas Database (CPCAD) states that 12.1% of Canada's total terrestrial area is 'protected' (Environment and Climate Change Canada (ECCC), 2020) (Figure 1). These totals include protected areas as well as other effective area-based conservation measures (OECMs; that is, areas that do not meet the formal definition of protected area but are intended to be managed in a way that conserves biodiversity over the long-term). Since 1990, Canada's total terrestrial area allocated to protected areas and OECMs has more than doubled (5.8% to 12.1% during this time) (Environment and Climate Change Canada (ECCC), 2020). Overall, however, Canada remains below the global average in terms of total terrestrial area allocated to protected areas and OECMs (15.0%) (UNEP-WCMC IUCN and NGS, 2020), and below the committment of at least 17% as signatory to the Convention on Biological Diversity.

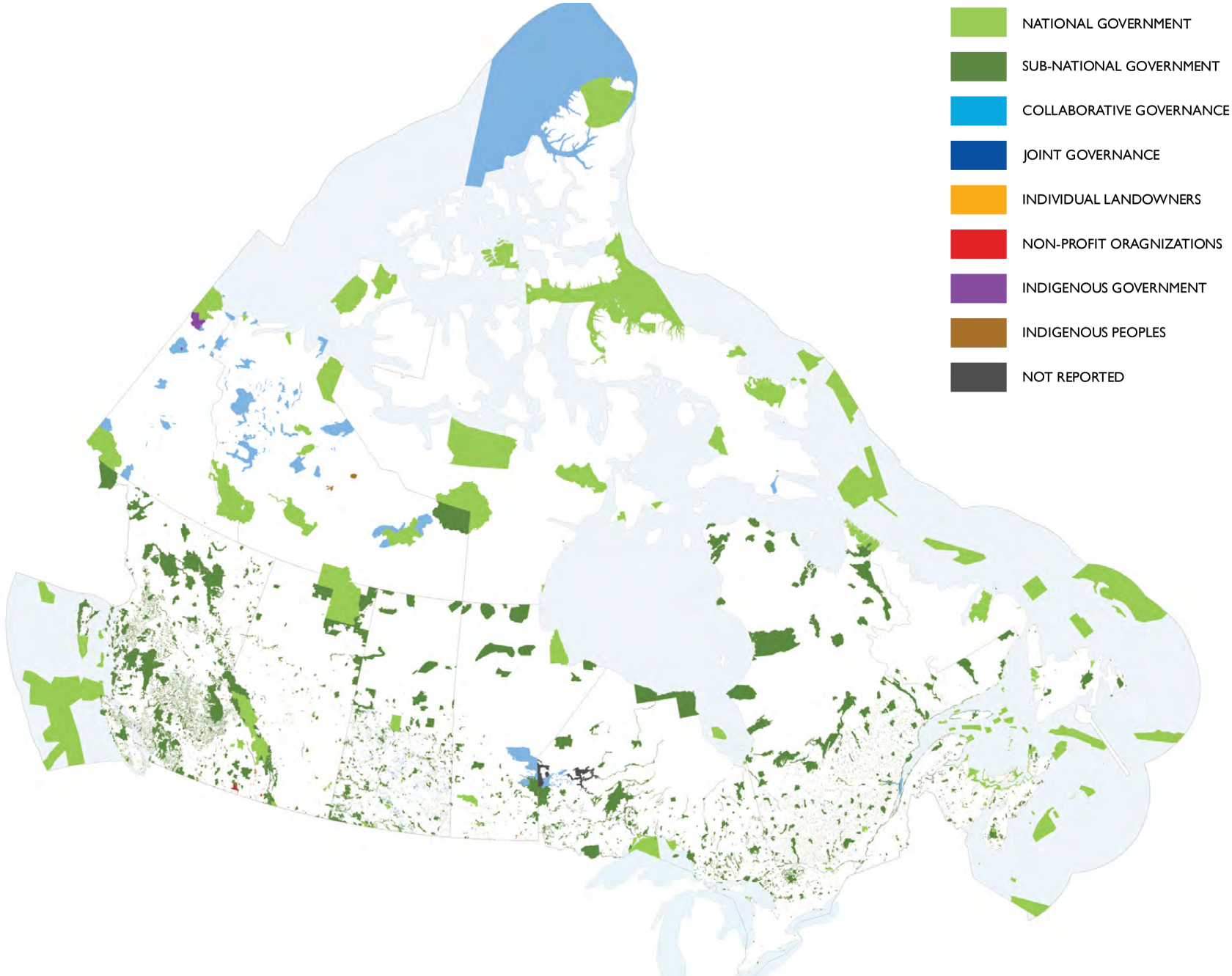
Despite the increase in both Canada's and the world's protected areas estate in recent years, a study published in *Nature* revealed that this growth in area has had limited success in protecting biodiversity and ecosystem services. The study found that only 21.7% of species assessed as threatened with extinction on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species™ were adequately represented within the world's protected areas in 2019 – only slightly more than 18.9% in 2010 when the Aichi Biodiversity Targets were adopted (discussed in more detail below) (Maxwell et al., 2020). A third of Key Biodiversity Areas (KBAs) – areas that contribute substantially to the global persistence of biodiversity – and more than half of all ecosystems on land and in oceans remain without adequate protection (Maxwell et al., 2020). Similar results have been found for Canada. For example, World Wildlife Fund (WWF)-Canada recently determined that 45% of the country's near 6,500 terrestrial habitats remain unprotected, and 31% are considered not adequately protected (World Wildlife Fund (WWF)-Canada, 2019). Furthermore, recent research shows that Canada's protected areas estate covers 14-16% of hotspots for ecosystem service capacity across the country (i.e., places where nature supplies carbon storage and the potential for freshwater and nature-based recreation) and only 11-12% of hotspots for provision (i.e., the places where human access and demand mean people receive the benefit) (Mitchell et al., 2021); the network of federal protected areas has particularly poor overlap with hotspots of ecosystem service capacity and provision. On the other hand, over half to two-thirds of the places identified as provision hotspots overlap with natural resource tenures.

Like other jurisdictions in the world, increasing demand for access to natural assets, land-use change, roads, pollution, and other cumulative effects resulting from human activities are implicated in a variety of coincident impacts affecting ecosystem health in Canada's terrestrial, inland water, coastal, and marine ecosystems (Federal, Provincial and Territorial Governments of Canada, 2010). This includes habitat loss, fragmentation and degradation, associated declines in species populations, increased risks to rare ecosystems and species, increases in wildfire, and significant shifts in marine, freshwater, and terrestrial food webs (Environment Canada, 2014; Federal Provincial and Territorial Governments of Canada, 2010).

The cumulative effects of these impacts on Canada's biodiversity are of increasing concern. Populations of Canadian species assessed as at risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) have declined by 59%, on average, from 1970-2016 (World Wildlife Fund (WWF)-Canada, 2020). Species of global conservation concern — assessed as threatened on the IUCN Red List of Threatened Species™ — also have declined in Canada by 42%, on average, from 1970-2016 (World Wildlife Fund (WWF)-Canada, 2020). The most recent (2019-2020) annual report by COSEWIC listed 810 wildlife species in various risk categories including 363 Endangered, 190 Threatened, 235 Special Concern, and 22 Extirpated (i.e., no longer found in the wild in Canada) (Committee on the Status of Endangered Wildlife in Canada (COSEWIC), 2020). In addition, 19 wildlife species have been assessed as Extinct (Committee on the Status of Endangered Wildlife in Canada (COSEWIC), 2020).

These trends show that Canada's biodiversity is under systemic pressure. Urbanization, economic growth, and a reliance on natural resources continue to result in species declines, attributed to the associated declines in the ecosystems that these species rely upon. And while protected areas will remain critical to the future of biodiversity, the nation's existing protected areas estate has been criticized for being too small, too isolated and inadequate in terms of ecosystem coverage to effectively conserve biodiversity over both short and long terms. Of particular note are gaps in representation and connectivity, particularly in the most northern and southern regions of Canada and in coastal and aquatic ecosystems. Furthermore, connectivity between 79% of Canada's near 6,500 physical habitats (as defined by the WWF) is either inadequately or not at all protected (World Wildlife Fund (WWF)-Canada, 2020). In a global assessment, less than 4% of Canada's lands were considered 'well protected and connected', below the global average of 7.5% and far short of the Aichi target of

Figure 1. Protected areas and other effective area-based conservation measures (OECMs) coverage in Canada (Environment and Climate Change Canada (ECCC), 2020). This map includes protected areas as well as areas conserved with other measures (that is, areas that do not meet the formal definition of protected area but are managed in a way that conserves biodiversity over the long-term).



at least 17% of land covered by well-connected protected areas (Saura et al., 2018).

On top of this, a large fraction of terrestrial and freshwater species face increased extinction risk under projected climate change, especially as climate change interacts with other stressors such as habitat modification, over-exploitation, pollution, and invasive species (Intergovernmental Panel on Climate Change (IPCC), 2018). Canada's ecosystems and species are already responding to climate change, a phenomenon projected to be exacerbated in the future (Bush & Lemmen, 2019), consistent with modeled projections of species range shifts and turn-over rates (losses and gains) in Canada and within its protected areas estate (Lindsay et al., 2016). The Intergovernmental Panel on Climate Change (IPCC) estimates that 20-30% of the plant and animal species evaluated so far in climate change studies are at risk of extinction if temperatures reach the levels projected to occur by the end of the century (Intergovernmental Panel on Climate Change, 2014). More recently, a study published in the *Proceedings of the National Academy of Sciences of the United States of America* (PNAS) found that one-third of all plant and animal species could be extinct by 2070 as a result of climate change (Román-Palacios & Wiens, 2020). Given that northern Canada has warmed and will continue to warm at more than double the global rate, terrestrial, freshwater, and marine ecosystems in this region will be particularly vulnerable (Bush & Lemmen, 2019).

In response to these issues and trends, a global *2011-2020 Strategic Plan for Biodiversity* was adopted in 2010 by Parties to the United Nations (UN) *Convention on Biological Diversity* (CBD). Canada, the European community, and 195 other member states are Parties to the CBD. The *Strategic Plan* included 20 biodiversity targets, known as the Aichi Targets, to be achieved by 2020 to help reverse the decline of biodiversity. Aichi Target 11 focused on the conservation of biological diversity through networks of connected protected and conserved areas (Box 1).

Parties were urged to develop their own national targets in support of the Strategic Plan using the Aichi Targets as a guide. In 2015, the federal government issued the *2020 Biodiversity Goals and Targets for Canada*, a suite of 19 targets covering issues ranging from species at risk to sustainable forestry to connecting Canadians to nature. Canada's Target 1 is generally aligned with Aichi Target 11 (Environment and Climate Change Canada (ECCC), 2015).

Box 1. The 2050 Vision for Biodiversity of the UN CBD Box 1. Aichi Target 11 of the *2011-2020 Strategic Plan for Biodiversity*.

Target 11: By 2020, at least 17 per cent of terrestrial and inland water areas and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascape.

In 2018, the CBD noted that despite many positive actions by Parties and others since 2010, most of the Aichi Biodiversity Targets would not be achieved by the end of 2020 (Convention on Biological Diversity (CBD), 2018). *Global Biodiversity Outlook 5*, the flagship publication of the UN CBD, recently confirmed this forecast and concluded that, at the global level, none of the 20 Aichi Targets has been fully achieved and only six targets have been partially achieved (Targets 9, 11, 16, 17, 19 and 20) (Secretariat of the Convention on Biological Diversity, 2020).

While Canada has yet to report on the status of its biodiversity goals and targets, it is unlikely that any will be fully achieved. A 2013 accountability report from the Commissioner of the Environment and Sustainable Development warned that Canada did not have clear plans to implement its international or national commitments to biodiversity conservation and recommended adding more specificity to its national targets and defining the key actions and initiatives required to achieve them (Office of the Auditor General of Canada, 2013). Five years later, another report by the Commissioner found that Environment and Climate Change Canada (ECCC) did not provide effective leadership in the implementation of the UN CBD *Strategic Framework on Biodiversity 2011-2020*, nor did they effectively coordinate the actions required to achieve Canada's 2020 biodiversity targets (Office of the Auditor General of Canada, 2018). That said, in the 2018 federal government allocated $1.35 billion over five years (including leveraging partnership support from foundations, provinces, territories, corporate and non-profit sectors, and others) to support the protection of Canadian ecosystems, landscapes, and biodiversity—including species at risk. The Canada Nature Fund was available to not-for-profit and Indigenous organizations, provinces and territories, and others, and has supported many conservation and protected areas initiatives across the country.

In addition to the lack of federal leadership, at least in the first several years of the UN CBD *Strategic Framework on Biodiversity 2011-2020*, a few additional challenges to effectively conserving biodiversity include inadequate staffing levels and financial resources, a lack of research and monitoring programs to assess the effects of management decisions (Office of the Auditor General of Canada, 2013), and a disconnect between researchers and decision-makers to support the planning and implementation of conservation efforts (Lemieux, Groulx, Bocking, & Beechey, 2018). In many instances, these institutional failures have significantly affected the ability of organizations responsible for Canada's conserved areas to achieve their legislated mandates (e.g., Auditor General of British Columbia, 2010).

Because of this, the strategic outcomes anticipated from the variety of commitments to biodiversity conservation, from the international to the provincial and territorial, remain elusive due to an assortment of social and ecological

challenges that hamper the capacity of institutions to maintain ecosystem integrity and halt (and reverse) the decline of biodiversity. The failure of Parties to the UN CBD to meet the goals and targets of the *Strategic Framework on Biodiversity 2011-2020* has necessitated the need for a renewed vision and new set of goals and targets aimed at reversing biodiversity losses (Maxwell et al., 2020). The *Post-2020 Global Biodiversity Framework* builds on the *Strategic Plan for Biodiversity 2011-2020* and will set an ambitious plan to implement broad-based action to bring about a transformation in society's relationship with biodiversity (see Box 1 in Executive Summary). While all of the goals and targets of the draft *Post-2020 Global Biodiversity Framework* are relevant to the discussions contained within this report, targets 1 and 2 specifically focus on the need for protected area and OECM expansion as well as a heightened awareness (compared to the 2011-2020 strategic plan) to retain and enhance connectivity (Box 2).

Box 2. Targets 1 and 2 of the updated draft *Post-2020 Global Biodiversity Framework*.

- **Target 1**. By 2030, [50%] of land and sea areas globally are under spatial planning addressing land/sea use change, retaining most of the existing intact and wilderness areas, and allow to restore [X%] of degraded freshwater, marine and terrestrial natural ecosystems and connectivity among them.
- **Target 2.** "By 2030, protect and conserve through well connected and effective system of protected areas and other effective area-based conservation measures at least 30 per cent of the planet with the focus on areas particularly important for biodiversity." (Convention on Biological Diversity (CBD), 2020)

THE GRAND CHALLENGE OF EFFECTIVELY CONSERVING BIODIVERSITY IN CANADA

Despite the significant expansion of Canada's protected and conserved area noted above, the evidence is clear: **Canada is not effectively meeting its intended goal of protecting biodiversity.** Much of Canada's attention over the past half-decade has focused on achieving the percentage area targets associated with Aichi Target 11 of the *2011-2020 Strategic Plan for Biodiversity*. While the area encompassed by protected and conserved areas is an important factor of biodiversity conservation, there is general agreement that the focus on protected area quantity is too narrow, particularly in view of the fact that habitat quality is just as critical to ecological integrity.

As a number of authors have repeatedly emphasized, the narrow focus on percentage area targets will inevitably lead to a partial, low quality, and ineffective collection of isolated protected and conserved areas across Canada (Lemieux et al., 2019; MacKinnon et al., 2015; Woodley et al., 2019). Accordingly, it is incumbent upon the Canadian jurisdictions to factor in all of the elements that comprise Aichi Target 11 (biodiversity, representativeness, connectivity, ecosystem services, equity, effectiveness management, and the integration into the wider landscapes and waterscapes), many of which are retained in the draft text of the *Post-2020 Global Biodiversity Framework*, if we hope to ecologically reconnect Canada.

THE CONNECTIVITY CONSERVATION IMPERATIVE

Canada's Pathway to Target 1 initiative identified three key challenges to biodiversity conservation: ensuring protection of 1) the right types (e.g., quality - what should these areas look like?) and 2) amount of habitat (e.g., quantity - how much is enough?), and 3) in the right ways (e.g., how do we use the answers to quality and quantity to meet biodiversity conservation target commitments) (Pathway to Target 1 National Steering Committee, 2018). While protected areas will remain the most effective means of addressing key threats to biodiversity from habitat loss, degradation, conversion and fragmentation, it is critically important to maintain, enhance, and restore ecological connectivity in order to protect the movement of species and flow of natural processes that sustain life on Earth. As a recent analysis on the current status of Canada's protected areas indicated, *"major opportunities to protect habitat and combat climate change are being overlooked"* (World Wildlife Fund (WWF)-Canada, 2019: 4).

Ecological connectivity is the unimpeded movement of species and the flow of natural processes that sustain life on Earth (Convention on Migratory Species (CMS), 2020a). It is one of the most studied features of ecosystem structure and function, and practitioners have developed and amassed a notable suite of tools and techniques to protect, restore, and secure areas of high connectivity value (Hilty et al., 2019, 2020; Keeley et al., 2019; National Steering Committe - Expert Task Team, 2017; Noseworthy, 2020). Scientists and practitioners have shown that conservation of species, habitats, and ecosystems can only be achieved if protected areas are functionally connected (Convention on Migratory Species (CMS), 2017, 2020b; Hilty et al., 2020 and many others).

Hilty et al. (2020) define and explain two terms which are critical to connectivity conservation: 'ecological network for conservation' and 'ecological corridor' (Box 3). Providing a clear definition of ecological networks for conservation and guidance on how to identify, establish, measure, and report on ecological corridors aids many countries in reaching the goal of identifying, establishing, managing and restoring 'well-connected systems'. For the purposes of this report, we adopt the definitions provided by Hilty et al. (2020).

Connectivity conservation will be key to the effective conservation of biodiversity (Coristine et al., 2018; Hilty et al., 2019; Keeley et al., 2018a, 2019). In conjunction with traditional protected area designations such as national and

Box 3. Definitions of 'ecological networks for conservation' and 'ecological corridor' (Hilty et al., 2020).

An **ecological network for conservation** is a system of core habitats (protected areas, OECMs and other intact natural areas), connected by ecological corridors, which is established, restored as needed and maintained to conserve biological diversity in systems that have been or may otherwise become fragmented. Ecological networks are composed of core conservation units – protected areas and OECMs – connected with ecological corridors.

An **ecological corridor** is a clearly defined geographical space that is governed and managed over the long term to maintain or restore effective ecological connectivity. They denote areas within ecological networks that are explicitly devoted to ecological connectivity, and may incidentally also contribute directly to biodiversity conservation.

provincial parks, many jurisdictions have added other types of areas such as provincial conservation areas, protected ravines and watercourses in urban areas, private lands and, more recently, Indigenous Protected and Conserved Areas (IPCAs) to the conservation toolbox (Ervin et al., 2010). These areas are valuable in their own right, but also may serve to connect protected areas into the wider semi-natural and natural landscapes that collectively increase the probability of retaining connectivity or reconnecting Canada where appropriate.

A rich knowledge base of the social, scientific, and engineering aspects of connectivity conservation in the airscapes, landscapes and waterscapes is also emerging. However, translating this knowledge into preferred outcomes remains elusive (Keeley et al., 2018b). And while some examples at the science-practice interface of connectivity conservation provide key lessons on connectivity conservation implementation (Bormpoudakis & Tzanopoulos, 2019; Keeley et al., 2018b, 2019; Wyborn, 2011, 2015; Wyborn & Bixler, 2013), most of these examples are focused outside of Canada (e.g., Australia, England, and the U.S.).

Going forward, meeting the remaining portions of the Aichi Targets and additional targets resulting from adoption of the *Post-2020 Global Biodiversity Framework* with a representative and connected network of high functioning ecosystems and their habitats will require unprecedented commitment by Canadian jurisdictions. Indeed, addressing ongoing threats to biodiversity in Canada will require a significant and urgent increase in the total area of protected areas (including IPCAs and privately protected areas where appropriate), and OECMs, connected with ecological corridors, along with broader transformations in social, economic and governance systems (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2019).

OBJECTIVES OF THE REPORT

It is timely that the Federal, Provincial, and Territorial Departments Responsible for Parks, Protected Areas, Conservation, Wildlife and Biodiversity have accepted a mandate to help *"All Canadians embrace a collective approach to biodiversity conservation"* (Pathway to Target 1 National Steering Committee, 2018: 37). To this end, Canadian federal, provincial, and territorial ministers responsible for parks, protected areas, and biodiversity conservation launched the Pathway to Canada Target 1 in 2017, a national initiative designed to coordinate efforts to conserve at least 17% of Canada's terrestrial and inland water areas by 2020 through networks of protected and conserved areas. Months of collaboration and consultation resulted in the release of *One with Nature: A Renewed Approach to Land and Freshwater Conservation in Canada* (Pathway to Target 1 National Steering Committee, 2018). One of the commitments in the report included:

"Work together and within each jurisdiction to identify and address barriers and gaps to achieving the qualitative elements of Canada Target 1. Collaborative efforts to address these barriers and gaps will consider biodiversity conservation needs at a range of scales."

Achievement of Canada's conservation vision *"...will be an effort for all Canadians"* to engage in a *"...coordinated approach for achieving Canada's conservation goals..."* to *"... fulfill our international obligations, become a global leader in conserving Nature and biodiversity, address priorities such as climate change, and take steps toward reconciliation among peoples in Canada and with the Earth"* (Pathway to Target 1 National Steering Committee, 2018: 34). Indigenous Peoples are Canada's first peoples who have rights to and continue to live and work in large ecologically intact areas in many parts of the country (Artelle et al., 2019; Garnett et al., 2018; Loring & Moola, 2020; Schuster et al., 2019; Zurba et al., 2019). Indigenous peoples in Canada and around the world have long contributed to conservation and are integral to future success (Loring & Moola, 2020). There is growing recognition of the effective governance of Indigenous lands by Indigenous peoples, with 40% of the earth's most intact remaining biodiverse areas in Indigenous stewardship (Garnett et al., 2018), and Indigenous-managed lands hosting similar levels of vertebrate biodiversity as protected areas in Brazil, Canada, and Australia (Schuster et al., 2019).

Building on the inspirational work of the Indigenous Circle of Experts (ICE) and given that social connectivity and natural connectivity are integral elements of cultural life and individual health and well-being, leadership and participation by Indigenous peoples in Canada is also key to reconnecting Canada (Indigenous Circle of Experts (ICE), 2018). Social connectivity and connectivity with nature are core elements of Indigenous worldviews, where all living beings and spirits are connected (Indigenous Circle of Experts (ICE), 2018). As Elder Dave Courchene noted *"Our people have always*

Jumbo Valley, South East British Columbia (Photo Credit Alex Popov)

understood that 'all life is connected.' You cannot fragment the Earth with the policies or structures" (Indigenous Circle of Experts (ICE), 2018: 56).

Recognizing these crucial aspects of connectivity, key commitments are described in the *One with Nature* report (Pathway to Target 1 National Steering Committee, 2018). These include development of 1) a 'conservation toolbox' of best management practices, methods and technologies, and planning tools that can be shared widely and 2) collaborative initiatives to identify and address barriers and gaps that currently limit the ability of jurisdictions to include potential protected and conserved areas as part of Canada's Target 1 and Aichi target 11 commitments.

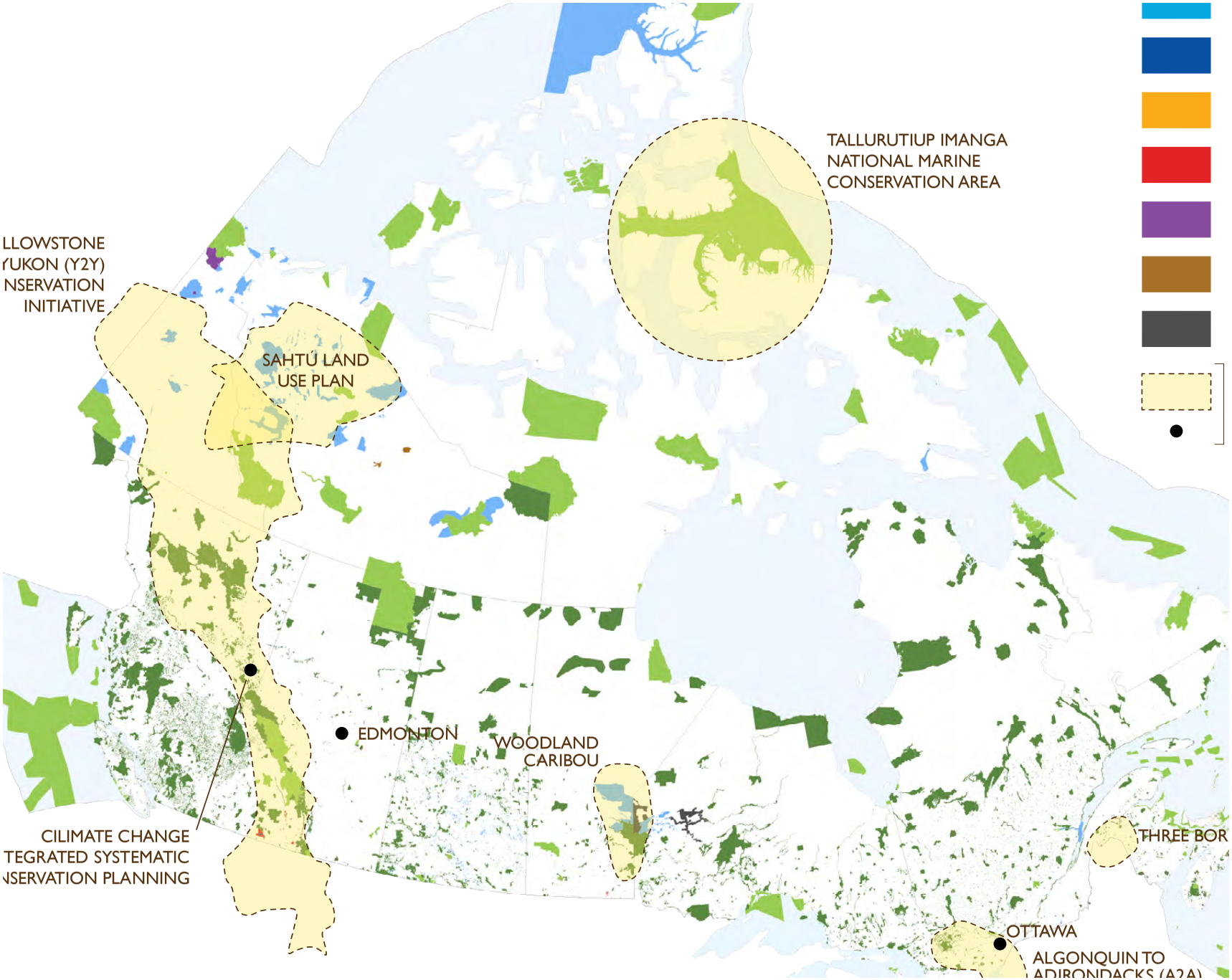
The Canadian Council on Ecological Areas (CCEA) and Pathway partners recognize that reversing the decline of biodiversity through the establishment of ecological networks for conservation will require immediate coordination of efforts if the goals and targets of the *Post-2020 Global Framework for Biodiversity* are to be achieved. Accordingly, through its Connectivity Working Group the Pathway partners sponsored this project designed to help assess progress and challenges related to connectivity conservation in Canada. It builds upon existing recent reports on ecological connectivity within Canada (National Steering Committee - Expert Task Team, 2017) and globally (Hilty et al., 2020). In collaboration with Pathway partners, the CCEA, and conservation experts from across Canada, the objectives of this report are to:

1. Summarize and assess approaches that have been used in Canada thus far and selected international examples, with some highlighted case studies;
2. Identify obstacles to achieving ecological connectivity in Canada, with an emphasis on connectivity between protected and conserved areas;
3. Identify the types of tools, best practices, guidance, and resources required by Canadian jurisdictions to address gaps and implement strategies;
4. Propose strategies to overcome obstacles that currently limit the capacity of Canadian agencies and organizations to achieve meaningful and socially acceptable levels of connectivity in ecosystems throughout Canada.

Although not included in the language of Canada Target 1, the timely establishment of effective ecological corridors will be crucial to physically reconnecting Canada and should be a key part of Canada's post-2020 conservation agenda. Ecological corridors contribute to the maintenance and enhancement of ecological integrity within protected and conserved areas and on the intervening landscapes and waterscapes; corridors can also supply or provide ecosystem services that contribute to the physical and mental health and well-being of people who live and work in or visit these areas. Furthermore, effective use of the variety of ecological networks for conservation provides important foundations for partnership, empowers people to assume ownership of the problems and opportunities created by climate change and other threats, and provides a mechanism for people to be part of the solution (Canadian Parks Council (CPC), 2013; Hilty et al., 2020; Lemieux et al., 2011).

While a fairly extensive scientific literature is devoted to the definition and classification of the types of ecological connectivity, and multi-scalar techniques of prioritizing connectivity requirements (see National Steering Committee - Expert Task Team, 2017), detailed empirical examinations of how connectivity is defined and operationalised by the agencies responsible for implementing connectivity initiatives is lacking (Keeley et al., 2018b). Similarly, few studies have explored the challenges, enablers, and needs of practitioners working to operationalise connectivity in landscapes and waterscapes. In addition to a literature review and survey, experts from across Canada completed 10 case studies on selected connectivity-related topics that range from systems level land use planning to climate change (Figure 2). Taken collectively, the case studies and survey results detailed within the report provide many lessons learned with regard to implementing connectivity conservation in Canada. Effective implementation of connectivity conservation will be

Figure 2. General locations of connectivity conservation case studies included in this report (map adapted from ECCC, 2020). Case studies in black font are included in Chapter 3, whereas case studies in light brown font represent shorter vignettes that have been placed throughout the report where appropriate.



key to maintaining the integrity of protected areas, increasing resilience to climate change, and will be fundamental to Canada's work to conserve biodiversity.

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Sahtu, NWT (Photo by Jean Polfus)

CHAPTER 2

Governance, Law and Policy Dimensions of Connectivity Conservation in Canada

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INTRODUCTION

Since the 5th International Union for the Conservation of Nature (IUCN) World Parks Congress took place in Durban, South Africa in 2003, concepts and practices related to the governance of protected and conserved areas has involved into a rapidly expanding and developing field of enquiry. The recognition of the importance of governance as a critical tool for effective and equitable conservation came after over a century of "fortress conservation" approaches where Indigenous peoples and local communities were displaced from protected areas and excluded from participation in decision-making.

Governance is defined as *"The interactions among structures, processes and traditions that determine how power and responsibilities are exercised, how decisions are taken and how citizens or other stakeholders have their say"* (Graham et al., 2003: 2-3). Broadly speaking, governance arrangements in and around protected areas can be quite diverse. Both IUCN and the United Nations (UN) *Convention on Biological Diversity* (CBD) recognize four broad types of protected area governance, defined on the basis of who holds authority, responsibility and can be held accountable for the key decisions (Table 1).

Table 1. IUCN governance types for protected areas (Dudley, 2008).

Governance type	Sub-types
Type A. Governance by government	• Federal or national ministry or agency in charge • Sub-national ministry or agency in charge (e.g., at regional, provincial, municipal level) • Government-delegated management (e.g., to an NGO)
Type B. Shared governance	• Transboundary governance (formal arrangements between one or more sovereign States or Territories) • Collaborative governance (through various ways in which diverse actors and institutions work together) • Joint governance (pluralist board or other multi-party governing body)
Type C. Private governance	• Privately Protected Areas established and run by: individual landowners; non-profit organisations (e.g., NGOs, universities); for-profit organisations (e.g., corporate landowners)
Type D. Governance by indigenous peoples and local communities	• Indigenous peoples' areas and territories established and run by Indigenous peoples • Community conserved areas and territories established and run by local communities

Box 1. Definition of Protected Areas, Other effective area-based conservation measures (OECMs), Indigenous Protected and Conserved Areas (IPCAs), and Privately Protected Area (PPA).

Protected Area: A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values (Dudley, 2013).

Other Effective Area-based Conservation Measure (OECM): A geographically defined area other than a Protected Area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the in situ conservation of biodiversity, with associated ecosystem functions and services and where applicable, cultural, spiritual, socio–economic, and other locally relevant values (International Union for the Conservation of Nature (IUCN)-World Commission on Protected Areas (WCPA), 2019).

Indigenous Protected and Conserved Area (IPCA): IPCAs are lands and waters where Indigenous governments have the primary role in protecting and conserving ecosystems through Indigenous laws, governance and knowledge systems. Culture and language are the heart and soul of an IPCA. While IPCAs vary in terms of their governance and management objectives, they generally share three essential elements: they are Indigenous-led; they represent a long-term commitment to conservation; and they elevate Indigenous rights and responsibilities (Indigenous Circle of Experts (ICE), 2018).

Privately Protected Area (PPA): PPAs can include governance by individuals and groups of individuals, non-governmental organisations, corporations, for profit owners, research entities or religious entities. Areas under private governance can also be classified as OECMs (Mitchell et al., 2018).

Within effective ecological networks, there are typically many different types of protected areas governed in a variety of ways. This is particularly true for connectivity since no protected area is sufficient to fully conserve all species and ecological functions that occur within its boundaries. Canada's conservation community is broad and growing. While 95% of Canada's protected areas are administered by federal, provincial, or territorial governments, the federal government administers or jointly administers approximately 45% of the terrestrial land area (Environment and Climate Change Canada (ECCC), 2016b), largely in northern Canada. That said, because federally protected areas tend to be

relatively large, the federal government is responsible for fewer protected areas by number than provincial governments. Thus, there is a lot more governance-type complexity in the Canadian mix of protected areas and other effective area-based conservation measures (OECMs). In recent years, Canada has begun to recognize OECMs on lands and oceans, and notable progress in the establishment of Indigenous Protected and Conserved Areas (IPCAs) has also been achieved. Furthermore, thousands of privately protected areas (PPAs) have been established primarily in southern Canada since the 1960s by the Nature Conservancy of Canada (NCC), Ducks Unlimited Canada and other land trusts.

As the IUCN World Commission on Protected Areas (WCPA) emphasizes, there is no "ideal governance setting" for all protected and conserved areas. However, a set of "good governance" principles can be taken into account vis-à-vis any protected area system or site (Borrini-Feyerabend et al., 2013). These governance principles include: (a) respect for rights and the rule of law; (b) promotion of constructive dialogue and fair access to information; (c) accountability in decision-making; and, (d) existence of institutions and procedures for fair dispute resolution (Borrini-Feyerabend et al., 2013). These principles provide insights about how a specific governance setting will advance or hinder desired conservation outcomes, sustainable livelihoods, and the rights and values of the people and jurisdiction concerned.

While high-quality science is necessary to implement effective strategies to establish areas of connectivity conservation to achieve a national network of protected areas, governance is the variable with greatest potential to both affect coverage and is a main factor in determining the effectiveness and efficiency of management (Borrini-Feyerabend et al., 2013). In fact, although rarely recognized, Parties to the UN CBD agreed to report about governance of protected areas as part of their obligations (9th and 10th Conferences of the Parties (COP) held in 2008 and 2010, respectively).

GOVERNANCE ARRANGEMENTS IN SUPPORT OF CONNECTIVITY CONSERVATION

As noted above, powers and responsibilities related to protected areas, while still primarily vested in governments and their agencies in Canada, have also been taken up by non-governmental organizations (NGOs) and individual landholders, Indigenous Peoples, and local communities, often working in partnership with each other. In 1994, the IUCN WCPA released *Guidelines for Protected Area Management Categories*, which introduced different types of protected area categories (Dudley, 2008, 2013). These categories (Box 2) provide descriptions of the type of protected area according to its management intent, and are recognized by international bodies, such as

Box 2. Protected Area and their associated categories (from Dudley et al., 2013).

The definition of a protected area (Box 1) is expanded by six management categories (one with a sub-division), summarized below. These are simple descriptions. The IUCN provides more detail, including primary objectives, other objectives, distinguishing features, role in the landscape/ seascape, and comparisons among each category.

Ia Strict nature reserve: Strictly protected for biodiversity and also possibly geological/ geomorphological features, where human visitation, use and impacts are controlled and limited to ensure protection of the conservation values.

Ib Wilderness area: Usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, protected and managed to preserve their natural condition

II National park: Large natural or near-natural areas protecting large-scale ecological processes with characteristic species and ecosystems, which also have environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities.

III Natural monument or feature: Areas set aside to protect a specific natural monument, which can be a landform, sea mount, marine cavern, geological feature such as a cave, or a living feature such as an ancient grove.

IV Habitat/species management area: Areas to protect particular species or habitats, where management reflects this priority. Many will need regular, active interventions to meet the needs of particular species or habitats, but this is not a requirement of the category

V Protected landscape or seascape: Where the interaction of people and nature over time has produced a distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.

VI Protected areas with sustainable use of natural resources: Areas which conserve ecosystems, together with associated cultural values and traditional natural resource management systems. Generally large, mainly in a natural condition, with a proportion under sustainable natural resource management and where low-level non-industrial natural resource use compatible with nature conservation is seen as one of the main aims.

The category should be based around the primary management objective(s), which should apply to at least three-quarters of the protected area – the 75 per cent rule.

the UN, as the global standard for defining and recording protected areas.

Governance in Canada can be complex even without connectivity conservation considerations, which can involve the active participation of many stakeholders and influencers, including governments, private organizations, Indigenous Peoples, local communities, and others. For example, many natural heritage systems in southern Canada have been stitched together using properties that are

Governance in Canada can be complex even without connectivity conservation considerations, which can involve the active participation of many stakeholders and influencers, including governments, private organizations, Indigenous Peoples, local communities, and others. For example, many natural heritage systems in southern Canada have been stitched together using properties that are owned by government, land trusts, NGOs, and individual private landowners, and are managed collaboratively under an Official Plan at the regional or municipal level. Many northern natural heritage systems, on the other hand, encompass combinations of federal, provincial/territorial and IPCAs.

Canada's first provisional attempt to categorize protected areas with reference to the IUCN categories was completed in May 2006 and found that roughly 95% of protected areas fall within IUCN categories I-IV. As of 2016, 95% of terrestrial protected areas remain in these categories (Environment and Climate Change Canada (ECCC), 2016b). It is worth noting that these calculations do not include OECMs, including many PPAs, which are not recognized within these categories (i.e., only protected areas are subject to classification).

Of the 95% of terrestrial areas that can be classified under the IUCN's categories, 62% are category II, primarily composed of large national, provincial and territorial parks and conservation areas (Environment and Climate Change Canada (ECCC), 2016b). A further 29% is category Ib (Environment and Climate Change Canada (ECCC), 2016b). As of 2019, Canada has declared 0.8% of its protected area as OECMs, slightly over half of which occur in B.C. The remaining protected areas fall into one of the other categories or have not yet been defined. Considering the majority of Canada's protected areas as categories II and Ib, it brings to question the capabilities of the differing IUCN categories to effectively increase connectivity.

As Hilty et al. (2020) note, ecological networks for conservation are defined as a system that are comprised of two types of core conservation areas, protected areas and OECMs, with ecological corridors being the third element. The ways in which these areas work together to support ecological networks is detailed in Box 3. owned by government, land trusts, NGOs, and individual private landowners, and are managed collaboratively under an Official Plan at the regional or municipal level. Many northern natural heritage systems, on the other hand, encompass combinations of federal, provincial/territorial and IPCAs.

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Box 3. Differences in the role of protected areas, OECMs, and ecological corridors. Note that all three terms refer to areas with conservation outcomes (from: Hilty et al., 2020: 17).

	Protected Areas	OECMs	Ecological Corridors
MUST conserve in situ biodiversity	✓	✓	
MAY conserve in situ biodiversity			✓
MUST conserve connectivity			✓
MAY conserve connectivity	✓	✓	

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Related to the above, a recent study (Saura et al., 2017) assessed global terrestrial protected area connectivity and found that 9.3% of the world is covered by protected connected lands on average for all the world's ecoregions. Only one-third of the earth's terrestrial realm is covered by

well-connected networks of protected areas. The study used this data to provide insight regarding which protected areas, according to IUCN categories, may be better equipped to promote connectivity. Their data is compared with a similar study that only considered protected areas in IUCN categories I-IV (Santini et al., 2016). Santini et al. (2016) obtained a global protected area coverage of 5.6%, less than half of coverage found in Saura et al. (2017) at 14.7%.

Further, Santini et al. (2016) found that there were 4-5 times less protected connected lands than reported in Saura et al. (2017). The difference in magnitude suggests that protected areas with categories other than I-IV (or with no reported category) do not merely increase the global protected area coverage, but are able to effectively increase connectivity of the entire network by acting as connecting elements between protected areas with categories I-IV, acting either as physical continuity of protected lands, or by functioning as stepping stones promoting movement between protected areas. A study in the Brazilian Atlantic forest by (Crouzeilles et al., 2013) found that the key connectors between forest patches were better covered by category V rather than I-IV protected areas, which lines up with the conclusion by Saura et al. (2017). This information calls for more research into IUCN category types and the actual efficacy of these classification of protected areas. In fragmented landscapes, private lands can play a critical role in connecting protected areas and maintaining wildlife corridors (Tack et al., 2019).

In the same way that there is no specific scientific strategy that works in all areas to protect or restore connectivity, no single model of governance will work for all areas where protected areas are to be connected. Governance arrangements should be dynamic and specific to the particular areas requiring connectivity. These arrangements should have the flexibility to evolve over time in response to events such as changes in partnerships, biophysical conditions including climate change, and management needs (Pulsford et al., 2015). Factors such as spatial scale, levels of government involved and their capacity for management, the role of NGOs, and whether land ownership or use rights are principally with government, private and corporate owners, or Indigenous and local communications affect the type of governance approach that may be most suitable for a specific area.

As the case studies in Chapter 3 reveal, a variety of governance arrangements have emerged that integrate ecological corridors to enhance the efficacy of protected areas. While a national strategic framework for connectivity does not exist for terrestrial protected areas at the national level, federal agencies have published reports that emphasize the importance of connectivity, such as *Canadian Protected Areas Status Report 2011-2015* (Environment and Climate Change Canada (ECCC), 2016b) and *How Much Habitat is Enough?* (Environment and Climate Change Canada (ECCC), 2013). There are also examples regional frameworks that involve governance across jurisdictional boundaries such as the New England Governors and Eastern Canadian Premiers Resolution on Ecological Connectivity, Adaptation to Climate Change, and Biodiversity Conservation that was signed in 2016 (St-Pierre et al., 2018).

While it is clear that large-scale connectivity conservation can only be done with collaboration across both geographical regions and jurisdictional boundaries, Canadian protected area organizations often report challenges working with other agencies on a number of planning and management issues, including those related specifically to connectivity and climate change (Barr et al., 2020; Environment and Climate Change Canada (ECCC), 2016b; Lemieux et al., 2018). Overall, governance arrangements for connectivity conservation are still in the early stages of development and understanding, and significant challenges are posed where areas cover a mixture of land and resource owners and uses and involve a broad range of stakeholders.

Despite these challenges, lessons are already being learned from case studies and research from around the world on how to effectively manage connected areas amongst protected areas, and governance options for addressing those needs (Box 4) (Hilty et al., 2020; Worboys, Francis, & Lockwood, 2010). Collaborating with NGOs can help facilitate communication, provide governance stability in times of changing political priorities and span jurisdictional boundaries that may impede progress. Indeed, cooperative arrangements should be encouraged, along with marketing and education, so that stakeholders, including municipalities and communities, can understand their role and work together to achieve connectivity amongst protected areas, IPCAs, OECMs, and PPAs where appropriate. What is clear is that all stakeholders must work together to achieve the goal of a connected network of protected areas across Canada, and where such efforts have already been initiated, they have improved biodiversity conservation outcomes.

LAW AND POLICY TOOLS IN SUPPORT OF CONNECTIVITY CONSERVATION IN CANADA

From a policy perspective, protected and conserved areas are recognised and facilitated through a number of legal tools and policy instruments. Canada has a complicated and growing mix of legislative and policy tools to aid in the establishment and management of protected areas and other conserved sites in this regard. Examples include international law and conventions, national/provincial/territorial legislation, policies, agreements and plans, formal management plans, and customary and local rules and plans. In recent years, OECMs and IPCAs have also been established. For this complex mix of protected and conserved areas to run effectively and efficiently, policies in support of governance that work to unify stakeholders in the creation and implementation of decisions and actions to build a connected network of protected areas will be required.

As to be discussed in more detail later in this report, translating what is known about science and management practices into effective policy for connectivity conservation currently presents a significant challenge. According to the IUCN WCPA's report on the *Legal Aspects of Connectivity Conservation* (Lausche et al., 2013), management aims and practices for areas of connectivity conservation should be explicitly prescribed in support of the specific biodiversity

Box 4. Potential governance models for areas of connectivity conservation (adapted from: G. Worboys et al., 2010). Note: connectivity conservation governance arrangements may not fall cleanly into the categories listed below. Instead, they may represent a dynamic hybrid of these various models.

Single 'Top-Down' Organization: Under the *single 'top-down' organization* model, one organization with wide ranging powers or resources may assume sole governance responsibility for a connectivity conservation initiative. The organization in power may be a government, an authority established and appointed by government, or a large international NGO. The ultimate power to determine processes and reach decisions is held within the organization and are then passed down to or imposed on local-level actors. The top-down nature of such arrangements may be moderated by engagement processes initiated by the governing organization, yet the organization retains authority. The single 'top-down' organization model may be more popular in jurisdictions where a strong central government is the norm and may also be used in the early phases of an initiative, particularly when the government or NGO is the initiator.

Single 'Bottom-up' Organization: Under the *single 'bottom-up' organization* model, a local Indigenous or community-based organization may initiate and assume ultimate authority for an area of connectivity conservation. However, due to the spatial extent of many areas, most initiatives would encompass multiple Indigenous lands and local communities so that a multi-community 'bottom-up' model along the lines of *Representative Authority, Representative Federation, or Loose Confederation* may be required.

Decentralized Authority: In the context of connectivity conservation, a government may devolve responsibilities to a lower level of authority, such as at the regional or landscape level. Under this model, many variations are possible under such an authority. For example, office bearers may be elected by a regional constituency or appointed by a government minister. The degree of autonomy granted to an authority can also vary considerably. At one extreme, a government may limit the devolved powers, for example, by making funding conditional on the organization pursing a particular strategic direction and adopting approved processes. At the other extreme, a government may grant an authority full independence.

Representative Authority: The *Representative Authority* model is a 'local government' model where a connectivity conservation organization is one in which its authority and office bearers are legitimated through an electoral process. Such an organization may be comprised of the residents of a defined geographic area encompassed by or adjacent to an area of connectivity conservation.

Representative Federation: Under the *Representative Federation* model, several organizations can come together to create a federation that represents each of their interests. Each member organization influences policy and the federation's direction, leaving day-to-day management to a secretariat led by a director or general manager. The federation may be formalized through articles of association, Memorandum of Understanding, or contract. Members could include governments, NGOs, private companies and community-based organizations.

Loose Confederation: Under the *Loose Confederation* model, several organizations can come together in a partnership focused around the vision for an area of connectivity conservation. There is no secretariat to coordinate and implement the initiative. Each partner undertakes actions according to their own interpretation of what is required, using their own resources and whatever additional resources are brought by the confederation.

and ecosystem values for which the area was selected or designated. In most of Canada, the onus for terrestrial connectivity is largely on the provinces and territories as they tend to have jurisdiction over land and wildlife (with notable exceptions, including federal protected areas, private lands and, more recently IPCAs, migratory birds, and others). Connectivity conservation at the provincial and territorial level should be supported and defined by the country's biodiversity conservation objectives and needs. The (severely outdated) *Canadian Biodiversity Strategy* (1995) and the *Biodiversity Outcomes Framework and 2020 Goals & Target* (2006 and updated in 2016) (Environment and Climate Change Canada (ECCC), 2016a; Environment Canada, 1995) provide guidance in this regard. It is important to have policies and strategies that help to define and classify areas of connectivity conservation according to site-specific conservation objectives while also considering requirements of the nation (Lausche et al., 2013).

The IUCN WCPA and World Commission on Environmental Law (WCEL) examined the approaches of 17 different countries to support connectivity (International Union for the Conservation of Nature (IUCN), 2007). They found a variety of planning tools, local government powers, and other types of legal instruments used to promote connectivity conservation on private land. These tools are essentially the same tools that can be used to establish protected areas and included incentives such as tax concessions, grants, technical support and materials, development concessions, management agreements, environment levies, and developer contributions (Box 5). The study concluded that policy and law makers must have a thorough understanding of the

Chignecto Isthmus, Nova Scotia (Photo by David MacKinnon)

Box 5. Law and policy tools for connectivity conservation (from: *Lausche et al. 2013*).

There are a variety of law and policy tools available in most legal systems for advancing the stated objectives and purposes of substantive laws. Such tools may be useful in particular situations, alone or in combination, for advancing connectivity conservation objectives.

Policy statements: official government policy statements or reports guiding development of rules, programs and supporting processes for specific outcomes; may be overarching policies across all sectors (e.g., national integrated development strategies, sustainable development policies) as well as policies in specific areas (e.g., biodiversity strategy, land-use policy, environmental protection policy).

Planning: essential initial steps for assessing needs and making decisions about appropriate legal tools to use for connectivity conservation. Planning aims to achieve certain public policy goals, such as conservation goals. Specific plans could span political levels (national, subnational, local), be integrated across sectors (e.g., national integrated development plans), focus on various spatial scales (national, regional, site-specific), or address issues across sectors or in specific sectors or at specific scales (e.g., environmental and biodiversity action plans, climate change adaptation plans, land-use plans, marine spatial plans, conservation plans, etc.). Depending on the subject and purpose, plans may be advisory, providing guidance, or prescriptive, requiring compliance. Strategic Environmental Assessments also may be an important tool to inform decision-making. Where feasible, planning that integrates connectivity should be a legal requirement.

Regulatory instruments:

- directed primarily to conservation;
- directed specifically at sustainable resource use;
- directed principally to land-use planning and development control (for example, zoning, EAs/IAs,
- expropriation or purchase of specific sites by government);
- directed principally to transportation, infrastructure, mining, energy development, etc.;
- tools to control individual actions: permits and licenses, conditions and obligations, planning
- permission, environmental requirements, notifications to permit or prohibit activities, etc.;
- environmental standards and quality objectives;
- legal easements (giving the easement holder the right to do something and requiring that the
- landholder do something); and,
- environmental/impact assessments (EA/IA) and strategic environmental assessments (SEA).

Economic instruments:

- positive incentives (e.g., technical assistance, subsidies, tax credits, reduced tax liability);
- negative incentives (e.g., higher taxes, holding back technical assistance);
- compensation (e.g., for conservation practices that result in loss of economic productivity);
- payments for environmental services (e.g., maintaining healthy forest cover for watershed
- services such as water supply, carbon storage, biodiversity conservation);
- stewardship payments (e.g., for applying stewardship principles to land and resources to help maintain
- and restore natural systems and ecological processes using an ecosystem management approach; and, market-driven tools (e.g., emissions trading regimes, habitat banking, conservation banking).

Land tenure instruments: pre-emptive rights, purchase, acquisition, land exchange.

Public participation tools: mechanisms for public participation in programs and deliberations of government authorities, self-initiated public input and monitoring, participation provisions in EAs/IAs and SEAs, etc.

Tools for data collecting and monitoring/ evaluation: inventories, environmental indicators, performance measures, monitoring for specific indicator.

Tools to promote voluntary conservation: public education, training, legal recognition of voluntary agreements and land trusts, covenants running with the land and conservation easements grounded in the law; incentives for private conservation (see [indicate where or what, above] above), community awards or publicity for special conservation achievements and stewardship, capacity building.

purpose of connectivity conservation to develop proper frameworks that support integrated land-use planning and management, and provide incentives, such as sustainable financing, for the long-term implementation of connectivity.

Every jurisdiction in Canada, including federal, provincial, territorial, and municipal governments, have legislative tools created to help establish protected and/or conserved areas. As of 2016, 55 separate acts are used to establish terrestrial and marine protected areas in Canada (Table 2). These pieces of legislation are diverse and include provisions for national parks, provincial parks, wildlife areas, conservation areas, private nature reserves, IPCAs, and more. In cases where one act is not sufficient to protect all values at a site, dual designation can be used. Each level of government has developed a broad suite of legislative and regulatory tools to aid in establishing and managing protected areas, which can be used to help Canada build a national network of protected areas. While not the focus of this report, the federal government, British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia, and Québec have specific legislation for the establishment of marine protected areas or legislation that enables protection of the marine environment through the establishment of terrestrial protected areas that extend to coastal waters (Environment and Climate Change Canada (ECCC), 2016b).

Table 2. Number of acts and types of protected areas in each Canadian jurisdiction (Environment and Climate Change Canada (ECCC), 2016b).

Jurisdiction	Types of Protected Areas	Number of Acts
Federal	6	6
Alberta	8	3
British Columbia	6	5
Manitoba	6	7
New Brunswick	2	2
Newfoundland and Labrador	5	4
Northwest Territories	3	2
Nova Scotia	4	5
Nunavut	1	2
Ontario	4	3
Prince Edward Island	3	3
Québec	14	5
Saskatchewan	10	5
Yukon	5	3
Total	**77**	**55**

Fairy Hill, Saskatchewan (Photo by Ryan Brook)

Table 3. Selected legislative and other strategic directions for connectivity within Canadian protected areas jurisdictions.

Jurisdiction	Legislative Direction	Provisions for Connectivity	Other Strategic Direction	Provisions for Connectivity?
Alberta	Alberta Provincial Parks Act (2000)	No	Environmentally Significant Areas in Alberta: 2014 Update (Fiera, 2014)	Four indicators to maintain core ecological processes and services have been identified; all reference connectivity as being critical for maintaining natural processes in terrestrial and aquatic environments (p. 10-11): 1. Terrestrial habitat patch size 2. Intact Landscapes 3. Lotic habitat connectivity 4. Lentic habitat intactness
	Wilderness Areas, Ecological Reserves, Natural Areas and Heritage Rangelands Act (2000)	No		
	Willmore Wilderness Park Act (2000)	No		
British Columbia	Protected Areas of British Columbia Act (2000)	No	Conservation Policy for Ecological Reserves, Parks, Conservancies, Protected Areas and Recreation Areas (BC Parks, 2014)	"B.C. Parks will make use of the best available landscape level inventories to ensure management activities support climate change adaptation and resilience and to maintain analyses of the representation, replication and connectivity status of the protected areas system." (p. 7)
			Canada-British Columbia Marine Protected Area Network Strategy (2014)	
	Park Act (1996)	No		Connectivity is noted in several areas throughout this report, including under "Ecological Design Principles" including: **"Connectivity:** To the extent possible, consider the dispersal dynamics, the home range(s) of marine organisms, and the distribution of marine habitats, over space and time, especially when assessing replicates and when determining the spacing of individual MPA sites within the network." (p. 14) **"Spacing:** Design MPA networks to reflect the spacing of habitats, cover the geographic range of habitats and facilitate ecological connectivity between sites. Spacing should be assessed at multiple scales (i.e., bioregionally and coast wide) to best facilitate connectivity." (p. 14)
	Ecological Reserve Act (1996)	No		
Manitoba	The Provincial Parks Act (1993)	No	Protecting Manitoba's Outstanding Landscapes: Manitoba's Protected Areas Initiative (2008)	While connectivity is not explicit, it is noted that "Today, a landscape level approach is being taken to protected areas planning with southern Manitoba (agro-Manitoba) and a number of forested regions being identified as priority areas. Establishing new protected areas has become much more difficult because the Protected Areas Initiative is now examining high use areas that have many competing interests. We take a balanced approach to protected areas planning and adequate time must be allowed to review protected area proposals with First Nations and Aboriginal communities, industry, and various stakeholders prior to designation." (p. 24)
	The Ecological Reserves Act (2015)	No		
New Brunswick	Protected Natural Areas Act (2002)	No	Biodiversity Strategy (2009)	No

Jurisdiction	Legislative Direction	Provisions for Connectivity	Other Strategic Direction	Provisions for Connectivity?
Newfoundland & Labrador	Provincial Parks Act (1992)	No	Caring for Special Places: A Framework (2004)	Newfoundland and Labrador use a three-component protected areas strategy, with each type of protected area performing a different function. Component 1 Reserves note "the habitat of each [caribou] herd should be contained inside one reserve or one system of connected reserves, not in smaller, unconnected areas that capture rutting, calving, and wintering areas separately-which is why Component 1 reserves have an area requirement of more than 1,000 km^2." Connectivity is also recognized in the design principles within the Framework, including the acknowledgement that "some reserves may need to be joined by corridors or connecting areas of protected land and water, to facilitate wildlife movement".
	Wilderness and Ecological Reserves Act (1990)	No		
Northwest Territories	Protected Areas Act (2019)	No, but connectivity is implicit in statements such as: "protected areas are intended to contribute to efforts to conserve biodiversity, ecological integrity and cultural continuity regionally, nationally and internationally." The act also states that "climate change considerations must be factored into protected areas planning and management."	Healthy Land, Healthy People: Government of the Northwest Territories Priorities for Advancement of Conservation Network Planning 2016-2021 (Environment and Natural Resources, 2016)	Priority 2 of the Healthy Land, Healthy People guiding policy states: "Develop a renewed strategy for conservation network planning in partnership with Indigenous governments and other partners."
			Northern Lands, Northern Leadership: The GNWT Land Use and Sustainability Framework (2014)	Ecological integrity implies some degree of connectivity: "Land use is sustainable if it maintains ecosystem integrity and biological diversity" (p. 3) and that "Environmental conditions are known and impacts to the land are prevented, monitored and mitigated to maintain ecological integrity and biodiversity." (p. 6)
			Sahtu Land Use Plan (2013)	Ecological integrity implies some degree of connectivity: "The ecological integrity of the region is maintained. The land, water and natural resources on which people depend are clean, healthy and abundant. There is a balance of industrial development and vast wilderness areas, a model of development hand in hand with environmental protection. Conservation Zones and legislated protected areas protect the most important places and values for future generations, while careful management allows sustainable development to proceed in all other areas.
Northwest Territories	Tlicho Agreement (self-government agreement)	No, but Chapter 12 (Wildlife Harvesting), 13 (Trees and Forest Management), and 14 (Plants) state that the agreement states each of the Parties shall: "make management decisions on an ecosystemic basis so as to recognize the interconnection of wildlife with the other components of the physical environment."		

Jurisdiction	Legislative Direction	Provisions for Connectivity	Other Strategic Direction	Provisions for Connectivity?
Nova Scotia	Provincial Parks Act (1989)	No	Our Parks and Protected Areas Plan (2015)	Addresses 're-connection areas', which are "areas that provide important natural connections across the landscape." (p. 9)
	Wilderness Areas Protection Act (1998)	No, but states a purpose of the act is to "maintain and restore integrity of natural processes and biodiversity" (s. 2a).		
	Sustainable Development Goals Act (2019)	No, but states that the act is founded on the principle of "Netukulimk". "Netukulimk" means, as defined by the Mi'kmaq, the use of the natural bounty provided by the Creator for the self-support and well-being of the individual and the community by achieving adequate standards of community nutrition and economic well-being without jeopardizing the integrity, diversity or productivity of the environment.		
Nunavut	Wildlife Act (2003)	No, but states a purpose of preserving the ecological integrity of the area (p. 62).	Parks & Special Place – Park Planning (n.d.)	Cultural connectivity: "There are also other indirect benefits that may be more difficult to measure, but are no less important. Parks and special places protect natural and cultural heritage values for everyone to appreciate, learn from, and enjoy. More so than other sectors, parks and parks-related tourism have considerable ability to promote, strengthen and support Inuit culture, improve quality of life, and develop positive role models. This is because opportunities more closely reflect cultural traditions on the land and are at the community level. As such, they have the potential to stimulate pursuit of traditional activities and Inuit Qaujimajatuqangit (IQ). By protecting and interpreting these important values and sites, parks encourage a sense of responsible stewardship in both individuals and communities."
Ontario	Provincial Parks and Conservation Reserves Act (2006)	No, but several objectives and planning/management principles ensure maintenance and restoration of ecological integrity. This may assume some level of connectivity is required to maintain ecosystem processes (p. 2).	State of Ontario's Protected Areas Report (2011)	Protected area targets include 'ecological function criteria', including that "the size, shape and connectivity among [PAs] are of particular importance within this criterion." (p. 24)
			Guideline to Management Planning for Protected Areas in the Context of Ecological Integrity (2014)	"Criterion 4 – Ecological functions: Ecological functions refer to the ecological role of a site within the broader context of the surrounding landscape and watershed. This criterion relates directly to biodiversity persistence. Ecological functions, in part, determine how well biodiversity, physiographic features and natural processes are likely to be maintained within a protected area. Hydrologic processes, and the size, shape and connectivity of protected areas are particularly important within this criterion."

Jurisdiction	Legislative Direction	Provisions for Connectivity	Other Strategic Direction	Provisions for Connectivity?
Ontairio	Far North Act (2010)	Yes. An objective is "The protection of areas of cultural value in the Far North and the protection of ecological systems in the Far North by including at least 225,000 square kilometers of the Far North in an interconnected network of protected areas designated in community-based land use plans" (p. 2).	An Introduction to the Far North Land Use Strategy (2013)	Refers to objectives for land use planning set out in Far North Act, including: "The protection of areas of cultural value in the Far North and the protection of ecological systems in the Far North by including at least 225,000 square kilometres of the Far North in an interconnected network of protected areas designated in community-based land use plans" (p. 13).
Prince Edward Island	Recreation Development Act (current to 2015)	No		
	Natural Areas Protection Act (current to 2019)	No		
	Wildlife Management Area Act (current to 2019)	No		
Québec	Parks Act (2001)	No	Policy for Québec National Parks (2018)	One of the goals is to "Improve connectivity with other natural areas" (Goal 1.2., p. 12). The policy also notes "special attention must be paid to maintaining and restoring the ecological connectivity of national parks with the surrounding natural environments." (p. 20) Social connections are also noted in terms of health and well-being benefits.
			Strategic Guidelines for Québec Protected Areas (2016)	"Maintaining or enhancing connectivity between various protected areas and reducing the size of human encroachment between them." (p. 5)
	Natural Heritage Conservation Act (2002)	No, but "The object of this Act is to contribute to the objective of safeguarding the character, diversity and integrity of Québec's natural heritage. The Act is intended to facilitate the establishment of a network of protected areas representative of biodiversity by introducing conservation measures for natural settings that complete existing measures, including the assigning of protection status to certain areas under the responsibility of other government departments, government bodies or regional authorities" (s.1).		

Jurisdiction	Legislative Direction	Provisions for Connectivity	Other Strategic Direction	Provisions for Connectivity?
Saskatchewan	The Parks Act (1986)	No	Various provincial park management plans.	It is worth noting that provincial park management in Saskatchewan has endorsed Ecosystem-based Management (EBM). EBM is based on the ecosystem concept, in which an area of land is seen as a system made up of air, water, soil, plants, animals and microbes, interacting with each other through ecological processes. Management plans are currently in development, and the plans will guide management of Saskatchewan park ecosystems to ensure ecological integrity while improving the aesthetic and the opportunities for recreation and education in a safe outdoor environment.
	The Wildlife Habitat Protection Act (1992)	No		
Yukon	Parks and Land Certainty Act (2002)	No, but conservation of ecological integrity and biodiversity is mentioned as part of the goal to protect core areas (p. 4-5).	Yukon Parks Strategy 2020-2030	Connectivity is noted in the application of conservation science. Specifically, the strategy notes: "We will continue to apply landscape conservation science to build a network of protected areas and other lands that allow native species to move, adapt and survive in the face of climate change. This will include using well-established international standards and concepts such as traditional knowledge, protected area design, ecological buffers, climate change resilience and landscape connectivity." (p.22)
Parks Canada	Canada National Parks Act (2000)	No, but management plans are required to contain a set of ecological integrity objectives and indicators (p. 6).	National Parks System Plan (1997)	No
	Canada National Marine Conservation Areas Act (2002)	No		
	Parks Canada Agency Act (1998)	No, but management plans are required to consider ecological integrity (p. 16).	Parks Canada 2014-15 Report on Plans and Priorities (2015)	"Projects will address priority ecological integrity issues by restoring habitat connectivity."
Environment and Climate Change Canada	Canadian Wildlife Act (1985) - Wildlife Area Regulations (last amended 2018)	No		
	Migratory Bird Convention Act (1994)	No		

Connectivity is recognized explicitly in a number of statutes, policies, and regulations used to manage ecosystem services in protected and conserved areas and on the intervening landscapes and waterscapes, but only a few require it (Table 3). Notably, the Government of the Northwest Territories (NWT) has committed to a jurisdiction-wide conservation network planning program (Vignette 1). A number of sub-national jurisdictions in Canada have developed, experimented with, and integrated connectivity into planning policies (see case studies for the City of Halifax, Oak Ridges Moraine, and the Sahtu planning region in the NWT). Furthermore, connectivity conservation is an important element in Canada-First Nations land use agreements such as the Tallurutiup Imanga National Marine Conservation Area (NMCA), which provides for the protection of a connected matrix of marine, coastal, terrestrial, and freshwater realms in the Arctic (Vignette 2).

Notably, a study by Vásárhelyi & Thomas, 2006 evaluated the capacity of both Canadian and American legislation and policies to create an ecologically functional Algonquin-to-Adirondack (A2A) protected area network that would extend from Ontario into the state of New York (see A2A case study in Chapter 3). The authors analyzed international treaties, national laws, and provincial and state laws and their regulations, and found a general lack of provisions to implement terrestrial networks. Most legislation did not identify ecological criteria to be used for the design and management of such networks. The study concluded that without explicit ecological criteria, protected areas legislation would not be sufficient to ensure that networks would have the features necessary to maintain long-term ecological integrity. The authors noted that current legislation requires amendments to be more conducive to maintaining ecological connectivity, and that collaboration between the disciplines of law and ecology is necessary to achieve ecological networks of connected protected areas.

Policy and legislative reform to strengthen mandates in support of connectivity conservation initiatives would foster and enhance the ability of Canada's organizations to establish connected networks of protected areas as called for in Aichi Target 11 and in the draft text of the *Post-2020 Global Biodiversity Framework*. While there is currently very little legislative or strategic direction for connectivity conservation in Canada, almost all organizations in Canada recognize the importance of protected areas in contributing to habitat connectivity, either as a secondary objective inferred as an aspect of ecological integrity or maintenance of ecological processes, or as a driver of candidate site designation (Environment and Climate Change Canada (ECCC), 2016b).

Grand Manaan, New Brunswick (Photo by Monique Cormier)

Vignette 1. Currently, the Northwest Territories is the only Canadian jurisdiction committed to a territorial-wide connectivity conservation program under the banner of 'Healthy Land, Healthy People: Government of the Northwest Territories Priorities for the Advancement of Network Planning 2016-2021' (Environment and Natural Resources, 2016)

Priority Outcome 1: Conclude the planning and decision-making processes for each of the existing candidate areas.

Objective 1: For each existing candidate area, lead a collaborative process with communities, regional Aboriginal governments and relevant partners to conclude the planning and review process toward a final outcome on the area.

Objective 2: Develop an equitable management governance framework.

Objective 3: Develop an establishment agreement model.

Objective 4: Propose new legislation for the establishment of conservation and protected areas.

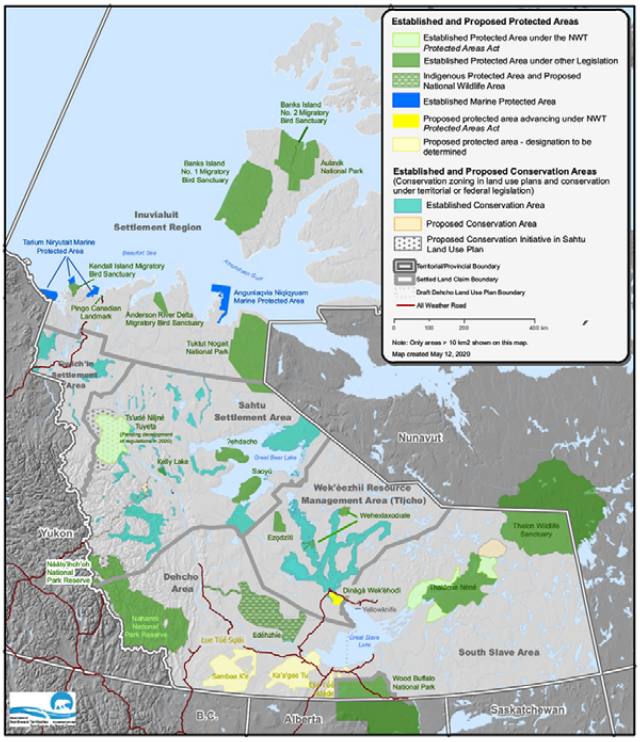
Priority Outcome 2: Develop a renewed strategy for conservation network planning in partnership with Aboriginal governments and other partners.

Objective 1: Clearly define and communicate the components of an NWT conservation network and the extent of the network.

Objective 2: Develop a process to implement ecological representation planning.

Objective 3: Finalize a strategy for conservation network planning for the NT in partnership with Aboriginal governments and other partners.

Established and Proposed Conservation Network in the Northwest Territories

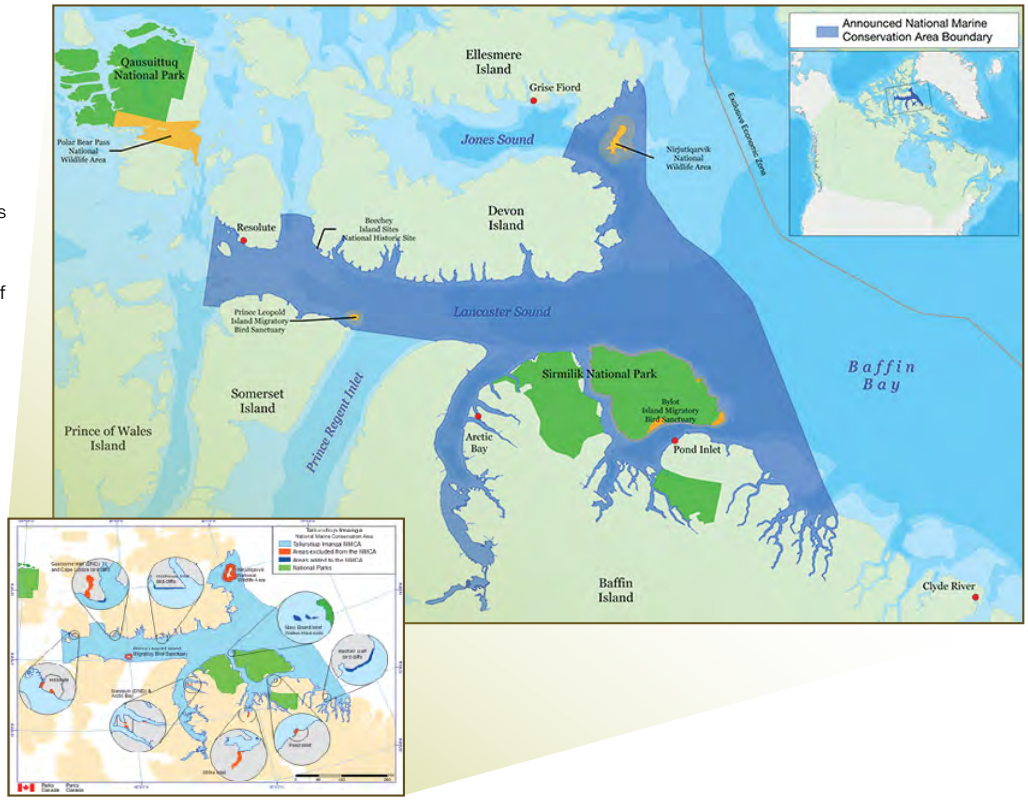


SOURCE: GNWT (2020)

Vignette 2, Tallurutiup Imanga, a critical connected matrix of marine, coastal, terrestrial, and freshwater realms.

Examples of Themes Contained in the Principles of the Tallurutiup Imanga National Marine Conservation Area Inuit Impact and Benefit Agreement

- Establishment, management and operation of the Benefit Agreement will be consistent with the Nunavut Agreement.
- Creates opportunities to secure socio-economic benefits and cultural opportunities for Inuit and is intended to foster reconciliation.
- Protects and conserves a representative marine area for the benefit, education and enjoyment of Inuit of Nunavut and the people of Canada, and the world.
- Managed and used in a sustainable manner that meets the needs of present and future generations.
- Inuit to engage in the management of Tallurutiup Imanga. The Parties work cooperatively using a consensus-based governance model outlined in the Benefit Agreement to manage Tallurutiup Imanga.
- Management plans will embrace the precautionary principle and principles of ecosystem management as described in the Convention on Biological Diversity, including the consideration in decision-making of Indigenous knowledge defined as Inuit Qaujimajatuqangit in the Agreement.



The NCC has formulated conservation strategies at broader landscape and regional levels and has shifted their emphasis towards conservation networks and using the Open Standards for the Practice of Conservation. Recently, the New England Governors and Eastern Canadian Premiers (NEGECP) signed a resolution focused on ecological connectivity, adaptation to climate change, and biodiversity conservation at their 40th Annual Conference (New England Governors and Eastern Canadian Premiers (NEGECP), 2016). In 2019, the Western Governors' Association passed a policy resolution supporting the conservation and management of wildlife migration corridors and habitat, and urging federal collaboration with state and local initiatives (Western Governors' Association, 2019). Consortia of NGOs are working together under umbrella organizations, such as Two Countries, One Forest (2C1Forest) and Staying Connected Initiative (SCI), the A2A Collaborative, Yellowstone to Yukon (Y2Y) Conservation Initiative, and Three Borders, to support and foster connectivity conservation across jurisdictions in key regions of Canada, and cross-border into the U.S. Many of these are detailed in Chapter 3 of this report.

OTHER IMPORTANT CONNECTIVITY CONSERVATION GOVERNANCE CONSIDERATIONS

Partnerships and Collaboration in Support of Connectivity Conservation

No single agency or organization has cornered the market on expertise and 'know-how' needed to effectively conserve biodiversity. Given the scale and complexity of social needs and the cumulative threats from land use change, pollution, climate change, invasive species, and habitat fragmentation, collaboration is important because progressive connectivity conservation benefits from the contributions of the diverse mix of people who come to the table with an eclectic variety of values, perspectives, interests, knowledge, and skills (Gray, 2012). In fact, a culture of collaboration is a key ingredient of partnership, and partnership provides a social foundation for sound governance (Gray, 2012; Pulsford et al., 2015).

Partnerships are created by agencies and organizations but succeed because of the people who bring their knowledge, skills, and personalities to the table (Trauger et al., 1995). Partnerships that center local concerns and communities as well as encourage knowledge coproduction are needed in order to work towards transformative pathways for conservation (Armitage et al., 2020). Effective partnership requires constant attention and like some sharks, must progressively move forward or die (Natural Resources Partnership Task Force (NRTPF), 1992). In practice, the chances of a successful partnership are improved if:

- Agencies and organizations clearly define and describe the program(s) requiring partnership. Highly focused issues drive effective partnership formation;
- A strong leader champions the partnership projects and goals with vision, energy, and enthusiasm;
- Partnerships are formed between committed and engaged agencies and organizations that jointly develop a shared vision and common goals, can apply the required level of expertise and experience to the tasks for which they are assuming responsibility, and are willing and able to resource the programs;
- There is a tenable partnership agreement, including rules of conduct. Key elements include respect, equity, and transparency in decision-making; and,
- There are tangible services, products, or experiences required from the partnership (Natural Resources Partnership Task Force (NRTPF), 1992; Pulsford et al., 2015; Trauger et al., 1995; Worboys et al., 2016).

Furthermore, national and global biodiversity designations can provide a foundation for collaboration and governance. There are sites across Canada where connectivity is mangled under these designations. Many of Canada's Important Bird Areas (IBAs) (soon to be incorporated into KBAs, see below) have been designated because of their important congregations of migratory birds, such as Delta Marsh in Manitoba. Several United Nations Educational, Scientific and Cultural Organization (UNESCO) World Biosphere Reserves are managed for connectivity by collaborative organizations. This includes promoting and managing connectivity within some Biosphere Reserves such a Beaver Hills in Alberta and Long Point in Ontario, but also Biosphere Reserves that function as important regional wildlife corridors including Ontario's Niagara Escarpment (see Vignette 3) and Frontenac Arch. Global and national criteria to identify KBAs have recently been developed and are now being applied in Canada. KBAs criteria that could be applied to identify important areas for connectivity include Ecological Integrity and Biological Processes. Regardless of the type of global or national designation, providing a boundary and name to an area for connectivity is an essential step to develop and coordinate governance.

Knowledge Management and Exchange

The amount and quality of the information we assemble in support of any decision and our success at transforming that information into useful advice has a direct bearing on ecosystem integrity and the quality of our lives. However, knowledge does not automatically or magically appear as a result of owning data and information. Knowledge is a condition or state of being that we create by using information to interpret the world around us. Margaret Wheatley describes it as *"…something [that] pulls me outside of myself and forces me to react. As I figure out what's going on, or what something means, I develop interpretations that make sense to me. Knowledge is something I create inside myself through my engagement with the world"* (Wheatley, 2001). In essence, Wheatley is telling us that while data and information management and the technology we use to gather it is important, life is about choices and our ways of being human in the use of knowledge determines the quality of our human being.

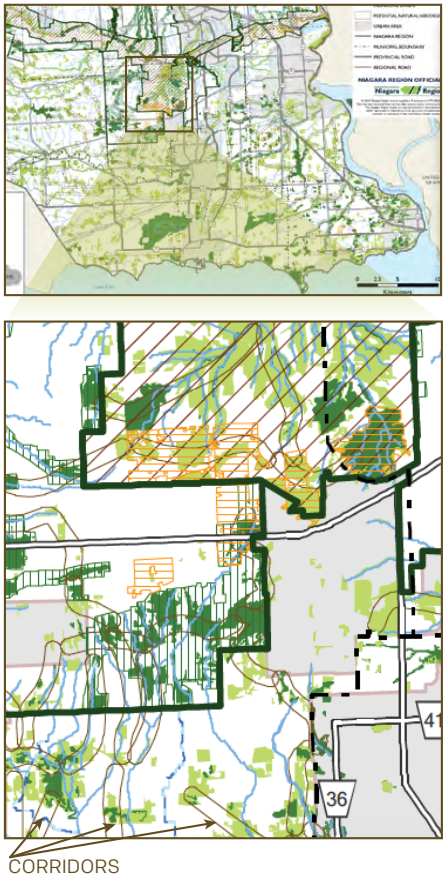
Effective connectivity conservation initiatives that result in the protection and/or restoration of ecosystems require

Vignette 3. The Niagara Official Plan and collaboration on habitat connectivity

SUMMARY: A HEALTHY LANDSCAPE, A SHARED RESPONSIBILITY

All levels of government work together, with input from the private sector and individual landowners, to develop and implement broad, community-based conservation strategies. Each has specific roles to play:

- **Landowners, Businesses, Local Residents and Community Groups** - Exercise environmental stewardship.
- **Local Municipalities** - Develop and adopt local Official Plans and Secondary Plans containing more detailed environmental policies in conformity with Provincial and Regional policies and plans and review and approve Zoning By-law Amendments and development applications (e.g., subdivision plans, site plans, severances and variances) with input from the Region and the Conservation Authority.
- **Niagara Peninsula Conservation Authority** - Undertakes land management and stewardship programs, establishes regulations and policies to manage hazards and water resources, comments to the Region and municipalities on planning and development applications, and assists the Region in carrying out certain Provincial review responsibilities such as stormwater management.
- **Niagara Region** - Uses the Official Plan to establish the framework for planning and development review in Niagara consistent with Provincial policies and plans, implements Provincial policies, reviews and approves Regional and local Official Plan Amendments, and reviews and comments on planning and development applications.
- **Federal and Provincial governments** - Provide direction through legislation, regulations, policies and guidelines, and establish plans to guide development (e.g., the Greenbelt Plan and the Niagara Escarpment Plan), administer specific approvals such as Permits to Take Water, and provide technical assistance to municipalities.



Examples of Statutes and Policies that Support Planning

- Conservation Authorities Act (Statutes of Ontario 1990a).
- Policies for the Administration of the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation (Ontario Regulation 155/06) (Statutes of Ontario 1990a).
- Conservation Authorities Policies and Procedures (Conservation Ontario 2010).
- Mining Act (Statutes of Ontario 1990b).
- Planning Act (Statutes of Ontario 1990c).
- Provincial Policy Statement under the Planning Act (MMAH 2014).
- Endangered Species Act (Statutes of Ontario 2007).

Integrated Regional and Local Planning

- Niagara Region Official Plan (Niagara Region 2014).
- Port Colborne Official Plan (City of Port Colborne 2017).
- Wainfleet Official Plan (Township of Wainfleet 2016).
- Wainfleet Bog Management Plan (NPCA 1997).

access to and use of robust natural and social science data, evidence-based scientific knowledge, Indigenous Knowledge, and local knowledge. Bennett (2016) defines evidence as *"any information that can be used to conclude and support a judgment… to make decisions that will improve conservation policies, actions, and outcomes"*. Knowledge management and exchange is directly linked to management effectiveness, and is associated with an organization's capacity to improve, transfer, share, and apply knowledge (Lemieux et al., 2018).

The knowledge and expertise requirements for connectivity conservation initiative, for example, can range from the legal aspects of acquiring a fee simple property or an easement; estimating restoration, administrative and management costs; coping with legal issues; monitoring and reporting on ecosystem function; managing for changing socio-economic conditions; to the implementation of remediation programs and enforcement. Some agencies with relatively broad and active mandates like Conservation Authorities in Ontario tend to retain some scientific and engineering expertise needed in-house, while other agencies with narrower mandates tend to rely on consultants or partner agencies to garner the expertise needed to achieve desired outcomes.

While knowledge and information are empowering, it must be resourced and current evidence suggests that various challenges plague Canada's conservation organizations, which limit access to data and knowledge that inform evidence-based decision-making. Examples include underfunded inventory and monitoring programs and lack of resources to complete effectiveness management assessments and deliver extension and education programs to the public (Auditor General of British Columbia, 2010; Office of the Auditor General of Canada, 2013, 2018; Office of the Auditor General of Ontario, 2020). From an institutional perspective, bureaucratic culture can fail to provide the adequate timeframes needed to competently assemble the knowledge and advice or fail to provide the mechanisms for knowledge exchange between scientists and practitioners/decision-makers (Lemieux et al., 2018).

Agencies require the capacity to assess connectivity conservation outcomes at socially, ecologically, and economically meaningful multi-temporal and multi-scalar levels of decision-making. Relevant information includes biodiversity-related data as well as tools and methodologies for implementing connectivity conservation initiatives, including the sharing of case-studies. Important considerations related to biodiversity-related knowledge should be given to the relationship between biodiversity and climate change, ecosystem services, and impacts on human well-being including Indigenous Peoples. Whether and how evidence is deployed in conservation management will be key to achieving the "effective" dimensions of Aichi Biodiversity Target 11 and any new goals and targets adopted in the post-2020 conservation agenda.

Management Effectiveness

The act of designating an area, or a connected network of protected areas, under any governance system does not guarantee effective management sufficient to protect the resources within it. In response, there has been a focus on Protected Area Management Effectiveness (PAME) evaluations that examine the extent to which management is protecting values and achieving goals and objectives including connectivity (Hockings, 2006). This focus on management effectiveness evaluation is built on research that demonstrates that improved management under any type of governance system leads to improved conservation outcomes (Coad et al., 2015; Geldmann et al., 2015; Gill et al., 2017; Hockings, 2006; Leverington et al., 2010). These studies, and many others, support the centrality of effective management to the achievement of conservation outcomes and identify a number of the specific factors (e.g., sustainable finance, well-defined boundaries, and legal frameworks) that are critical elements of that management. Empirical analysis demonstrates that just completing PAME evaluations alone leads to improve management effectiveness.

Internationally, PAME evaluations have been underway since the early 1990s. More than 20,000 PAME evaluations have been done internationally and commitments to complete PAME evaluations were part of the Aichi Biodiversity Targets for the UN CBD. There are now a number of well developed and tested methodologies for PAME designed for a wide range of governance situations and the IUCN WCPA published a framework and guidelines to assess management, drawing on methodologies that had been developed to date (Woodhouse et al., 2015). A revised framework (Hockings, 2006) and a series of other resources are widely available (https://www.protectedplanet.net/) and are tracked through the Global Database on Protected Area Management Effectiveness (GD-PAME).

Canada included a commitment to management effectiveness as part of the Canada Target 1 direction and subsequently the National Advisory Panel recommended implementation of PAME evaluations across all protected areas and OECMs by 2030. A discussion paper with detailed resources was also prepared as part of the Canada's Pathway to Target 1 (https://www.conservation2020canada.ca/discussion-papers). However, within Canada, adoption of PAME approaches is still limited. Federally, national parks, World Heritage Sites and Biosphere Reserves are the only organizations that report into the GD-PAME; although the methodologies used include some of the most complete data about the condition of ecological integrity, they do not explicitly evaluate management effectiveness. In 2016, Ontario and Alberta began piloting an approach to PAME developed in conjunction with the University of Northern British Columbia adapted for a Canadian context and several protected areas in each province have since undergone PAME evaluations (Wright, 2020; Wright et al., 2017). In 2019, B.C. Parks also began engaging in a limited application of PAME evaluations focusing on larger protected area complexes and explicitly including an evaluation of connectivity starting with the Garibaldi Complex in 2019 and then the Muskwa-Kechika Complex in 2020. However, without widespread adoption of management effectiveness evaluations as a part of the planning and management

Buffalo Pound Lake, Saskatchewan (Photo by Jason Bantle)

Table 4. Relationship between potential and known threats to connectivity and adaptive responses available to decision-makers and practitioners (Keeley et al., 2018; World Wildlife Fund (WWF)-Canada, 2017).

Adaptive Responses to Protect and Enhance Connectivity or Protect Species that Require Isolation	Bio-physical Threats to Connectivity and Isolation Resulting from Human Activities				
	Habitat Loss and Alteration	Climate Change	Pollution	Invasive Species	Unsustainable Harvest of Flora & Fauna
Land Use Planning					
Protected Areas	✓	✓	✓		✓
Protection of ecosystem services on the intervening landscapes and waterscapes	✓	✓	✓		✓
Protect Species that require isolation	✓	✓	✓	✓	✓
Mitigation - Restoration					
Re-naturalization of habitat	✓	✓		✓	
Elimination source of pollution (CO_2, oil, etc.)		✓	✓		
Infrastructure to overcome a barrier (e.g., highway) and return opportunities for safe passage between habitats	✓	✓			
Infrastructure to improve passage (e.g., culvert replacement, lighting in buildings)	✓	✓			
Removal of barriers (e.g., dams) to connect habitat	✓	✓			
Control and/or elimination (e.g., feral cats)				✓	
Land Securement					
Fee simple purchase	✓	✓	✓		✓
Conservation easement	✓	✓	✓		✓
Leases and agreements	✓	✓	✓		✓

process for protected areas there will be no real evaluation of the appropriateness and effectiveness of protected areas governance for biodiversity conservation and connectivity.

Governance and Policy Dimensions Beyond Protected and Conserved Areas

Beyond protected areas legislation and programs, complementary efforts by local governments and other sectors are crucial to maintain, enhance and restore connectivity and reduce or eliminate threats where possible (Table 4). Canada's biodiversity strategy noted the importance of caring for natural assets outside of protected areas on the intervening landscapes and waterscapes in Strategy 1.18 by managing *"…in consultation with landowners, regional and urban governments, local and indigenous communities, and interested stakeholders, human activities in and around protected areas to minimize adverse impacts on protected area biodiversity and to maintain connectivity…"* (Environment Canada, 1995: 25).

Biodiversity conservation measures on the intervening landscapes and waterscapes in Canada is context specific. Such efforts will undoubtedly have the ability to be more widespread and enduring than efforts confined to protected area jurisdictions, legislations, and programs (Mackey & Watson, 2010). They could serve to protect and conserve important areas outside of protected areas as conservation planning must factor in requirements of large-scale, spatially dependent, ecological and evolutionary processes that are essential for the long-term persistence of biodiversity.

Complementary connectivity efforts in Canada can come in many forms. One obvious example is through national and subnational biodiversity strategies. Furthermore, in the north, efforts can be focused more broadly in land use and water quality plans, and in forest management plans and practices, mining practices, and harvest regulations (Table 5). These efforts can be connectivity initiatives with aims to increase, restore or maintain biodiversity, land-use plans that contain provisions for the conservation of biodiversity, or biodiversity assessment tools and indicators. Unlike other jurisdictions where conservation network planning is focused on repairing damaged ecosystems, including the restoration of connections, the NWT governments focus on the maintenance of intact ecosystem processes where land outside of the territory's conservation network is managed to maintain ecosystem processes and enable the movement of wide-ranging species. As a result, the conservation network does not need to be physically connected to achieve connectivity and decisions are made within a broad land management framework that includes multi-regional

Table 5. Selected examples of Canadian legislation, policies, and guiding documents (beyond core protected area organizations) that explicitly acknowledge connectivity.

Biodiversity Strategies	**Provision for Connectivity**
Ontario – Ontario's Biodiversity Strategy, 2011: Renewing Our Commitment to Protecting What Sustains Us (2011)	Habitat connectivity is listed as part of the core principles under "Ecological Principles" (p. 33) Listed under: "Objective: Maintain, restore and recover ecosystem function" to increase connectivity of fragmented landscapes in Ontario. (p. 48), which is repeated under "Outcomes" (p. 64).
Manitoba – Tomorrow Now: Manitoba's Green Plan (2012)	"Increased protection of endangered and threatened species and their habitats...through stronger legislation and policy that ensures the timely inventory, monitoring and assessment of species at risk, the development of recovery and conservation strategies and the enhanced protection of habitat for listed species. The protection of rare natural habitat types would reduce the need to designate individual species at risk, and more efficiently focus resources on conservation at the landscape level." (p. 39)
Northwest Territories – Northwest Territories Biodiversity Action Plan – Report 2: Gap and Overlap Analysis and Recommendations for Future Action (2006)	"Fragmentation is not yet a major problem in the NWT. Prevention of fragmentation and maintaining connectivity are aspects of the NWT-PAS Action Plan. As well, protecting habitats is a major function of National Parks; connections have a role in park establishment/expansion." (p.31)
Other:	
Alberta – City of Edmonton Natural Areas Systems Policy C531 (2007) (see Vignette 4)	"To safeguard our natural capital and the associated ecological services, the City of Edmonton is committed to conserving, protecting, and restoring our natural uplands, wetlands, water bodies, and riparian areas, as an integrated and connected system of natural areas throughout the city. Natural area systems provide essential habitat for plants and animals, support biodiversity, and maintain a high quality of life for current and future citizens by supplying critical ecological services, as well as opportunities for education, research, appreciative forms of recreation, and aesthetic and spiritual inspiration." "Restoration: the re-establishment of habitat in order to improve ecological processes or connectivity."
Manitoba – Planning Act – Provincial Planning Regulation (2011)	Policy 7.2.2. states that the following should be promoted: "linkages between public transit, streets, sidewalks, river corridors, pathways and greenspaces to form an interconnected network."
Ontario – Provincial Policy Statement (2020)	Section 2.1 acknowledges the importance of connectivity in the wise use and management of resources. Section 2.1.2 states "The diversity and connectivity of natural features in an area, and the long-term ecological function and biodiversity of natural heritage systems, should be maintained, restored or, where possible, improved, recognizing linkages between and among natural heritage features and areas, surface water features and ground water features." (p. 24)
Ontario – Niagara Escarpment Planning and Development Act (1990)	Section 8 (d) under "Objectives" of the Act states one of the objectives is, "to maintain and enhance the open landscape character of the Niagara Escarpment in so far as possible, by such means as compatible farming or forestry and by preserving the natural scenery."
Québec – An Act Respecting the Conservation of Wetlands and Bodies of Water (Statutes of Québec, 2017)	Section 46.0.3. states that applications for projects taking place in wetlands and bodies of water the following information must be provided: "(d) a description of the wetlands' and bodies of water's ecological functions that will be affected by the project, based on the various functions listed in the second paragraph of section 13.1 of the Act to affirm the collective nature of water resources and to promote better governance of water and associated environments (chapter C-6.2), including the wetlands' and bodies of water's connection to other wetlands and bodies of water or other natural environments." (p. 23)
Nova Scotia – Halifax Green Network Plan (2018)	The Halifax Green Network Plan (HGNP) provides land management and community design the HGNP provides land management and community design direction to: • Maintain ecologically and culturally important land and aquatic systems; • Promote the sustainable use of natural resources and economically important open spaces; and, • Identify, define and plan land suited for parks and corridors.
British Columbia – B.C. Water Sustainability Act (2014)	The Act recognizes the hydraulic connectivity of streams and aquifers, stating that the extraction and use of groundwater can affect aquatic ecosystems (s. 15).

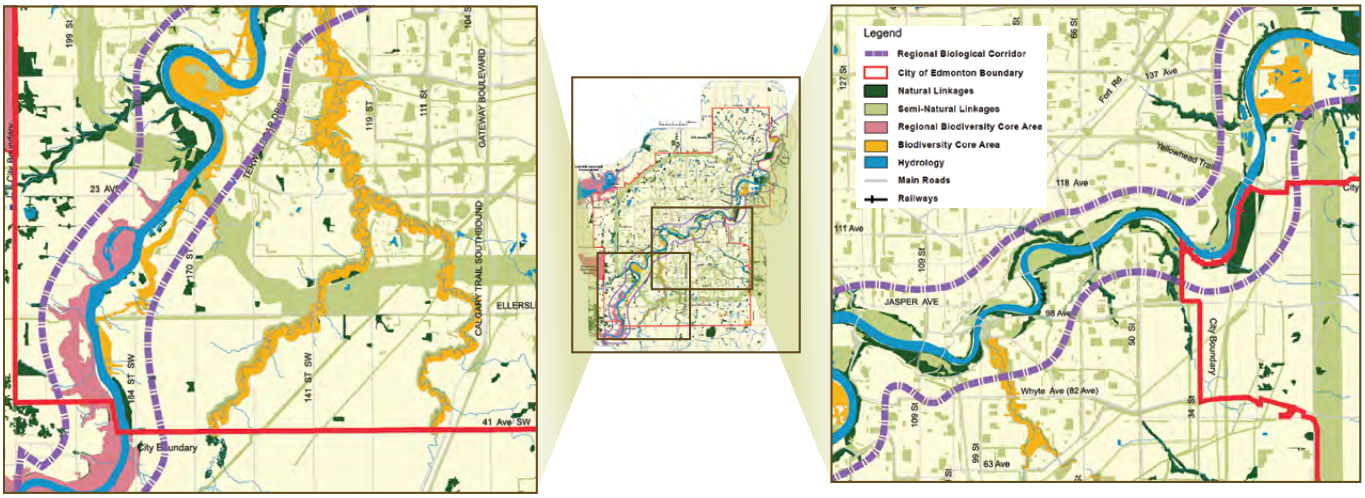
regulatory processes and land use planning (Environment and Natural Resources, 2016).

Canada's Pathway to Target 1 initiative explicitly recognized the important role of local governments in the conservation of biodiversity through the establishment of a Local Government Advisory Group (LGAG). Parks and protected areas located within municipalities contribute significantly to the health and quality of life of a large number of Canadians, and to fostering public interest in biodiversity protection (see Vignette 4). Local governments have a long history of shared decision-making across jurisdictional boundaries, including private landowners, nature conservancies, and land trusts, and are well-positioned to build the processes required to achieve local support for connectivity.

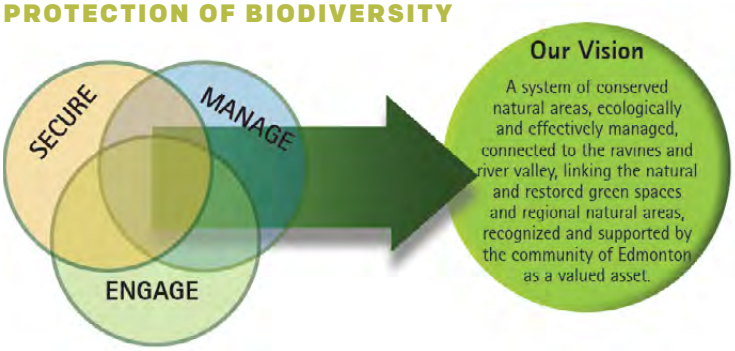
This was evident in our survey results (detailed in Chapter 4). For example, in densely populated southern Ontario, where urbanization and agriculture have significantly reduced biodiversity, the provincial government sponsors a Provincial Policy Statement (PPS) under the Planning Act that subscribes to a vision of *"Strong communities, a clean and healthy environment and a strong economy are inextricably linked. Long-term prosperity, human and environmental health and social well-being should take precedence over short-term considerations"* (Ministry of Municipal Affairs and Housing (MMAH), 2020: 6). For example, the PPS requires that the *"…diversity and connectivity of natural features in an area, and the long-term ecological function and biodiversity of natural heritage systems, should be maintained, restored or, where possible, improved, recognizing linkages between and among natural heritage features and areas, surface water features and ground water features"* (Ministry of Municipal Affairs and Housing (MMAH), 2020: 24). The PPS also requires that healthy, liveable and safe communities be sustained by promoting development and land use patterns that conserve biodiversity and address the impacts of climate change.

Connectivity can also be considered in regional growth plans, hazard land, and flood control designations, and other initiatives. For example, the City of Ottawa's Wildlife Strategy *"strives to reflect the full complexity of human relations with wild animals, from the impacts of urban expansion on the integrity and connectivity of wildlife habitat, to the welfare of individual animals in conflict with human needs."* (City of Ottawa, 2020) The expansion of the Terry Fox Drive roadway in Ottawa is an example of how ecological impacts were integrated into roadway design. The roadway goes through rocky terrain that contains relatively undisturbed, old growth forests and several provincially significant wetlands (PSW), also designated as a provincial Area of Natural and Scientific Interest (ANSI). Five Species at Risk were found in the area of development, including wild American Ginseng (Panax quinquefolius) and Blanding's Turtle (Emydoidea blandingii). Reducing environmental impacts of the roadway was a challenge, but road ecologists and engineers integrating wildlife needs into the principles of wildlife design (Vignette 5) (City of Ottawa and Dillion Consulting, 2016).

Vignette 4. Edmonton's Natural Connections Program.



A VISION AND GOALS FOR THE PROTECTION OF BIODIVERSITY



Legislation, Policy and Plans

- Natural Areas Systems Policy – C351
- Urban Parks Management Plan
- Municipal Development Plan
- Transportation and Drainage Plans
- Under Policy C531, the City of Edmonton supports a planning program with outcomes to "Conserve, protect, and restore natural area systems through the physical planning and development process; according to the provisions of municipal, provincial and federal policy and legislation".
- A Natural Area System is a "...network of natural and/or semi-natural landscape elements that is configured and managed with the objective of maintaining or restoring ecological functions as a means to conserve biodiversity while also providing appropriate opportunities for education, research and passive recreation".

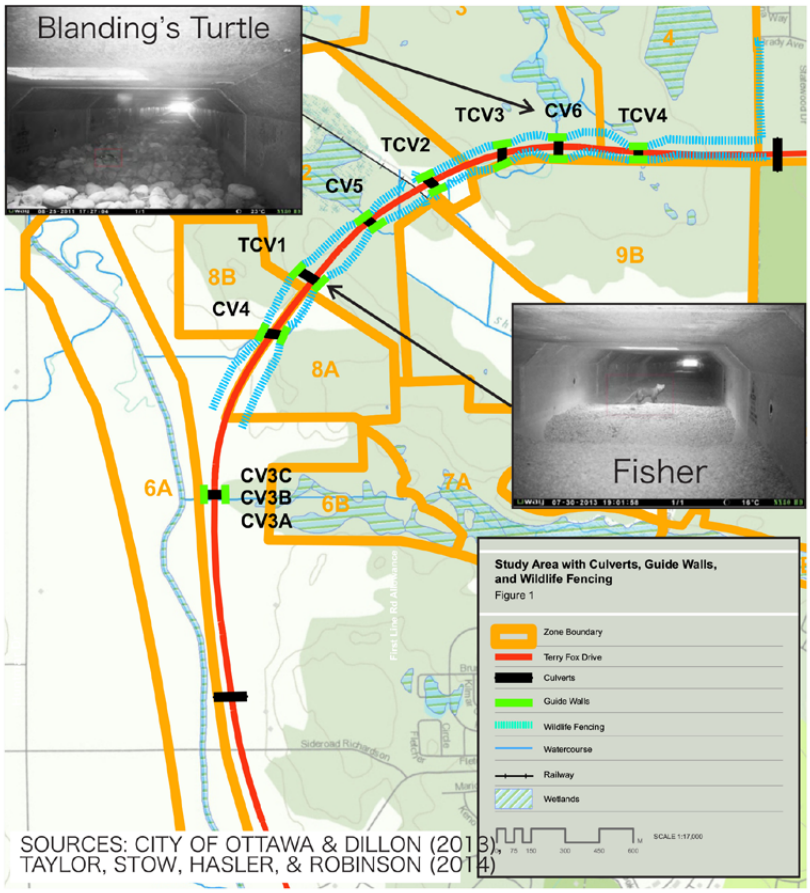
Vignette 5. Monitoring the effectiveness of a wildlife habitat connectivity program along Terry Fox Drive in Ottawa, Ontario (City of Ottawa and Dillion Consulting, 2016; Taylor et al., 2014).

SUMMARY

- A 4-lane arterial road (Terry Fox Drive) fragments wildlife habitat and creates a physical barrier to animals attempting to move between habitats, requiring mitigation.
- Ottawa constructed an integrated system of 4 wildlife-only culverts and 6 hydraulic culverts carrying watercourses, barrier walls, and fencing to direct movements of small and mid-sized reptiles, amphibians and mammals.

EXAMPLE LESSONS-LEARNED

- 24 species used the culverts, even with the low openness factors, variable bottom substrates, and limited headroom.
- Spacing between culverts was broadly set around an average of 250 m apart, but at locations that made sense rather than dictated by a literature reference or guideline.
- Fence-culvert systems work because they give animals no other choice to complete their movement.
- Good logic, observations of game trails, anecdotal evidence and sound field sense by experienced biologists provided an effective way of establishing culvert locations on a project of this size.



Specific sectors such as mining, forestry, and oil and gas need to be engaged in connectivity initiatives as well. For example, The Mining Association of Canada has developed industry standards in the form of the Towards Sustainable Mining (TSM) initiative. TSM provides a set of tools and indicators that includes a biodiversity conservation framework and assessment tool. The assessment tool provides an indicator of the level of implementation of biodiversity conservation as part of the TSM initiative. While it does not have provisions for connectivity specifically, it considers 'significant biodiversity aspects', such as critical habitats, valued ecosystem components, and endangered and threatened species, which must consider connectivity on some level.

Relatedly, at the Conference of the Parties (COP) 13 of the CBD in December, 2016, a decision on mainstreaming which included a focus on impact assessment was adopted, inviting Parties and other governments *"To take measures to improve the effectiveness of environmental impact assessments and strategic environmental assessments, including by strengthening the application of strategic environmental assessment methodologies and by using tools to evaluate potential impacts on biodiversity and ecosystem functions and services, including on resilience."* (Paragraph 18 (c)) (Convention on Biological Diversity (CBD) Conference of the Parties (COP), 2016). In Canada, opportunities exist to integrate biodiversity and connectivity considerations in environmental/impact assessments (EA/IA), a policy and planning arena which has largely overlooked connectivity conservation (Bigard et al., 2017).

EAs and related assessment processes tend to focus on project-specific or species-specific impacts (Tarabon et al., 2019a; Whitehead et al., 2017). Cumulative negative effects on biodiversity resulting from "death by a thousand cuts" from smaller projects which get approved due to their limited impacts on a given species or ecosystem (Whitehead et al., 2017). Conversely, studies conducted in the south of France indicate that by understanding the implication of development projects and their influence on the function of the entirely of an ecological network, decisions can be made at the project level to mitigate negative effects on habitat connectivity and in fact, improve the design of development projects (Tarabon et al., 2019a, 2019b). As our results in Chapter 4 reveal, Canada clearly needs legislation and policy frameworks that explicitly require biodiversity targets in the early project planning stage. The ways in which more effective integration of connectivity conservation considerations in EA/IA can be addressed is detailed in the Conclusions and Executive Summary of this report.

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Bruce Peninsula National Park, Ontario (Photo by Chris Lemieux)

CHAPTER 3 Case Studies of Connectivity Conservation in Canada

OVERVIEW

While Canada has established many protected areas across the country, in all provinces and territories, and in the three surrounding oceans, the distribution of these protected areas is varied: there are few large, widely dispersed protected areas in northern regions of Canada, and more, less dispersed but much smaller protected areas in southern regions. Currently, the progress towards achieving the area-based quantitative goals of Aichi Target 11/Canada Target 1 is being tracked, but progress towards achieving spatial configuration and qualitative aspects such as connectivity has not been reported on to-date.

Given the heightened presence of connectivity in the draft United Nations (UN) Convention on Biological Diversity (CBD) *Post-2020 Global Biodiversity Framework* (Convention on Biological Diversity (CBD), 2020), it will be important for Environment and Climate Change Canada (ECCC), Canada's national focal point to the CBD, to begin the process of more effectively tracking and reporting on progress on this important measure.

Fortunately, there is growing practitioner support for connectivity planning in Canada in response to the impacts caused by human activities and climate change. Some provincial, territorial, and federal agencies have created frameworks or strategies to support connectivity initiatives within their jurisdictions (Chapter 3). Furthermore, organizations such as the Nature Conservancy of Canada, Three Borders, and 2 Countries 1 Forest (2C1Forest), and the Yellowstone to Yukon (Y2Y) Conservation Initiative have developed initiatives to increase connectivity conservation within Canada, as well as across transboundary areas with the United States (U.S.).

A summary of the case studies included in this chapter is provided in Table 1. The case studies offer insight into the breadth of approaches being used to advance conservation of ecological corridors to benefit ecological networks in terrestrial and freshwater ecosystems in Canada. The summary table is followed by a series of graphical and textual case study summaries, organized from West to East and then North. These case studies shed light on how Canada's increasingly diverse conservation community is addressing connectivity at international to local levels in an effort to build resilience into protected areas systems and prevent biodiversity losses.

Table 1. Schematic overview of the Connectivity Conservation in Canada case studies included in this report.

Case study title	Type of study region	Greatest threat to connectivity	Approaches to conserving ecological corridors
Climate Change-Conscious, Connectivity-Focused, Systematic Conservation Planning	Terrestrial, rural	Forestry, mining, oil and gas development	Systematic conservation planning Connectivity analysis Indigenous Protected and Conserved Areas (IPCAs)
Rock Creek Corridor	Terrestrial, rural	Fragmentation from roads, human development	Collaboration and coordinated actions of multiple stakeholders Protection of areas important for biodiversity Land securement Wildlife crossings at key sites Community engagement
Yellowstone to Yukon (Y2Y) Conservation Initiative	Terrestrial, rural	Fragmentation from roads, human development	Protection of areas important for biodiversity Restoration and maintenance of areas for ecological connectivity Direction of development away from areas of biological importance Promotion of people and wildlife living in harmony
Woodland Caribou Corridor	Terrestrial, aquatic	Cumulative landscape disturbances, unintegrated management	Protection and care of ecologically and culturally significant lands and waters Indigenous land use planning

Case study title	Type of study region	Greatest threat to connectivity	Approaches to conserving ecological corridors
Restoring a Highly Fragmented Landscape in Southern Ontario	Terrestrial, rural, agricultural	Habitat loss, roads	Connectivity analysis Land securement and restoration Wildlife crossings at key sites
Oak Ridges Moraine	Peri-urban, forest/wetlands/ rivers/ aquifer recharge areas, agriculture/rural	Urban sprawl, infrastructure	Provincial level plan with legally binding detailed maps and policies Landscape/multi scale, multi-disciplinary watershed based connected systems Strong civil society advocacy and ongoing involvement
Algonquin to Adirondacks (A2A) Collaborative	Rural and natural landscape (woodland, wetland, rock outcrops, and highlands) Small settlement areas	Habitat loss/degradation, roads and fragmentation. All within the context of climate change	Connectivity analysis and mapping Conservation action planning with local groups to provide regional corridor context to local initiatives Road ecology work and wildlife crossings A2A trail connecting Algonquin and Adirondacks for education and development of conservation ethic Education and capacity buildings with partners Advocacy and policy analysis
Three Borders	Terrestrial, rural, dominantly forested	Fragmentation by new 4-lane highway	Building capacity and stakeholders' engagement Connectivity analysis and wildlife crossing planning Land securement and resource management in selected corridors
Connectivity in the City of Halifax	Terrestrial, urban, rural	Urban development	Land use planning Park network management Guidance to current and future project work Partnerships with other levels of government, universities, non-profits, community groups and other stakeholders
Sahtu Land Use Plan	Terrestrial and aquatic, rural	Roads and infrastructure, mining, oil and gas	Protection, conservation and special management of areas important to Indigenous communities for traditional use and cultural reasons, which tend to correlate with ecologically important areas, and follow natural trails and waterways

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Mountain Caribou (Rangifer tarandus caribou), British Columbia (Photo by David Moskowitz)

CHAPTER 3a

Climate Change-Conscious, Connectivity-Focused, Systematic Conservation Planning: A Methodological Approach

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Pamela Wright, *University of Northern British Columbia*

CLIMATE CHANGE-CONSCIOUS, CONNECTIVITY-FOCUSED, SYSTEMATIC CONSERVATION PLANNING

JERRICA MANN (BRITISH COLUMBIA MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS)
AND PAMELA WRIGHT (UNIVERSITY OF NORTHERN BRITISH COLUMBIA)

Lesson Learned

- Enhancing landscape-level habitat connectivity is a critical component of climate change adaptive conservation planning.

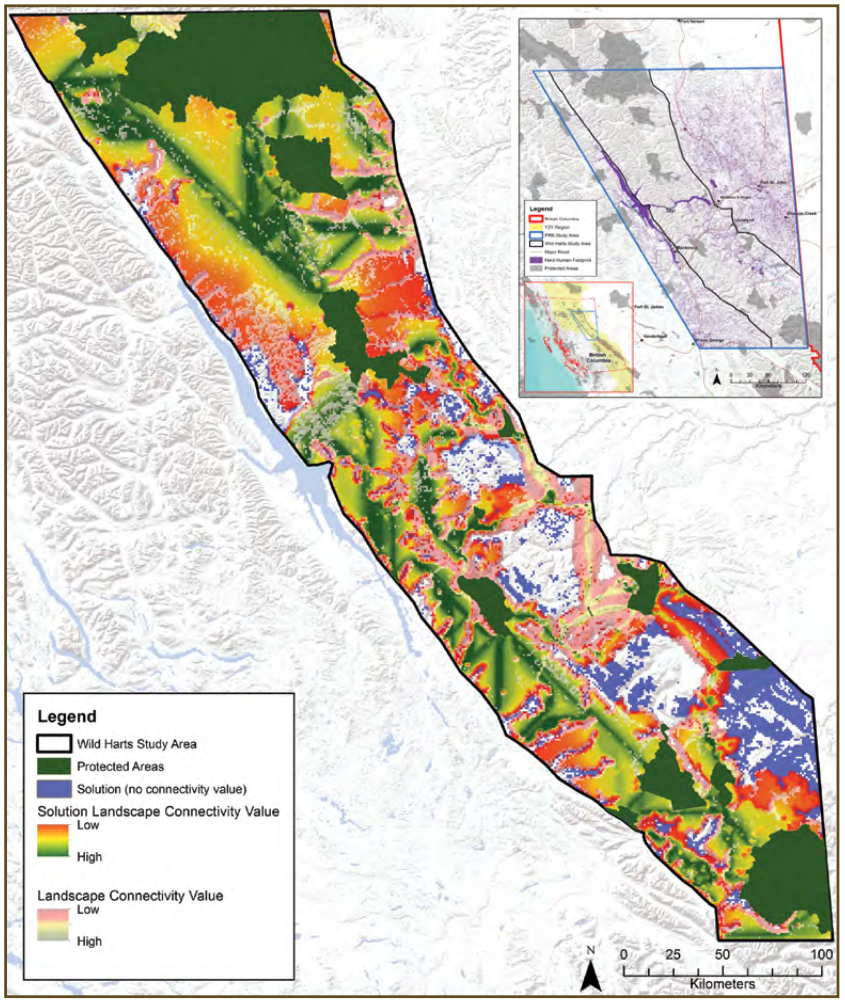
Recommendation

- Holistic climate change-conscious conservation planning should identify areas important for biodiversity and connectivity. Corridor planning should seek to incorporate all relevant variables including multivariate climate velocities, cumulative climate change exposure, landscape permeability, dispersal capabilities, as well as current and future land-use patterns.

SUMMARY

- Anthropogenically induced climate change and habitat fragmentation compromise the effectiveness of protected areas.
- Isolated protected areas can no longer be expected to effectively conserve biodiversity in the medium to long-term.
- As species adjust their ranges to track suitable climates and habitat needs, they will encounter geographical and anthropogenic barriers that hinder their migrations. Consequently, enhancing landscape connectivity is a critical component in adapting conservation planning for climate change.
- This study builds on earlier systematic conservation planning methods by explicitly incorporating climate change resiliency.
- Climate change-conscious systematic conservation planning methods were developed and used in northern British Columbia's Wild Harts of the Peace River Break.
- Mann and Wright incorporated climate metrics and connectivity analysis to compare how high priority sites for landscape-level conservation differ between a static biodiversity-based approach and a climate change resiliency-based approach.

An intersection of the optimal conservation solution that includes both current biodiversity features and future climate features with connectivity corridors provides an opportunity to assess the connectivity value of the optimal conservation solution. This figure shows the connectivity value of each pixel in the solution. The bright, bold red-green connectivity corridors indicate where the solution and the connectivity corridors overlap. The blue areas indicate pixels prioritized for conservation due to their high conservation value that are not within connectivity corridors. In contrast, the areas in a faded, transparent red-green colour ramp represent important connectivity corridors that were not selected in the solution.



BACKGROUND

Loss of biodiversity is one of the planet's prevailing environmental challenges with three-quarters of the planet's terrestrial areas already altered by anthropogenic activities (Venter et al., 2016; Watson et al., 2016). In addition to the rapid degradation of our planet's natural habitats, anthropogenically-driven climate change poses a serious threat to biodiversity conservation that is challenging to predict (Lemieux, Beechey, Scott, & Gray, 2011) and results in myriad coincident impacts. These include disturbances in regional precipitation patterns and temperature regimes, sea-level rise, severe weather events, and changes in ecosystem composition, structure, and function (IPCC 2007a, 2007b; Lemmen et al. 2008). Within Canada, warming rates have increased at nearly double the global average (Environment & Climate Change Canada, 2016).

Against this backdrop, protected areas are the cornerstone of strategies to tackle the biodiversity crisis. They provide refuge for species, provide critical ecosystem services like clean water and air for people, carbon-storage to buffer the effects of climate change, and many other ecological benefits.

Research suggests that the size of a protected area affects its ability to support the persistence of biodiversity but that even large protected areas may not be able to meet the needs of wide-ranging species like caribou and wolves (e.g., Gurd et al., 2001). Despite this, few Canadian protected areas meet minimum size thresholds for ecological persistence. In 2015, three-quarters of Canada's protected areas were less than 10 km^2 with the majority of the largest protected areas occurring in the northern parts of the provinces and territories where the threat of disturbance is much less than that of their smaller southern counterparts. Furthermore, protected area establishment has largely been biased towards economically marginal lands characterized by steep slopes, low soil fertility, and therefore, low land degradation pressure (Brooks et al., 2004; Rodrigues et al., 2004; Joppa & Pfaff, 2009).

Given these limitations connectivity between protected areas is critical. Connectivity promotes ecological persistence by facilitating dispersal and allowing for critical ecological exchanges at the genetic and population levels (Wright, 2016). By enhancing structural connectivity (landscape permeability) between protected areas and across landscapes, functional connectivity (actual movement of organisms and their genetic material) can be improved, thus promoting ecological persistence (Doerr, Barrett, & Doerr, 2011).

As global climate changes proceed at unprecedented rates, isolated protected areas can no longer be expected to effectively conserve biodiversity. As species venture out of their current ranges in an attempt to track suitable climates and find shelter in refugia, they will encounter geographical and anthropogenic barriers that hinder their migrations. Consequently, enhancing landscape connectivity is also a critical component in adapting conservation planning for climate change (Heller & Zavaleta, 2009).

Both palaeoecological records and observed species' migrations in response to contemporary climate change show that many species will shift their ranges as they attempt to track suitable climates. This means, future habitat locations must be within reach. Although protected areas may be effective in conserving certain habitats and species, they are only a partial solution to climate change adaptation strategies as migration to and between refugia, climatically suitable habitats, and protected areas will likely need to be facilitated through the establishment and protection of corridors (Littlefield, McRae, Michalak, Lawler, & Carroll, 2017).

Traditional connectivity models identify areas that help species movements between current habitats and within their current distributions. As a result, these connectivity models disregard the inevitability that climate-sensitive species will be forced to track suitable climates as they shift outside of their traditional ranges (Tingley et al., 2009; La Sorte & Jetz, 2012; Nuñez et al., 2013).

CLIMATE-CONSCIOUS SYSTEMATIC CONSERVATION PLANNING

More recently, a suite of decision support software tools have been developed under systematic conservation planning (SCP) frameworks (Margules & Pressey, 1988). SCP is efficient in using limited resources to achieve conservation goals, can incorporate large amounts of data, is flexible and defensible in the face of competing land uses, and makes decisions transparent (Margules & Pressey, 2000). Furthermore, SCP supports the identification of protected area networks that represent regional species and ecosystems diversity, contains enough habitat of specific types to maintain viable species populations, enables continued community and population processes, including shifts in species ranges, and allows natural patterns of disturbance (Baldwin, Scherzinger, Lipscomb, Mockrin, & Stein, 2014). It can be used proactively, in areas with limited human disturbance prior to receiving protection, or retroactively in areas with a significant human footprint and an existing set of protected areas.

The challenges associated with obtaining reliable climate change data, understanding and working with that data, and determining how to incorporate the data into the SCP framework and tools can make climate change-conscious SCP overwhelming. As a result, there have been only a few attempts to explicitly incorporate a climate change lens into SCP with the goal of pre-emptive planning for future climate conditions and climate change impacts. With the recent widespread availability of emission scenarios and reliable climate change data, the SCP framework is well poised to take advantage of climate information and evolve into a climate change conscious approach to conservation planning.

The following section describes the climate-conscious and connectivity-focused systematic conservation plan (CCC-SCP) methods developed by Mann and Wright (2018) and used in a case study in northern British Columbia's Wild Harts of the Peace River Break. We incorporated climate

metrics and connectivity analysis to model the differences between scenario planning that explicitly incorporated climate targets and those that did not.

THE WILD HARTS

Located in northeastern British Columbia's Rocky Mountain Cordillera, where the Boreal Plains meet the Northern Boreal Mountains and the Rocky Mountain Hart Range intersects with the Peace River, lies an area referred to as the Peace River Break (PRB) (Figure 1). Here the Peace River valley breaks through the Rocky Mountains, creating a continental climate that supports diverse ecosystems that sustain an abundance of vegetation and wildlife (Apps, 2013). Despite the high conservation value of the region, less than 5% of the PRB is currently protected, leaving this important landscape vulnerable to the threat of impending industrial attrition.

Contrary to most other Rocky Mountain regions, the PRB is characterized by a substantial human development footprint from forestry, seismic exploration, mining, wind, and hydropower. Cumulatively, these developments are rapidly transforming the PRB into an industrialized landscape at an alarming rate. Half of the PRB is within .5 km of the hard human footprint. Forty-three percent of the area has a medium-high potential for resource development and an additional 25% a high-very high potential (Mann and Wright, 2018).

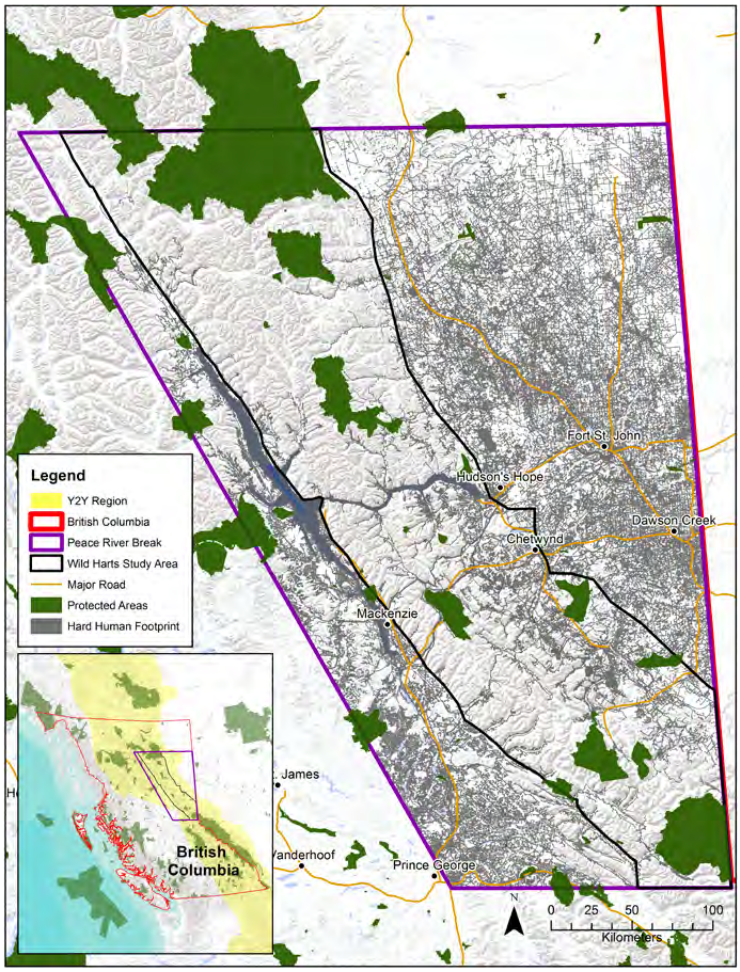


Figure 1. Wild Harts study area and the human footprint.

These development pressures, in addition to natural constraints, results in a critical "pinch-point" in vitally important wilderness areas. This "pinch-point" hinders critical movements and ecological connections east-west over the Rocky Mountains and also north-south between the mountain national parks and the Muskwa-Kechika Management Area.

The result is that the PRB is a highly threatened and highly contested landscape. The recent approval and construction of the Site C Dam on the Peace River; a significant downturn in the forest sector in part related to dwindling wood supply; a lack of provincial action on conservation measures for endangered Southern mountain caribou; and heroic Caribou maternal penning initiatives by First Nations are just some of the dynamics that characterize the area.

In spite of resource development pressures, a narrow, relatively intact, wildlife corridor still exists along the spine of the Rockies in the Muskwa and Hart mountain ranges. These areas, which comprise what is referred to as the 'Wild Harts' serve as refugia for species living within an otherwise hostile landscape matrix. The Wild Harts serves both as a landscape-level corridor of continental significance as well as contains topographic diversity with the potential to promote climate change resiliency and provide a myriad of climate niches that promote a diversity of species assemblages.

METHODS: ADAPTING SYSTEMATIC CONSERVATION PLANNING TO BE CLIMATE-CONSCIOUS AND CONNECTIVITY-FOCUSED

We sharpened the focus of Margules and Pressey's (2000) SCP framework through the explicit incorporation of a climate lens that built climate change resiliency into the analysis and resulting proposed high-value conservation lands thus promoting both current and future biodiversity. We mapped coarse-and-fine-filter conservation features under current and future climate scenarios, prioritized lands for conservation using MARXAN-ILP software (Beyer, Dujardin, Watts, & Possingham, 2016) for portfolio selection and utilized GnarlyLandscapeUtilities and LinkageMapper/Circuitscape (McRae, Shirk & Platt, 2013; Gallo & Greene, 2018) to perform a landscape connectivity analysis. We utilized a multi-scale prioritization strategy for identifying and prioritizing lands for conservation that are important for both current as well as future biodiversity. To do this, we incorporated the known extent of current biodiversity, macro refugia, as well as areas with high-environmental diversity that can serve as microrefugia within areas of low climatic velocity, across landscape types.

The approach, developed for this application to the Wild Harts, is now being applied in the adjacent Tsay Keh Dene Territory, further south in the Cariboo Mountains, and on a

smaller scale in the Garibaldi Provincial Park area. The core steps are outlined in Table 1 and described in detail in Mann (2020). Here we emphasize providing details on the unique climate and connectivity components of the overall methods (*italicized* in Table 1).

Step 1. Select Current and Future Climate Conservation Features

A total of 43 conservation feature layers were constructed, overlain across the entire planning region, and made available for selection by MARXAN-ILP. An additional 45 representational zone and 4 connectivity corridor datasets were included in the analysis as supplemental information. Each conservation feature maintained its unique individual, continuous, pixel values in order to allow for the preferential selection of areas with the highest conservation value (Table 2).

Current climate conservation features utilized in the model included coarse-filter surrogates of forest patterns and processes (Figure 2A) based on combinations of natural disturbance type (NDT), biogeoclimatic zone and young/natural or mature/old forest types. Fine-filter biodiversity surrogates include habitat suitability models for fisher, bull trout, grizzly (Figure 2B) and caribou (the latter segmented by herd) along with special features including wetlands, mineral licks and karst topography.

At a coarse-filter level we also included land facet diversity and rarity (Carroll et al., 2017). Land facets are recurring landscape units with uniform combinations of abiotic variables defined on the basis of geology, soil, and topography. They are relatively stable variables that largely determine ecological patterns and processes and represent features that are unlikely to experience abrupt reorganization in response to shifting climate regimes (Beier & Brost, 2010). Hence, the protection and connection of land facets can serve as a geophysical-based approach to conserve and connect topographically diverse areas capable of supporting current and future biodiversity despite changing climates (Anderson & Ferree, 2010; Beier & Brost, 2010).

Climate velocity metrics provide yet another approach to climate change-conscious conservation. Climate change velocity is a function of the spatial and temporal variation in climate across a landscape and can serve as a useful index to evaluate the rate of migration required by populations to track changing climate conditions (Loarie et al., 2009). As climate shifts in space and time, climate velocity metrics

Table 1. The systematic conservation planning steps used to prioritize lands for conservation in the Wild Harts study area.

1. Select Conservation Feature Data
a) Identify multi-spatial surrogates for current biodiversity
b) Identify multi-spatial surrogates for future biodiversity, projected future species distribution data, climate change refugia and climate connectivity data
c) Select data with sufficient rigor and consistency for inclusion in the analysis
2. Analyze Anthropogenic Disturbance
d) Compile a human footprint model to quantify and spatially model the current state of anthropogenic disturbance
e) Perform land use/cover conversion analyses to identify the rate of land conversion
f) Perform resource development potential models to spatially identify which areas are most susceptible to future development
3. Conduct Connectivity Analysis
g) Identify features that affect landscape permeability
h) Create a landscape resistance spatial layer using Gnarly Landscape Utilities
i) Perform a landscape connectivity analysis between protected areas in the WH using the previously created landscape resistance layer and Linkage Mapper
4. Identify Conservation Goals and Targets
j) Set goals for conservation in the WHSA that promote climate change resiliency, facilitate climate change induced migrations, facilitate landscape connectivity, and promote current and future biodiversity
k) Translate these goals into quantifiable targets
5. Conduct Gap Analysis
l) Determine the extent to which the existing protected areas network achieves the identified targets
6. Generate a Portfolio of Additional Protected Areas
m) Use MARXAN - ILP to spatially delineate additional areas for conservation while minimizing costs
7. Perform a Comparative Analysis
n) Compare the resulting proposed protected areas network with a protected areas network that was created using the traditional SCP framework that did not include climate change projections.
8. Analyze Connectivity of the Final Scenario
o) Analyze the extent of connectivity between high value conservation features.

Table 2. Current and future conservation features

Course- Filter Features	
Land Facets	Land Facet Diversity
	Land Facet Rarity
Environmental Diversity	Elevation Diversity
	Heat Load Index Diversity
	Ecotypic Diversity
	Climatic Diversity
Forest Patterns and Processe	NDT1-ESSF-Burned
	NDT1-ESSF-Mature/Old
	NDT1-ICH-Burned
	NDT1-ICH-Mature/Old
	NDT2-ESSF-Burned
	NDT2-ESSF-Mature/Old
	NDT2-SBS-Burned
	NDT2-SBS-Mature/Old
	NDT2-SWB-Burned
	NDT2-SWB-Mature/Old
	NDT3-BWBS-Burned
	NDT3-BWBS-Mature/Old
	NDT3-SBS-Burned
	NDT3-SBS-Mature/Old

Fine-Filter Features	
Grizzly Bear	Grizzly Habitat Capability
	Grizzly Habitat Suitability
Woodland Caribou Herds	Burnt Pine Caribou Herd
	Finlay Caribou Herd
	Gataga Caribou Herd
	Graham Caribou Herd
	Hart Ranges Caribou Herd
	Kennedy Caribou Herd
	Moberly Caribou Herd
	Muskwa Caribou Herd
	Narraway Caribou Herd
	Pink Mountain Caribou Herd
	Quintette Caribou Herd
	Scott Caribou Herd
	Fisher
	Bull Trout
	Special Features

Climate Chagne Features	
	Backward Velocity Refugia
	Biotic Refugia
	Novel Climates

can aid predictions of which species are likely to adapt in place to new climate conditions, migrate to areas with newly suitable climate conditions, or face the prospect of extirpation or extinction (Garcia et al., 2014). We used data from the AdaptWest Climate Adaptation Conservation Planning Database (www.adaptwest.databasin.com) for North America for time periods 1961-1990, 2041–2070 and 2071–2100, derived from a CMIP5 multimodel data set (Coupled Model Intercomparison Project phase 5) based on the business-as-usual representative concentration pathway (RCP) 8.5 scenario (IPCC 2013). These data, projection timeframes, and RCP scenario were chosen due to their widespread acceptance, recognised reliability (Wang et al. 2016) and public availability.

In order for protected areas networks to be effective in the face of climate change, networks of conservation areas should also protect climatic refugia. Climatic refugia are habitats that components of biodiversity retreat to, persist in, and potentially expand from under changing climatic conditions (Keppel et al., 2012). Backward climate velocity (Figure 2C) based on the top 50% of the AdaptWest Refugia Index (Carroll et al., 2017) representing those areas with the highest refugium potential was used to determine the distance from a projected future climate location back to similar existing climate locations. This metric reflects the relative difficulty for a species to colonize a new habitat based on exposure to climate change (Hamann et al., 2015). Areas with low backward velocities and high refugium potential are predominantly found within the mountainous areas of the Wild Harts, as in these areas similar climates from nearby downslope locations are often within reach. In contrast, valley bottoms were typically missing climatic refugia as they often lacked nearby similar climates. This results in longer migration distances to colonize locally new habitat/climate conditions.

In some cases, high or very high backward velocities indicate that no similar climates may be found. This signifies the emergence of a new, or novel, climate. Novel climates are classified using the climatic distance between the projected climate and its closest historical analog (Williams et al., 2007). Areas with the lowest elevations are more likely to emerge as novel climates (Mahony et al., 2017). Novel climates may promote the development of novel species associations, biomes, and other ecological surprises (Williams et al., 2007). As areas predicted to convert to novel climate regimes in the future are also are likely to contain fewer species adapted to future climate conditions, these sites may present opportunities for establishing non-native species through managed relocation. Within the Wild Harts, novel climates mapped by Mahony et al (2017) are predicted to occur predominantly in low elevation areas flanking the Rocky Mountains as well as some of the low elevation valleys of the Rocky Mountains.

While novel climates are anticipated to emerge predominantly in low latitude and elevation areas, high

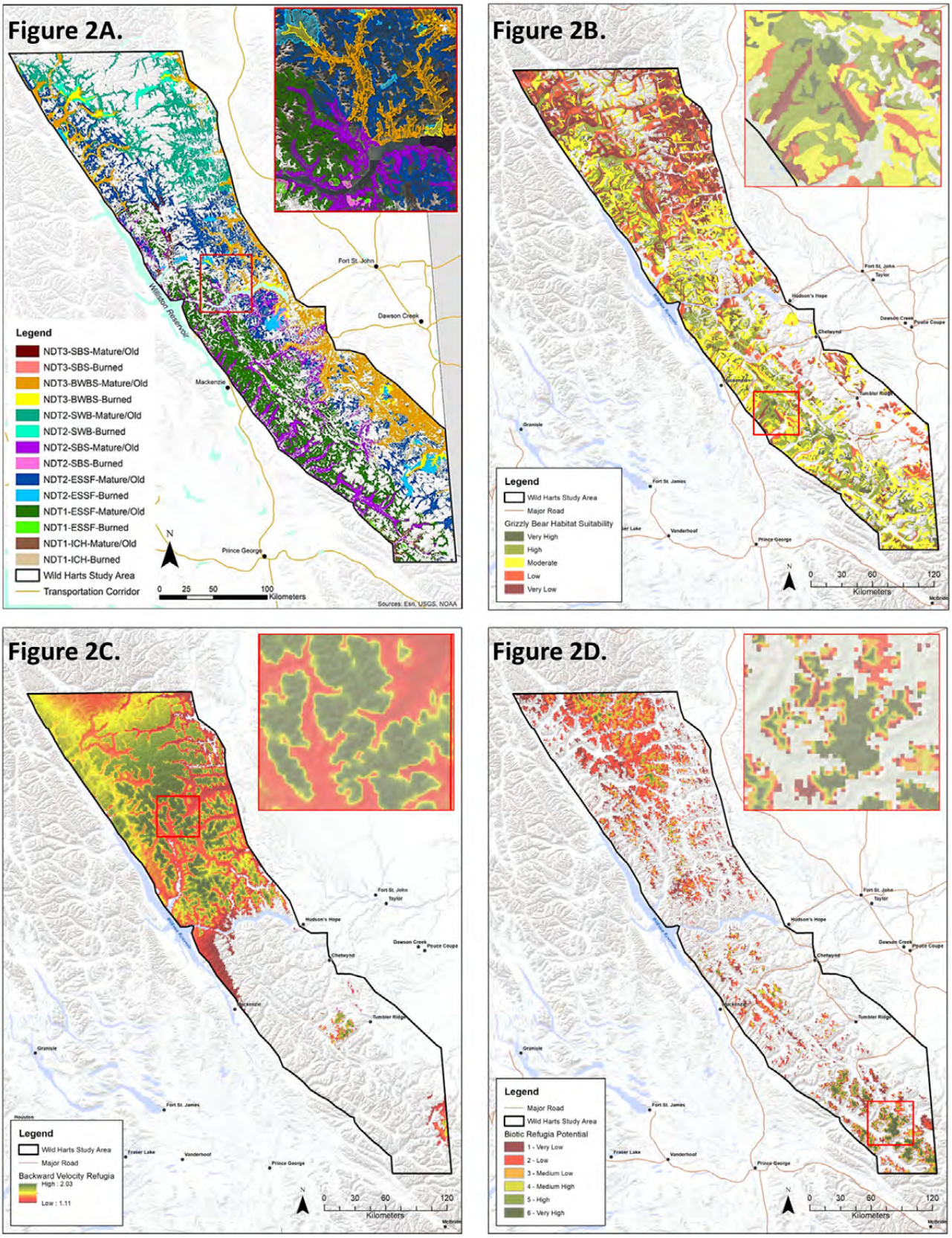


Figure 2. Spatial distribution of select conservation features (A. Forest Pattern and Process. B. Grizzly Bear Habitat Suitability. C. Backward Velocity Refugia. D. Biotic Refugia). Insets represented by red frame illustrate close-ups.

elevation and latitude areas often are characterized by exceptionally high or infinite forward climate change velocities that represent disappearing climates (Williams et al., 2007).

Disappearing climates increase the probability of declining populations, species extirpations, extinctions, and community disruption for species endemic to particular climatic regimes (Jackson & Williams, 2004). Furthermore, many areas where climates are anticipated to disappear closely overlay regions identified as critical hotspots for biological diversity and endemism. This suggests that the identification of disappearing climates and the species they support is vitally important for pro-active management strategies that combat species extinctions and losses to biodiversity. We used climatic/biotic refugia data (Figure 2D) (Michalak et al., 2018) that identified areas with increasingly rare climatic conditions, required by, and within reach of, a species in the future. This was based on niche breadth analyses for 200 birds (Birdlife International, 2014), 450 mammals (Patterson et al., 2007), 498 amphibians (IUCN, 2014), and 24 tree species in North America (Roberts & Hamann, 2012).

We also included data on a series of environmental diversity metrics as they can offer a simple, and generalizable approach to identifying potential micro-refugia (Carroll et al., 2017). These can help to prioritize conservation of areas that maximize landscape-level adaptive capacity, or areas that can disproportionately facilitate persistence of biodiversity and ecosystem function under climate change. When combined with macro-refugia such as land facets one can better evaluate the range of ecological and physical processes that influence the persistence of species and identify a network of areas resilient to threats at multiple scales. Specifically, we included elevational diversity (the degree of variation in elevation), heat load index diversity (degree of variation in potential annual solar radiation exposure), ecotypic diversity (developed based on physical features, climate and land cover data, growing degree days, lithology, aridity, landform and land cover type), and climate diversity (variation in 11 biologically relevant climate variables from mean annual temperature to mean annual precipitation) (Carroll et al., 2017).

Additionally, elevation, ecoregion and biogeoclimatic, and climate zones were included as representational zones to be reviewed rather than incorporated as conservation features. This allowed for the assessment of representation of these zones within the protected areas network without introducing uncertainties associated with these projections or targeting of areas based on characteristics other than their ability to facilitate biodiversity into the analysis.

Step 2. Analyze Anthropogenic Disturbance

Conservation planning models like MARXAN-ILP not only select areas with high conservation (e.g., overlapping) features but they work to find solutions that minimize costs. In our case we calculated cost as a penalty constructed from a human footprint model that the MARXAN model attempted to avoid whenever possible. Data from the Human Footprint Project (Mann and Wright, 2018) was used with each type of footprint variably buffered according to caribou avoidance behaviors and then combined and summed to give a disturbance rating from no disturbance (value of 0) to maximum disturbance (12 of the disturbance layers overlapped).

Given the intensive human footprint in the area, our human footprint model occupied 40% of the Wild Harts with variable layers of disturbance. In the southern half of the Wild Harts, the highest penalties are associated with extensive resource development. In the western portions, the highest penalties lie within valleys and river bottoms that provide road, transmission line, and pipeline access.

Step 3. Conduct Connectivity Analysis

We conducted landscape connectivity analysis using Gnarly Landscape Utilities and Linkage Mapper software. Linkage Mapper is a relatively new tool that utilizes both random walk analysis and electric circuit theory to measure the matrix permeability of all possible pathways available to moving organisms across a landscape/surface (McRae, Dickson, Keitt, & Shah, 2008). This allows measurement of current (modeled movement of organisms) and resistance (opposition to individual movement) between habitat patches. The result is a map of movement probabilities of

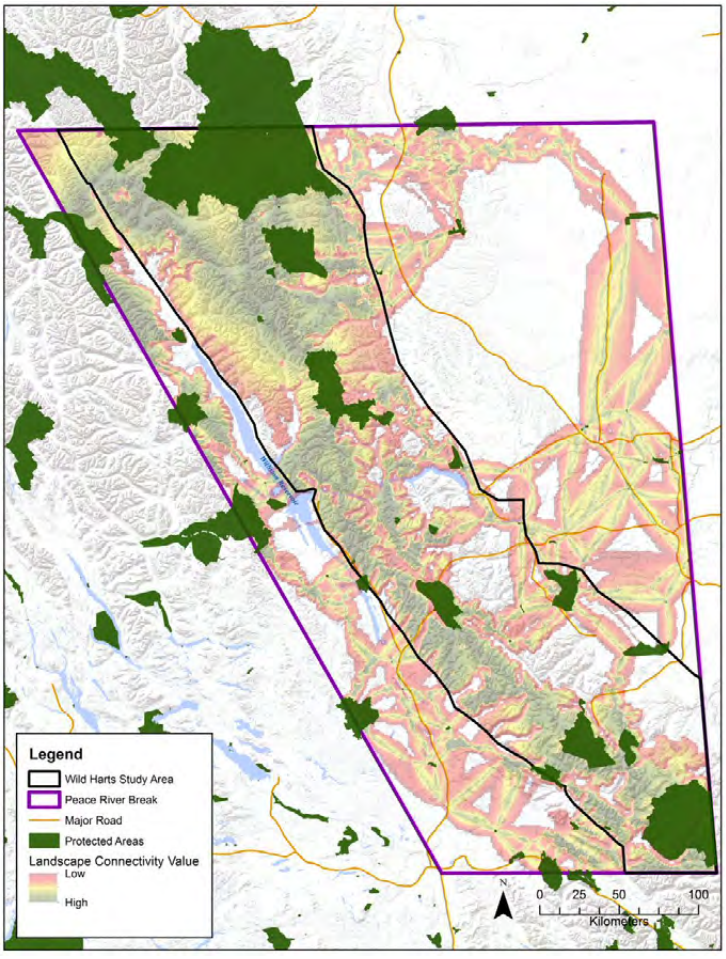


Figure 3. Landscape connectivity analysis used to assess conservation scenarios.

organisms across a resistance layer. The output connectivity map is not species-specific, but rather, focuses on the structural connectivity of natural lands.

Landscape Resistance/Permeability

Our landscape resistance/permeability analysis incorporated land cover, slope, anthropogenic disturbance and caribou avoidance buffers. While high landscape resistance values are widespread in the Wild Harts, a large area of low landscape resistance occupies the northern half of the area and funnels into a band of low resistance that follows the mountainous terrain in a northwest-southeast line.

Landscape Connectivity

A landscape connectivity layer was created using the landscape resistance/permeability data. This connectivity layer represents the probability of an organism moving between protected areas in the broader Peace River Break region. Within the Wild Harts, corridors of high movement probability are largely absent in the southeastern quarter of the area where compounding anthropogenic disturbances result in high landscapes resistances. In contrast, connectivity is wide and dispersed throughout the northern third of the area (Figure 3).

Climate Connectivity

In addition to the conservation features and representational zones, climate corridor data was used to provide insights into which areas may serve as important corridors for species tracking shifting climates. Within the Wild Harts, forward shortest-path centrality corridors, which represent the number of dispersal paths that overlap along the shortest paths from current to future climate locations, are prominent and run the length of the Wild Harts corridor except in the northwest and southwest (Figure 4A). Backward shortest-path centrality corridors, which represent the number of dispersal paths that overlap from future to current climate analogs are prominent in the northern half of the Wild Harts, and follow a similar spatial pattern to the forward shortest-path centrality corridors along the northeastern portion of the Wild Harts (Figure 4B).

The resulting connectivity layers were used as supplemental information and mapped to highlight important areas of connectivity between existing and potential protected areas. Whereas the climate connectivity corridors identified the best routes between current climate types and where those climates will likely occur in the future, the landscape connectivity corridors highlighted the best routes between protected areas while avoiding anthropogenic disturbance barriers. When viewed together, areas where landscape and climate corridors overlap identify important areas important for, and capable of, supporting connectivity between existing and future habitats. These three datasets were not incorporated analytically into the MARXAN-ILP model as there would be no way to discourage MARXAN-ILP from selecting small portions of disparate corridors. Without ensuring the full protection of a corridor, future development could result in a fracture, thereby rendering the corridor ineffective. Furthermore, the importance/value of each individual corridor would change with the establishment of new protected areas and differing conservation goals. However, the climate connectivity corridors were used in overlay analysis when the final model was complete.

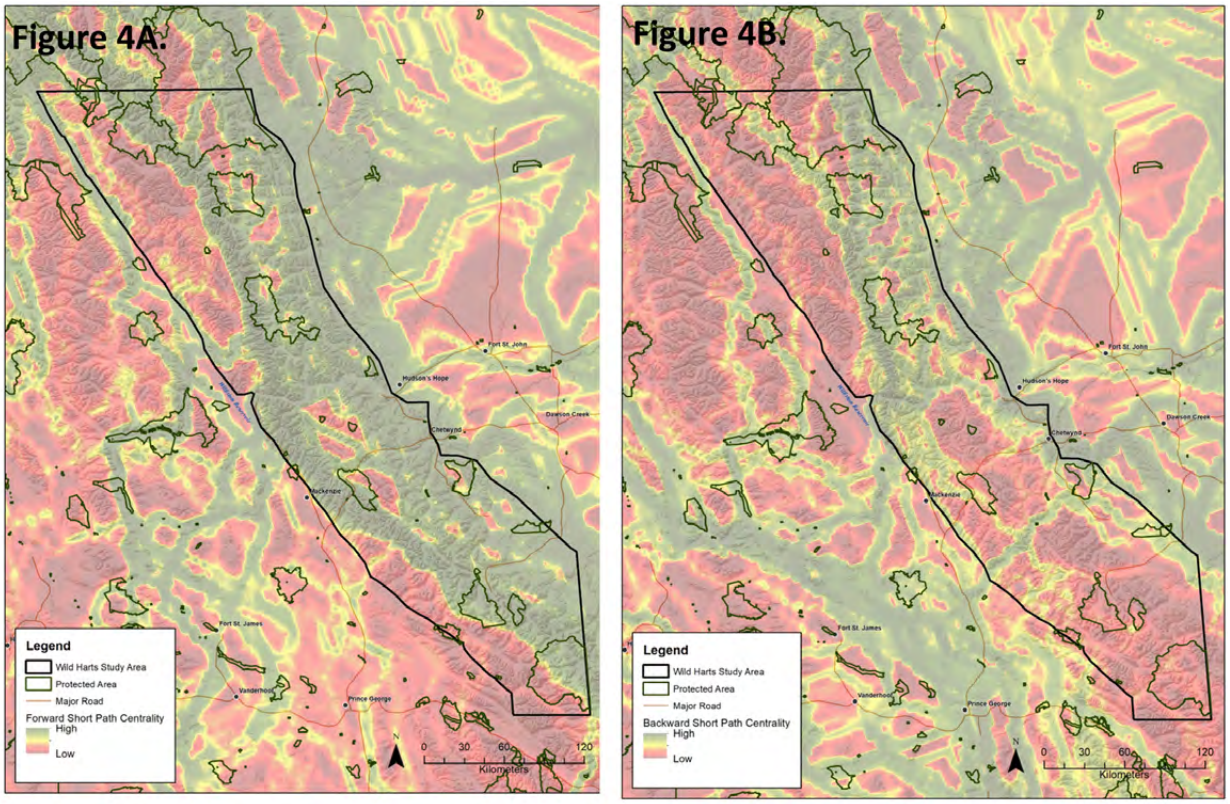


Figure 4. A) Forward Short Path Connectivity and B) Backward Short Path Connectivity.

Steps 4 & 5. Set Conservation Targets and Conduct Gap Analysis

Overarching conservation goals for the Wild Harts were to prioritize lands for conservation that would strengthen the existing protected areas network within the region by promoting climate change resiliency, biodiversity, and ecological sustainability, connectivity, and maintaining disturbance regimes. In contrast to approaches that used area-based targets, we set conservation-feature based targets based on the best available science were available (Wiersma and Sleep, 2016). Scientific knowledge from the literature and expert opinion was used to assign a target to each conservation feature based on the feature's spatial extent within the Wild Harts (e.g., Heinemeyer et al., 2004; Province of BC, 1995). Targets for climate features have not been established in the literature and thus we chose a conservation target of 50%. These targets were used in the

Table 3. Targets and Gap Analysis for current and future conservation features.

Current Biodiversity Features			**Future Biodiversity Features**		
Conservation Feature	**% Protected**	**% Target**	**Conservation Feature**	**% Protected**	**% Target**
Grizzly Habitat Capability	17	60	Climatic Diversity	13	50
Grizzly Habitat Suitability	18	60	Ecotypic Diversity	11	50
Burnt Pine Caribou Herd	0	90	Elevation Diversity	26	50
Finlay Caribou Herd	1	90	Heat Load Index Diversity	30	50
Gataga Caribou Herd	25	90	Land Facet Diversity	16	50
Graham Caribou Herd	14	90	Land Facet Rarity	28	50
Hart Ranges Caribou Herd	16	90	Biotic Refugia	41	50
Kennedy Caribou Herd	15	90	Backward Velocity Refugia	23	50
Moberly Caribou Herd	3	90	Novel Climates 2025	2	50
Muskwa Caribou Herd	95	90	Novel Climates 2055	21	50
Narraway Caribou Herd	19	90	Novel Climates 2085	18	50
Pink Mountain Caribou Herd	27	90			
Quintette Caribou Herd	6	90			
Scott Caribou Herd	0	90			
Fisher	8	60			
Bull Trout	19	60			
Special Features	22	60			
NDT1-ESSF-Burned	22	100			
NDT1-ESSF-Mature/Old	8	74			
NDT1-ICH-Burned	23	100			
NDT1-ICH-Mature/Old	30	75			
NDT2-ESSF-Burned	2	100			
NDT2-ESSF-Mature/Old	13	75			
NDT2-SBS-Burned	5	100			
NDT2-SBS-Mature/Old	5	66			
NDT2-SWB-Burned	67	100			
NDT2-SWB-Mature/Old	26	83			
NDT3-BWBS-Burned	24	100			
NDT3-BWBS-Mature/Old	10	46			
NDT3-SBS-Burned	0	100			
NDT3-SBS-Mature/Old	1	76			

Table 4. Scenarios analyzed in MARXAN-ILP.

Scenario	Conservation Feature Inputs
I.	grizzly bear; caribou; fisher; bill trout; special features; forest patterns & processes
II.	land facet diversity & rarity; heat load index diversity; ecotypic diversity; climate diversity; backward refugia; biotic refugia; novel climates
III.	All of the above

MARXAN-ILP analysis to inform the tool of how much (%) of the conservation feature the analysis was required to obtain when performing prioritizations.

The representation of conservation features within the existing protected areas network in the Wild Harts was highly variable with some well represented and others with little-to-no (<1%) representation. A gap analysis identified that none of the future biodiversity conservation features were well represented (>50%) within existing protected areas (Table 3).

Steps 6 & 7. Generate a Portfolio of Lands with High Conservation Value and Compare Scenarios

We developed and ran three scenarios to contrast the differences between SCP based on I) current climate biodiversity conservation features; II) future climate features, and III) a scenario that optimized for both (Table 4).

Once MARXAN-ILP scenarios were run we assigned a conservation value for each planning unit based on the number of overlapping conservation features to help us select planning units according to their conservation value. For each of the three scenarios, MARXAN-ILP produced a solution by selecting those planning units that met conservation targets, had the highest individual and cumulative conservation value, and the lowest amount of human footprint (cost).

In all three scenarios, a noticeable spatial pattern exists along a corridor of selected lands that stretches from the southwestern extent of the Wild Harts to Northern Rocky Mountains Provincial Park in the northeast. Below the Peace Arm, the selections are largely concentrated to the western half of the Rocky Mountains. Conversely, north of the Peace Arm, the solutions curves to the eastern portion of the Rocky Mountains around Graham Laurier Provincial Park then back to the western side of Redfern-Keily before occupying the majority of the northern portion of the top of the Wild Harts. The solutions are largely absent from on the south eastern quarter of the Wild Harts below Hudson's Hope down to Monkman Provincial Park and along the western boundary of the Wild Harts north of the Peace Arm.

Scenario I selected for, and achieved, all targets for current biodiversity features and resulted in a clear bias towards high elevation areas. This scenario also coincidently adequately protected (>60%) all of the climate change conservation features except for the 2025 novel climate feature (Figure 5A).

Scenario II, selected for future conservation features, and had a similar pattern on the landscape as scenario A but was much more spatially condensed. Scenario II highlights a corridor of high conservation lands that stretch from the southwest of the planning region to Northern Rocky Mountains Provincial Park in the northeast (Figure 5B). Solution II was successful in achieving targets for future biodiversity within those planning units with the highest individual and collective values. However, it was not successful in achieving the majority of the current biodiversity targets.

Scenario III targeted both current and future conservation features. Similar to scenario I, scenario III covers 68% of the study area and is spatially distributed along a corridor of high conservation value lands that stretch from the southwest of the planning region to Northern Rocky Mountains Provincial Park in the northeast (Figure 5C).

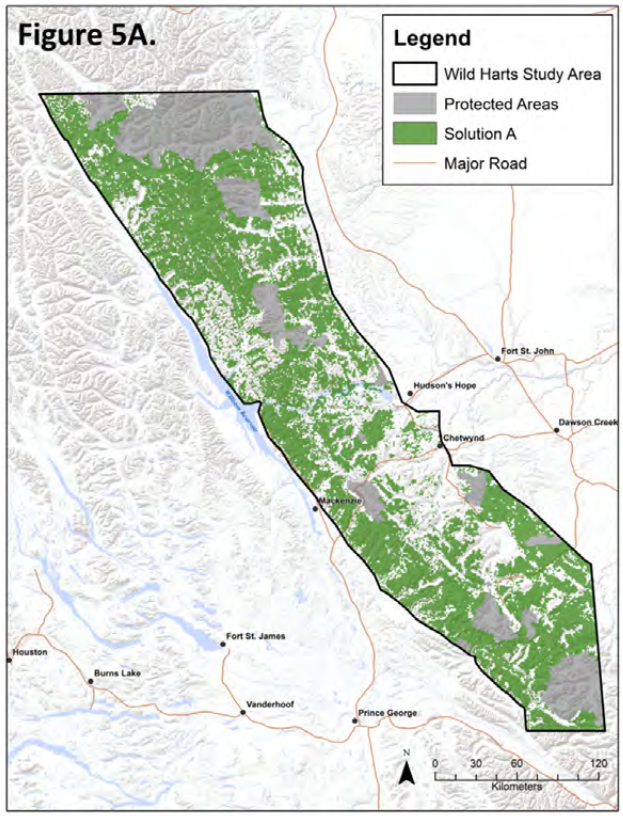
Although scenarios I and III achieved the exact same target amounts, Scenario III was able to make a "smarter" selection by selecting those planning units with the highest individual and collective values, taking into consideration both current and future biodiversity conservation feature values. In doing this, the uncertainties associated with the legitimacy of future biodiversity features did not compromise the solution's ability to capture current biodiversity targets nor did it increase the total area required to achieve biodiversity targets.

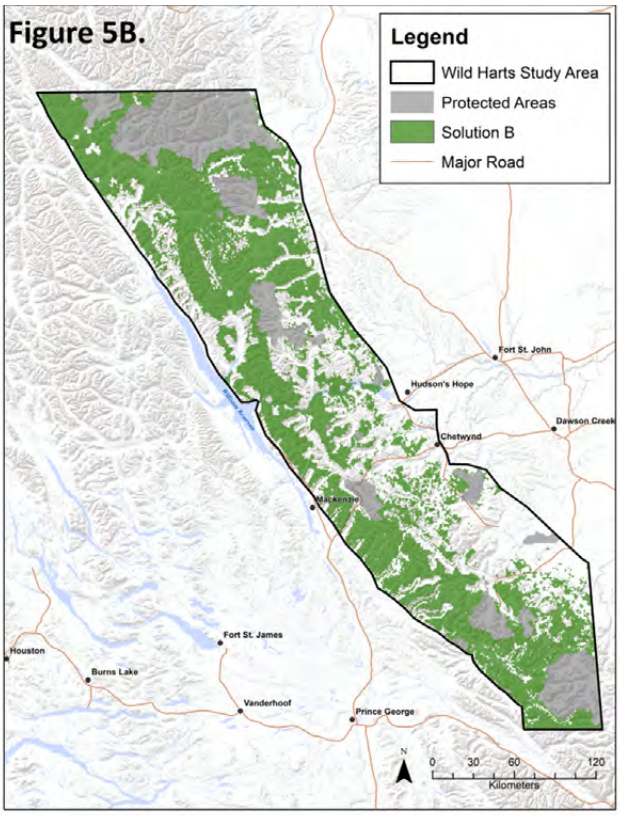
Step 8. Analyze Connectivity of the Final Scenario

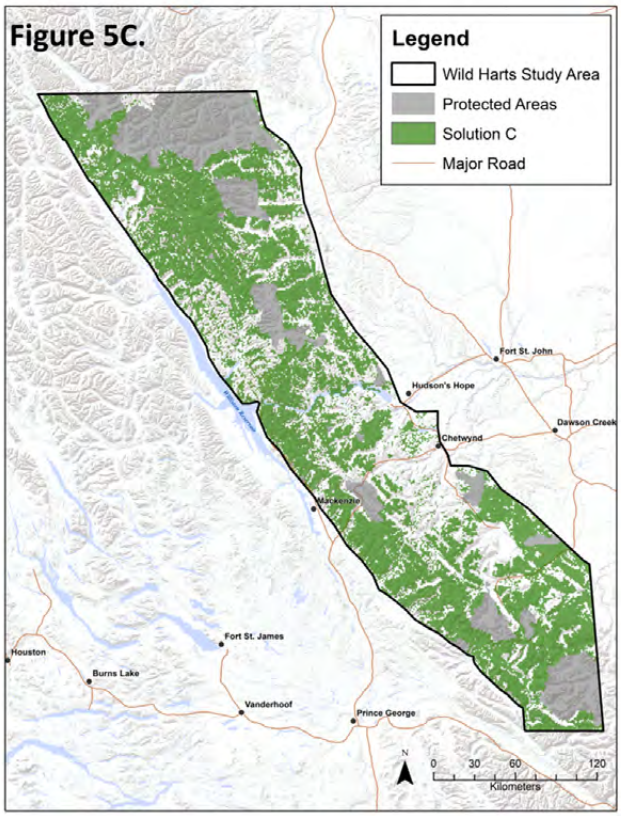
Intersecting the connectivity corridors generated earlier in Step 3 the scenario III (current and future biodiversity values) is represented in Figure 6. This figure shows the connectivity value of each pixel in scenario III. The bright, bold red-green connectivity corridors indicate where scenario III and the connectivity corridors overlap. The blue areas indicate important conservation features selected in scenario III but not within connectivity corridors. In contrast, the areas in a faded, transparent red-green colour ramp are connectivity corridors that were not selected in scenario III.

CONCLUSIONS

Climate change is catalyzing the dynamic nature of biodiversity, requiring conservation planners to step outside of their comfort zones and to pre-emptively plan for uncertain future conditions. Protected areas established to preserve biodiversity in perpetuity may soon fail to adequately represent or even contain the biodiversity features they were once created to protect. Anticipating when and where habitats and their associated species may be distributed across the land base is important to consider when evaluating whether a protected area, or protected areas network, will be capable of effectively achieving conservation goals over time.







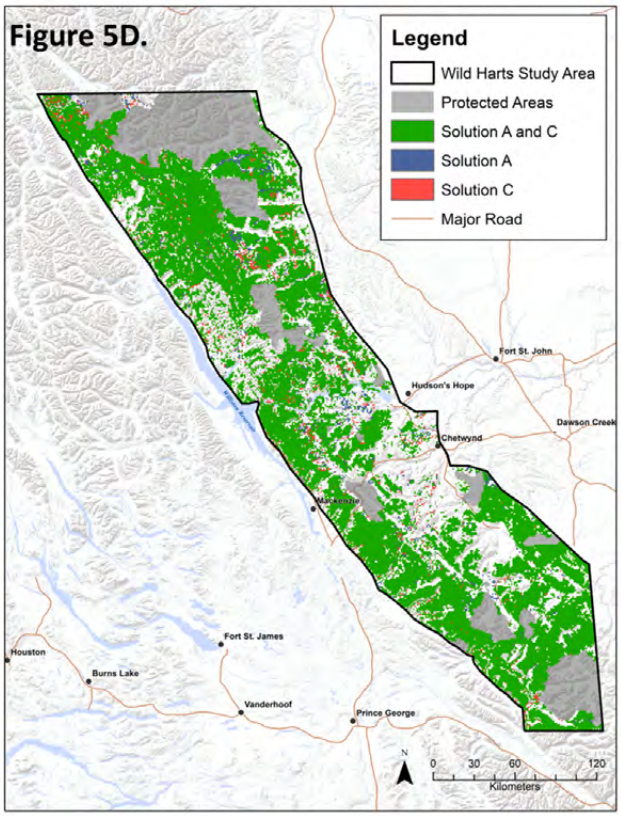


Figure 5. Scenarios A) Current Climate; B) Future Climate; C) Current and Future Climate; and D) a comparison of the 3 Scenarios.

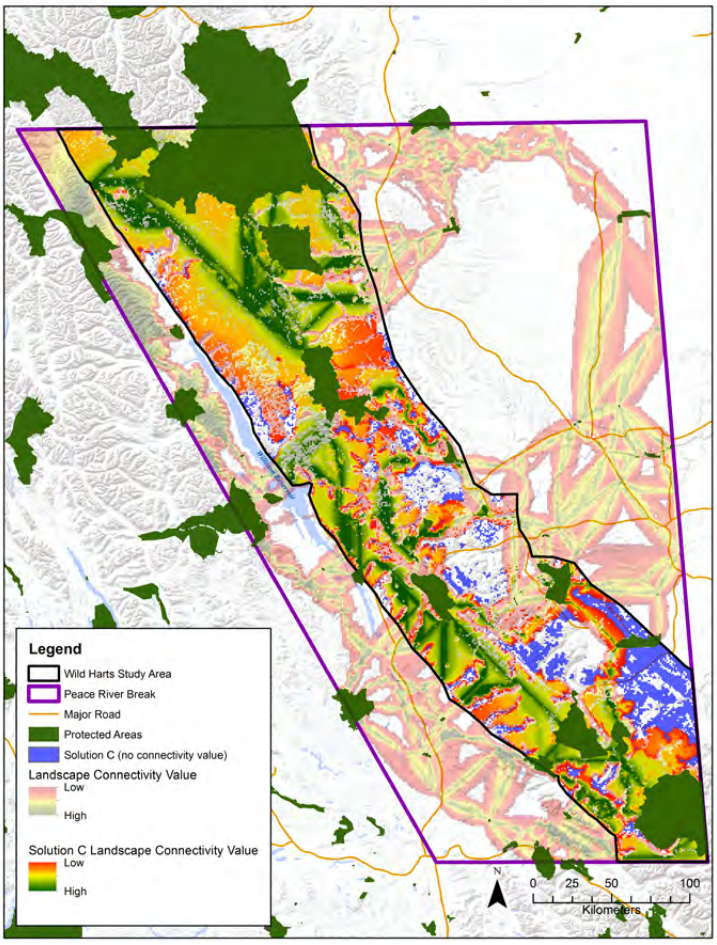


Figure 6. Climate-change conscious solution with connectivity.

The identification of important movement corridors and the prioritization of areas for enhancing climate change connectivity remains a significant challenge. Where traditional *in-situ* (within current ranges) connectivity corridors has proven beneficial for ecological persistence, *ex-situ* (outside of current ranges) connectivity corridors that connect habitat patches across larger distances in time and space, such as the Yellowstone to Yukon (Y2Y) ecological network, can promote the persistence of future biodiversity in the face of climate change. Holistic climate change-conscious corridor planning should seek to incorporate all relevant variables including multivariate climate velocities, cumulative climate change exposure, landscape permeability, dispersal capabilities, as well as current and future land-use patterns.

Where biotic velocities cannot keep pace with climate velocities or anthropogenic, topographic, or climatic barriers interrupt range shifts, managed relocation, or *ex-situ* measures such as captive breeding and gene banking of the species could be necessary to preserve species and genetic diversity. Proactive and effective connectivity planning, and the protection of important movement corridors, can largely reduce the need for such drastic and costly measures. Therefore, a concerted effort is necessary to identify and protect these areas before their capacity to support species' movements is stripped by anthropogenic alterations.

The output of the SCP analysis was not a specific set of proposed protected areas but rather a portfolio of lands with high conservation value that could be used in subsequent design of an appropriate core and corridor solution. This will also allow identification of what conservation measures are necessary to protect specific values. While some conservation features are best suited to a protected areas designation, some high-value lands identified in this process may be adequately protected by *in-situ* conservation measures such as Ungulate Winter Range designations or Transitional Old Growth Management Areas status.

Effective, CCC-SCP initiatives should strive to sustain rich, complex, and ecologically unique communities through a hybrid approach that incorporates fine- and coarse-filter approaches to conservation, consider both the current and projected future state of the landscape, and facilitate species dispersal through enhanced connectivity. By utilizing a hybrid approach that incorporates all of these variables, conservation scientists can pre-emptively plan for future climate conditions, hedge against uncertainty, take advantage of new information and methods, and customize planning to the unique needs and limitations of planning areas, thereby improving biodiversity conservation outcomes.

Systematic conservation planning continues to rapidly evolve as new information and tools become available and is poised to take advantage of climate information and evolve into a climate change conscious approach to conservation planning. Despite the limitations imposed by a high degree of complexity and uncertainty, climate change-adaptation strategies should serve as an integral component of the SCP framework. This case study demonstrated how climate change adaptation strategies can be incorporated into the SCP framework without allowing uncertainties inherent in modeled climate simulations to compromise the efficacy of the overall results. Furthermore, climate change resiliency can be integrated into the SCP framework easily and without increasing the overall cost of the final solution.

Conservation scientists now more than ever need to utilize a CCC-SCP framework in combination with sophisticated software tools and reliable climate change data to recognize and respond to opportunities for action, conserve our planet's biodiversity and mitigate the effects of climate change. The extent to which ongoing attrition of valuable wilderness areas compromises biodiversity and contributes to global warming can be greatly minimized by the prompt and targeted expansion of the global protected areas network under the CCC-SCP framework.

For the Wild Harts, the topographic diversity of the Wild Harts provides a myriad of climate niches that promote a diversity of species assemblages. The topographic diversity of the region also results in numerous areas of low climatic velocity (climate change refugia) and increasingly rare climate conditions required for species (biotic refugia). These areas of refugia are likely to serve as important habitats where species can retreat to, and persist in, during large-scale and long-term climatic change. However, these areas will only

serve as refugia if anthropogenic disturbance is minimized in these areas.

Analysis from this work, along with other related projects, was used to support some significant conservation response in the area. The extraordinary leadership of the West Moberly First Nations and the Saulteau First Nations led to a partnership agreement with the federal and provincial government in 2019 (ECC Canada, 2020). In February of 2020, the existing Klinse-za Provincial Park located just south of the Peace Arm was expanded as an Indigenous Protected Area from 2,689 ha to 28,000 ha. In spring of 2021 there is further expansion to follow to 206,000ha. These expansions are surrounded by other land use agreements where restoration and conservation will be the focus. In addition, an interim moratorium on all new tenures and development has been agreed to on a further 550,000 ha of high elevation caribou recovery area. While interim, it can only be lifted if all parties agree which is an unlikely proposition, given the long-term caribou recovery goals of the the West Moberly and Saulteau First Nations and Canada's commitments under the Species at Risk act. This new Indigenous Protected and Conserved Area (IPCA) represents a remarkable conservation gain for caribou and for climate change resiliency within a critical ecological pinch point in the Wild Harts. Although there is still significant work to do both north and south of this newly protected area these recent conservation actions provide hope.

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Rock Creek, Canadian Rockies (Photo by David McIntyre)

CHAPTER 3b

The Rock Creek Corridor (Southern Canadian Rocky Mountains)

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ROCK CREEK CORRIDOR, SOUTH SASKATCHEWAN PLANNING REGION, ALBERTA

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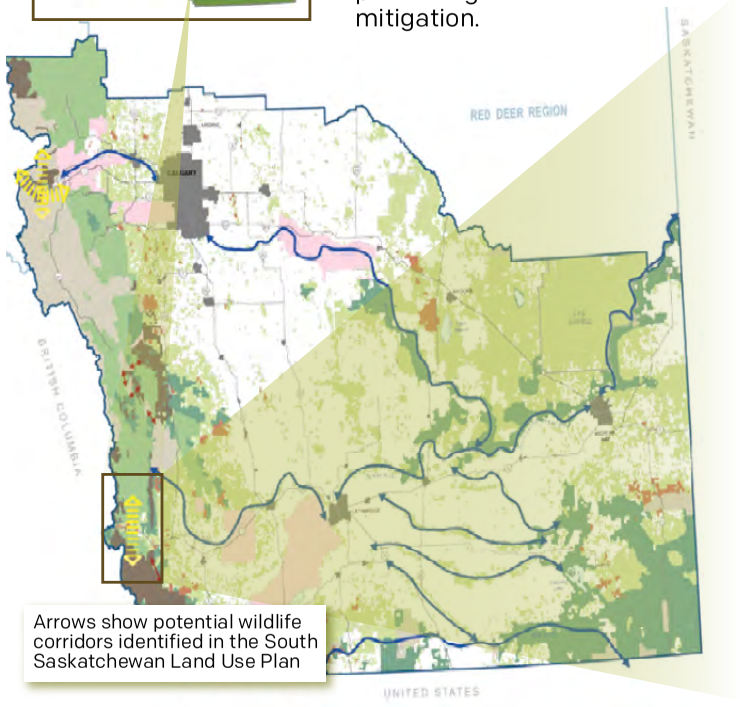
Example of Lesson Learned

- Collaboration is essential because wildlife connectivity has and will only be preserved in the Corridor through the coordinated actions of many different players working across several jurisdictions.

Example of Recommendation

- A policy that enables government agencies, Alberta Transportation (AT) and Alberta Environment and Parks (AEP) to work together and share data could improve approach to prioritizing investment in road mitigation.

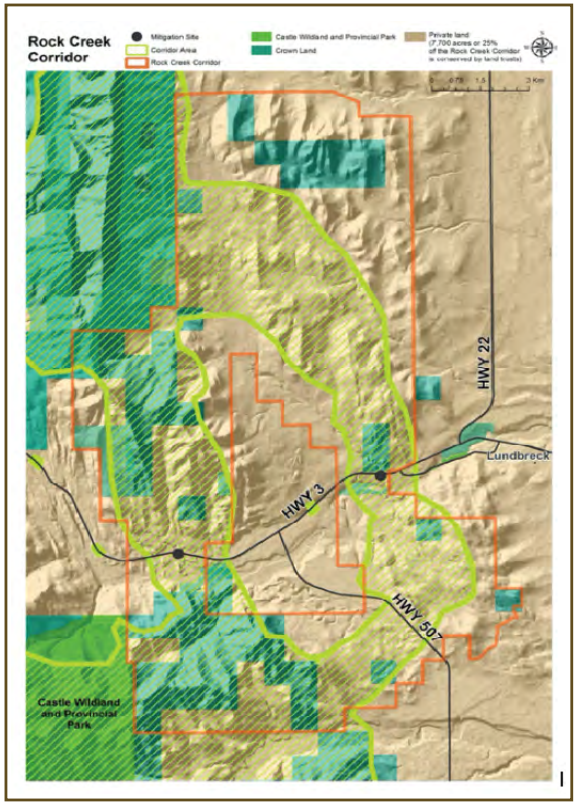


Arrows show potential wildlife corridors identified in the South Saskatchewan Land Use Plan

SUMMARY

The Rock Creek Corridor is an important piece of the connectivity puzzle along the southeast slopes of Alberta's Rocky Mountains.

The Corridor provides a unique example of how protecting and managing a linked mosaic of private and Crown land supports Canada Target 1.



Important ecological functions in the Corridor include the maintenance of biodiversity and watershed health.

The area covers a large portion of the headwaters for the Old Man River Watershed, including the Crowsnest and Castle rivers.

The Corridor is a complex, dynamic, and working landscape that supports ranching, rural residential development and tourism, including world renowned fishing and hunting.

The Corridor sits on the boundary between the Grassland and Rocky Mountain natural areas, creating a unique transition zone that provides habitat for a number of provincially and federally listed Species at Risk. The Corridor is a high risk to motorist safety due to animal-vehicle collisions with deer and AT plans to build an underpass and fencing to reduce motorist safety risk and promote wildlife connectivity.

The Highway 3 Collaborative worked with AT on mitigation design standards to ensure consideration of animal connectivity for grizzly bear, elk and moose.

The investment of AT in highway mitigation could not have occurred without the investment in private land conservation by land trusts and purchase of key parcels by AEP, nor without community support for mitigation generated through the citizen science projects; collaboration is key.

Policy and legislation are limited which reduces the ability of government agencies to maintain or mange for wildlife connectivity.

INTRODUCTION

The Rock Creek Corridor (the Corridor) sits within the southern Canadian Rocky Mountains, connecting the Crown of the Continent Ecosystem (centered about Glacier–Waterton International Peace Parks) with the Banff–Jasper–Kootenay–Yoho mountain parks complex to the north (Figure 1). The southern Canadian Rocky Mountains support the most diverse, intact assemblage of carnivores in North America and represents a significant zone for north-south movement by carnivores, in particular to areas of lower carnivore populations to the south (Apps et al., 2007; Chetkiewicz & Boyce, 2009; Proctor et al., 2005). Therefore, maintaining landscape connectivity is crucial for the wellbeing of the wildlife species that currently thrive in theregion but also for the long-term viability of these species on a continental scale.

The Corridor is an important piece of the connectivity puzzle within the southern Canadian Rocky Mountains, specifically along the southeast slopes of Alberta's Rockies.

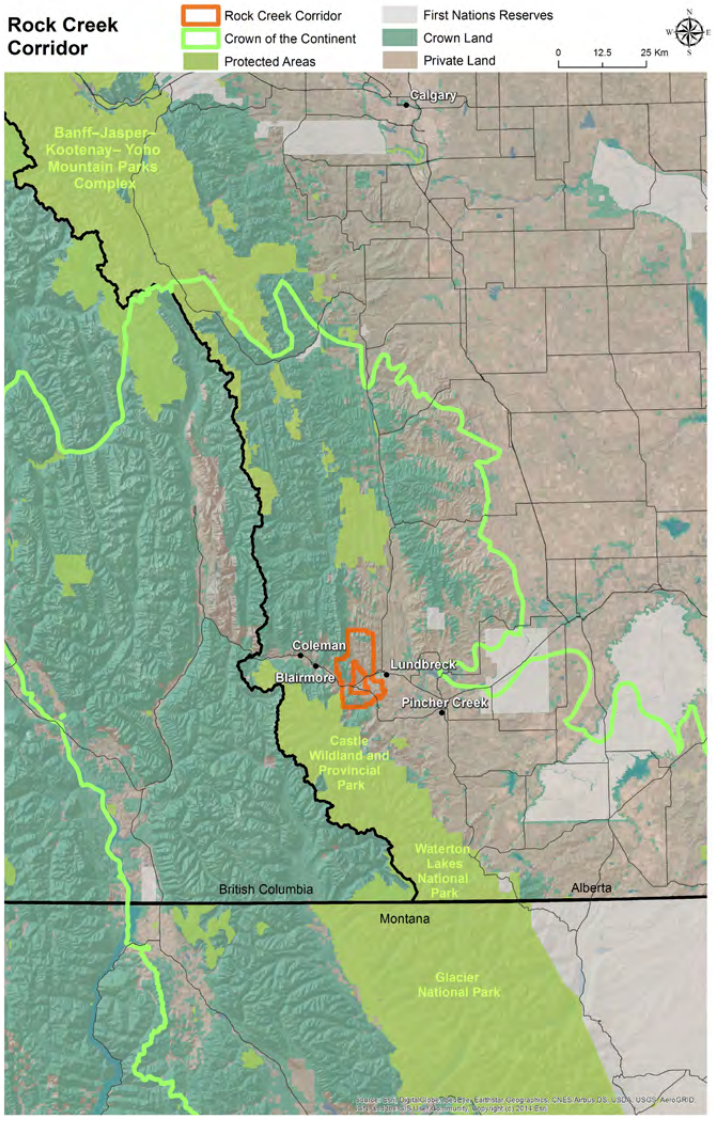


Figure 1. Rock Creek Corridor in relation to Crown of the Continent Ecosystem and national park complexes.

The Corridor provides a unique example of how protecting and managing a mosaic landscape of private and Crown lands that link protected areas, contributes to achieving Canada's Target 1 objectives through Other Effective Area-based Conservation Measures (OECMs). Over the past 10 years, multiple stakeholders including landowners, provincial, and municipal governments, land trusts and conservation groups have collaborated on sustained efforts to advance conservation within the Corridor to ensure long-term connectivity for wildlife. These efforts have been further aided by legislated land use planning processes which recognize the ecological importance of this landscape.

The Corridor is a complex, dynamic, and working landscape that supports ranching, rural residential development, and tourism, including world renowned fishing and hunting. The Corridor is situated mostly in the Municipal District of Pincher Creek, with its western portion in the Municipal District of the Crowsnest Pass. The extent of the Corridor connects provincial Crown land on its northern end with private land to the east, follows south across Highway 3, and then links back west to the Castle Provincial Park south of Highway 3.

The Corridor supports several important ecological functions, including the maintenance of biodiversity and watershed health on both a local and regional scale. The area covers a large portion of the headwaters for the Old Man River watershed, including the Crowsnest and Castle rivers. The largely undisturbed nature of the lands within the Corridor help to store and control surface water runoff, reduce soil erosion, and maintain water quality downstream. The Corridor also sits on the boundary between the Grassland and Rocky Mountain natural areas, creating a unique transition zone that provides habitat for a number of provincially and federally listed Species at Risk. It is also used by a large number of bird species during migration.

The vegetation in the Corridor is a mosaic of grasslands, deciduous and conifer woodlands, including a wide variety of rare plants. Large, intact native grasslands occur on the south and west facing slopes which are comprised mainly of fescue species (Festuca campestris, F. altaica). Deciduous woodlands are common along the valley bottoms where rich, mesic soils prevail. Coniferous woodlands are dominated by Douglas-fir (Pseudotsuga menziesii) with white spruce (Picea glauca) on wetter sheltered sites, and limber pine (Pinus flexilis) on drier ridges.

THREATS TO THE ROCK CREEK CORRIDOR

The primary threat to connectivity in the Corridor is a major transportation route that bisects the Corridor. The other major threat is fragmentation of the landscape from rural residential development due to the high scenic and recreational values of the area. Highway 3, which bisects the Rock Creek Corridor, is a two-lane highway with an average traffic volume of 6,500 – 9,000 vehicles a day (and is projected to increase). This transportation corridor runs west–east over the Continental Divide at Crowsnest Pass in the Canadian Rockies. Highway 3 has long been recognized

as posing a significant threat to wide-ranging carnivores (Apps et al., 2007; A. Clevenger et al., 2010; Proctor et al., 2005; Weaver, 2013). The implications to wildlife include direct mortality from collisions with highway vehicles and fragmentation of the landscape due to avoidance behavior by wildlife from increased traffic volumes. Research demonstrates that Highway 3 is currently a demographic barrier for female grizzly bear movement, indicating avoidance behaviour is already occurring and highlighting the potential of Highway 3 to become a significant fracture zone in the Canadian Rocky Mountains (Proctor et al., 2005).

In addition to transportation corridors, there is a persistent threat of rural development expansion in the Corridor due to the large percentage of private land (73%). Rural residential development refers to the subdivision of large parcels into smaller parcels which results in increased linear disturbance and general disturbance to wildlife which could either change or eliminate their use of the habitat altogether. Residential lots within the Corridor are exceptionally scenic and sought after for sub-division potential. Recent changes to the land use zoning from rural residential development to a natural area within the Burmis Lundbreck Corridor Area Structure Plan has reduced this concern somewhat immediately around a proposed highway mitigation site located at Rock Creek (Oldman River Regional Services Commission, 2013).

Finally, the Rock Creek Corridor lies directly adjacent to the three communities all of which relied historically on coal mining. More recently, the natural resource economies have become increasingly supplemented by tourism and recreation in the area resulting in increased traffic volumes, primarily on weekends and holidays. The Grassy Mountain Coal Project is a proposed steelmaking coal mine that will be developed on a legacy mining area in the Crowsnest Pass, Alberta. The Project is projected to produce around 93 million tonnes of product coal over its currently proposed 23-year mine life. Currently, the Project is being reviewed by the provincial and federal regulators. The Project footprint is estimated at approximately 1,500 hectares (3,706 acres). While not located directly in the Corridor, if approved, it would result in increased local traffic volumes and potentially increased pressure for residential development and subdivision.

CONSERVATION ACTION IN THE ROCK CREEK CORRIDOR

The South Saskatchewan Regional Plan (SSRP), enabled through the Alberta Land Stewardship Act (ALSA), identifies Rock Creek as an area that is important for providing connectivity across the Highway 3 transportation corridor (Alberta Government, 2014). However, no formal provincial or federal protection exists in the Corridor lending to the importance of integrated conservation efforts and OECMs to protect this important wildlife movement area. The Corridor comprises 46,358 acres of land (73% private land and 27% crown land). Of the 33,841 acres of private land, 25% is protected by conservation easements, including almost all key parcels adjacent to the proposed highway mitigation site for wildlife movement.

A broad collaboration between multiple organizations has occurred over the past 10 years to maintain and improve wildlife connectivity along Highway 3 and specifically within the Corridor. These collaborative partners include municipal and provincial governments (Municipality of Pincher Creek, Alberta Environment and Parks [AEP] and Alberta Transportation [AT]), land trusts (Southern Alberta Land Trust Society [SALTS] and Nature Conservation Canada [NCC]) and conservation organizations (Miistakis Institute and Yellowstone to Yukon Conservation Initiative). Momentum has largely been maintained over the decade by the continued efforts and facilitation on the part of the conservation organizations and land trusts. This has included efforts to secure numerous grants to develop the scientific justification and potential solutions for mitigation efforts to maintain wildlife connectivity, along with grants that support land conservation. It has also involved consistent engagement of the larger group of collaborating organizations through one on one meetings, presentations, and workshops. To date, conservation successes include:

- Community engagement and participation in citizen science to provide wildlife mortality, and movement data and support for highway mitigation; Identification of priority highway sections along Highway 3 for mitigation through collaborative research and community engagement; scoping of appropriate mitigation design to facilitate movement of carnivore species; and commitment from AT to invest in highway underpass and fencing at Rock Creek.
- Investment from AEP to secure land parcels adjacent to the highway mitigation site; and development of a community vision to protect key parcels through land securement and subsequent placement of conservation easements on a significant number of parcels.
- Land use zoning change by the Municipality of Pincher Creek from rural residential subdivision to a natural area.

GOVERNANCE, LEGISLATION, AND POLICY

The Rock Creek Corridor is jurisdictionally complex including land ownership and planning oversight involving provincial and municipal governments as well as private landowners. Maintenance of wildlife connectivity ultimately requires coordination and action on the part of several different management authorities and organizations but without a legislative framework or direction supporting these actions, coordination and buy-in are challenging.

Management agencies are guided by legislation that explicitly or indirectly supports or enables their engagement in wildlife connectivity discussions. Alberta Environment and Parks (AEP) manage Alberta's wildlife, and recognize the key role connected habitats play in protecting biodiversity.

For example, the SSRP indicates that wildlife habitat across and within land-use planning regions is an important strategy for maintaining and protecting biodiversity (Alberta Government, 2014). In addition, maintaining wildlife connectivity has been identified as an important strategy in the recovery plans for threatened or endangered species. For example, the grizzly bear recovery plan highlights the importance of maintaining regional connectivity between designated grizzly bear populations (Alberta Environment and Parks, 2016). Recently, AEP released a draft Biodiversity Management Framework for the South Saskatchewan Region and identified a fragmentation index as one of their indicators to monitor biodiversity. Lastly, AEP has developed 'Recommended Land Use Guidelines' for specified wildlife and biodiversity zones in Alberta. These guidelines argue for the protection of locally- and provincially-significant wildlife movement corridors (Alberta Environment and Parks, 2015).

There are two key acts that enable conservation actions and tools used in the Corridor. The ALSA enables the use of conservation easements on private land, a tool used extensively by land trusts to protect wildlife habitat and connectivity in the Corridor. Additionally, the Public Lands Administration Regulation (under the Public Lands Act) enables the use of Public Land Use zone (PLUZ) where activity restrictions can be outlined on public lands.

Alberta Transportation manages highways, with a top priority to enhance human safety. Animal vehicle collisions (AVCs) are responsible for 50% of all vehicle collisions in rural areas, and represent an important motorist safety concern (Alberta Transportation, 2017) Alberta Transportation will mitigate highways to reduce the risk of AVCs to motorists as per their mandate. The Corridor represents a high risk to motorist safety due to AVCs with deer and Alberta Transportation plans to build an underpass and fencing to reduce motorist safety risk. The Highway 3 Collaborative worked with Alberta Transportation on mitigation design standards to ensure consideration of animal connectivity for grizzly bear, elk and moose.

ENGAGEMENT, PARTNERSHIP, COLLABORATION AND TRUST

The collaboration on the Rock Creek Corridor has resulted is an informal working group that engages government agencies, municipalities, environmental non-governmental organizations (ENGOs), land trusts, and a research institute to outline progress and barriers to maintaining wildlife movement along Highway 3 in general and specifically the Corridor. The main driver of the collaborative in terms of facilitating dialogue between stakeholders, protecting private land, and research that has formed the foundation of the business case for connectivity, has been ENGOs, the land trust community, and a research institute. Actions such as change in municipal zoning, agreement to build an underpass and fencing to facilitate safe animal movement and purchasing key land parcels or placing protective notion on crown parcels has been spearheaded by government agencies.

PLANNING AND IMPLEMENTATION

Strategic Planning

Many planning documents overlap with the area designated as the Rock Creek Corridor or have been developed specifically to address its conservation. Each of these documents highlight the importance for connectivity and identify the Corridor as an important area for wildlife habitat, highlight the area as a key wildlife movement area, and support the case for conservation, mitigation and land protection. Planning exists at a variety of scales including; international and provincial transboundary initiatives, provincial planning exercises, collaborative initiatives focused on the front ranges of the southern Canadian Rockies, topic focused (e.g., highway mitigation, species focused) exercises and localized or small-scale area focused plans. Each has its strengths in resonating with a particular audience, and the similarities in each of these plans consistently highlight wildlife connectivity in the region as an important measure of conservation success. Many plans reference those at broader and more local context, use mapping products that align for consistency, and are developed by drawing in expertise and lessons learned from past initiatives focused on the region. Due to the varied ownership, management, and legislation that meet where private and public lands intersect, there is a need for a variety of strategies to be aligned when attempting to conserve and connect key habitat for wildlife movement.

Planning initiatives that overlap the Corridor are listed from largest to smallest scale and separated by their inception as a government driven initiative or those created by non-government organizations.

Government Initiatives

- The South Saskatchewan Regional Plan (Alberta Government 2014)
- Livingstone-Porcupine Hills Land Footprint Management Plan (Alberta Environment and Parks, 2018)
- Livingstone-Porcupine Hills Recreation Management Plan (Alberta Environment and Parks, 2017)
- Burmis Lundbreck Corridor Area Structure Plan (Oldman River Regional Services Commission, 2013)

Non-Government Initiatives

- Southern Eastern Slopes Conservation Strategy (Southern Eastern Slopes Conservation Collaborative, 2018)
- Castle Crowsnest Watershed Natural Area Conservation Plan (Nature Conservancy of Canada, 2016)
- Transportation mitigation for wildlife and connectivity in the Crown of the Continent Ecosystem (A. Clevenger et al., 2010)

- Linking Landscapes and Wildlife along the Highway 3 Transportation Corridor (Miistakis Institute, 2016)
- Rock Creek Strategy (Thompson & Lee, 2015)
- Highway 507 Wildlife Connectivity (D. G. Paton, 2012)

The SSRP, mentioned in the section above due to its legislative backing, is the broadest planning document outlined in this document and it is derived from the ALSA and the Alberta Land Use Framework. The SSRP, even at the broadest spatial scale, highlights and sets the stage for the value of the

Corridor (Alberta Government, 2014). The other plans listed above are more specific and outline how conserving this corridor can occur.

Many of the plans outlined above will be updated over time through an adaptive management strategy, following organizational timelines ranging from 5 to 10-years, or have the option for amendments following an audit process. Specifically, the SSRP, the NCC Natural Area Conservation Plan, and the Burmis Lundbreck Corridor Area Structure Plan specifically note that updates or amendments are part of the process.

Due to the varied nature, spatial scales, and timeframes of the planning documents listed above, not all plans explicitly outline a vision statement or focus their vision statement purely on wildlife connectivity. Some outline a purpose, or a statement of intent, but the themes that align each planning document include: connectivity; maintaining ecosystem integrity; supporting biodiversity; maintaining large patches of intact native habitat, and keeping these patches connected; and, the desire to protect habitat on public and private lands. Even the Recreation Management plan, a plan with the focus on human recreation, describes management intent to avoid high value wildlife corridors wherever feasible (Alberta Environment and Parks, 2017)

GOALS, OBJECTIVES AND STRATEGIES FOR CONSERVING ROCK CREEK

Goals and Objectives from planning documents overlapping with the Rock Creek Corridor align on several general statements:

- Increasing protection within the areas identified as wildlife corridors or areas important for connectivity (public and private lands);
- Maintaining the existing open/intact habitat in the region (specifically native grassland and intact montane habitat from either a view-scape or biodiversity perspective);
- Forming consensus on priority areas (core habitat, wildlife movement areas, etc.) and aligning messaging, maps, and information that is being used with government, the public, and partners;
- Recognizing the efforts and successes of conservation (public and private) and creating new opportunities to pursue securement and stewardship projects;
- Minimizing or reducing the human footprint and avoiding critical wildlife corridors; and,
- Promoting awareness to the community, governments (multiple levels) and supporters of the conservation community to work that is ongoing and information that is available.

Since these goals were distilled from documents ranging from ENGOs, collaborative initiatives, municipal and provincial plans, the overlap and similarity is quite remarkable, and demonstrates the desire for collaboration to achieve a connected landscape using a variety of tools. Specific Goals that are directly applicable to the Aichi Target 11 include:

- By 2023, increase conservation land in identified wildlife movement corridors by 5 parcels, with 3 of those parcels being in pinch-points, leading to a 1-2% increase in potential corridor coverage (Nature Conservancy of Canada, 2016).
- The regional network of areas that support biodiversity - conservation is enhanced through additional conservation areas (Alberta Government, 2014).
- Improve and maintain connectivity for wildlife across major highways and roads (Southern Eastern Slopes Conservation Collaborative, 2018).

Strategies directed at achieving these Goals are more specialized to the organization that established the planning document.

The province (Alberta Government, 2014) has focused their attention on the following:

- Implement guidelines to avoid conversion and maintain intact native grasslands on public land;
- Encourage and support the continued stewardship of Alberta's private lands through the development and piloting of regionally appropriate conservation tools. These tools may include exploring market-based options, voluntary conservation easements and the provision of other government and/or private sector incentives that assist in achieving environmental outcomes. This will be done within the provincial approach for management of ecosystem services; and
- Consider connectivity of intact native grasslands as the highest priority under the Land Trust Grant Program.

Land trusts (Nature Conservancy of Canada, 2016; Thompson & Lee, 2015) have focused their attention on:

- Engaging local landowners within the Corridor interested in Conservation Easements (SALTS and NCC) or Fee Simple (NCC only) of high priority parcels;
- Supporting the protection and stewardship of Crown Land when applicable; and
- Engaging in collaborative efforts and information sharing with partners, municipal and provincial governments, and local landowners.

The Miistakis institute and Yellowstone to Yukon Conservation Initiative have brought together a collection of stakeholders and outlined similar strategies to those above, but also included:

- Site-specific monitoring and research for species movement (terrestrial and aquatic) and identification of road sections where wildlife cross and/or are involved in wildlife-vehicle collisions;
- Continuing engagement with AEP and AT in relation to highway mitigation;
- Improving public support for wildlife connectivity through public safety, citizen science, and community engagement;
- Reducing the impacts from recreation; and
- Engaging municipal governments and the AEP planning processes.

The Highway 3 Collaborative which is an informal working group that engages GOA agencies, municipalities, ENGO's, Land Trusts and a research institute annually to outline progress and barriers to maintaining wildlife movement along Highway 3 and within the Rock Creek Corridor also made specific recommendations for the Corridor, including:

- a new bridge structure should be designed to maximize wildlife movement under Highway 3, allowing adequate space (>6 m wide) and substrate for wildlife travel
- Wing fencing (minimum 200 m) should be used to guide wildlife to the bridge; and,
- Boulders between fence and roadway and jump-outs may be required depending on the situation (A. P. Clevenger et al., 2010).

From a local municipal perspective, the Burmis Lundbreck Corridor Area Structure Plan identified policies with specific reference to wildlife corridors in support of connectivity, such as:

- direction to implement policies which promote agricultural uses, wildlife crossings, and ungulate wintering ranges;
- encourages the use of conservation easements by landowners to preserve ungulate travel corridors and wintering ranges; and
- additional strategies focused on open space and community aesthetics.

MANAGEMENT AND OPERATIONAL PLANNING

The Alberta Land Trust Grant (ALTG) is a major funder of private land conservation in Alberta and dictates that it must "consider connectivity of intact native grasslands as the highest priority under the Land Trust Grant Program" (Alberta Government, 2014). This funding drives many private land conservation projects that occur in Alberta. When NCC completed the NACP for the region (Nature Conservancy of Canada, 2016), consultation occurred with SALTS, local wildlife experts, and Miistakis to facilitate a securement prioritization process, where the Corridor was identified as an area of high priority. This planning initiative also allows NCC access to additional funding that can be applied to high priority conservation projects in the region.

Through the ALTG, land donations, federal support through the Natural Area Conservation Program, and other financial contributions, 25% of the private land (ca. 7,700 acres) within the Corridor is currently protected. Most of these projects are Conservation Easements with annual monitoring requirements, and some are fee simple projects with a Property Management Plan that includes effectiveness monitoring at a property scale. Within the Crown land portion, most parcels include Protective Notations (PNT), representing a trigger to the government to review applications that are related to a sale of the land, surface dispositions. Some parcels allow grazing, similar to much of the private land within the Corridor. Any parcels with fescue grasslands on them now have an additional PNT which requires additional written clearance before any development occurs. These notations are not perfect, but they are a tool available to add layers of protection to important Crown parcels.

From a mitigation perspective, the plans completed by A.P. Clevenger et al., Miistakis Institute and Thompson and Lee, along with municipal support, community engagement has led to the current mitigation efforts being completed at Rock Creek. A recently completed functional design study by Alberta Transportation along Highway 3 identified Rock Creek as a high priority mitigation site and recent 2019 provincial budget specifically mentions development of an underpass and fencing at Rock Creek. The underpass has been designed (4x6m) to facilitate large carnivore and ungulate movement, instead of a culvert (2x2m) that would facilitate movement of deer, primary species involved in wildlife vehicle collisions.

Within the Burmis Lundbreck Corridor Area Structure Plan, important wildlife habitat to the south of Highway 3 at Rock Creek was designated for rural residential sub-division. In 2012, the Municipal District of Pincher Creek worked with Miistakis to understand reports and spatial data relevant to their decision. This process led to the designation of the habitat as an Environmentally Sensitive Corridor (Oldman River Regional Services Commission, 2013). This highlights the support for Corridor from the municipal perspective, and the impact that can come from proper planning and

providing the necessary information to those that make decisions.

BIODIVERSITY OUTCOMES

The Alberta Government outlined that part of the Land Management plan was to develop metrics, also identified in the SSRP (Alberta Government, 2014) as part of the Biodiversity Management Framework. Neither of these currently has monitoring in place focused specifically on wildlife connectivity in the Corridor. Outcomes for conservation easements and Crown lands are typically driven by the restrictions built into them, therefore the monitoring that occurs is not specifically targeting the biodiversity outcomes. A collaborative project between the Alberta Biodiversity Monitoring Institute, SALTS, NCC, and Lethbridge College was launched in 2019 using camera traps and audio recording units that may provide insight to the biodiversity outcomes based on current conditions and future trends.

KNOWLEDGE MANAGEMENT

Scientific knowledge, including both animal modeling and citizen science monitoring were foundational in developing conservation actions to protect wildlife connectivity in the Rock Creek Corridor. Scientific knowledge informed two conservation actions; the location and road mitigation strategy to reduce wildlife vehicle collisions while facilitating safe animal movement across Highway 3 (A. P. Clevenger et al., 2010) and prioritization of private land conservation through delineation of core habitat and corridors to support large mammals (Miistakis Institute, 2016).

Scientific data informing the need for road mitigation was summarized for use by decision makers in A. P. Clevenger et al. (2010)where grizzly bear, moose and elk crossing locations were identified based on where the road intersected habitat and/or movement models (Benz et al., 2016; Chetkiewicz & Boyce, 2009; Proctor et al., 2005). In addition animal carcass data from Road Watch in the Pass (citizen science program) and highway maintenance personal was analysed to identify road sections with a high number of animal carcasses to represent sites where human and wildlife safety may be at risk (Lee et al., 2006). The scientific and monitoring knowledge was used to identify mitigation emphasis sites along Highway 3, prioritized the sites based on a set of ecological and social political criteria and recommend mitigation measures to ensure safe movement of animals across Highway 3 (A.P. Clevenger et al., 2010). The report laid the foundation for dialogue with AT about the need for investment in highway mitigation and resulted in the formation of the Highway 3 Collaborative working to maintain animal movement across Highway 3. Science or monitoring datasets continue to collect information and support Rock Creek as an important crossing location for animals including development by Alberta Transportation of Alberta Wildlife Watch Program where highway maintenance personal report wildlife carcasses via a smartphone application (Alberta Transportation, 2017). Information on wildlife movement across Highway 507 was documented to enable prioritization of private land parcels (D. Paton, 2015).

To better understand movement needs of wildlife, the Highway 3 Collaborative hosted a workshop to review animal models and delineate core habitat patches and movement corridors. Figure 2 highlights Rock Creek area, parcel jurisdictions and wildlife corridors based on expert opinion and assessment of elk, moose, grizzly bear, cougar and wolverine models (Benz et al., 2016; Braid et al., 2015; Chetkiewicz & Boyce, 2009; Proctor et al., 2005).

The importance of animal movement through the Corridor and across Highway 3 and 507 has been communicated with the public through a variety of mechanisms, including information transfer approach (i.e., infographics, pamphlets, and media articles), community engagement through citizen science programming and hosting of public community events.

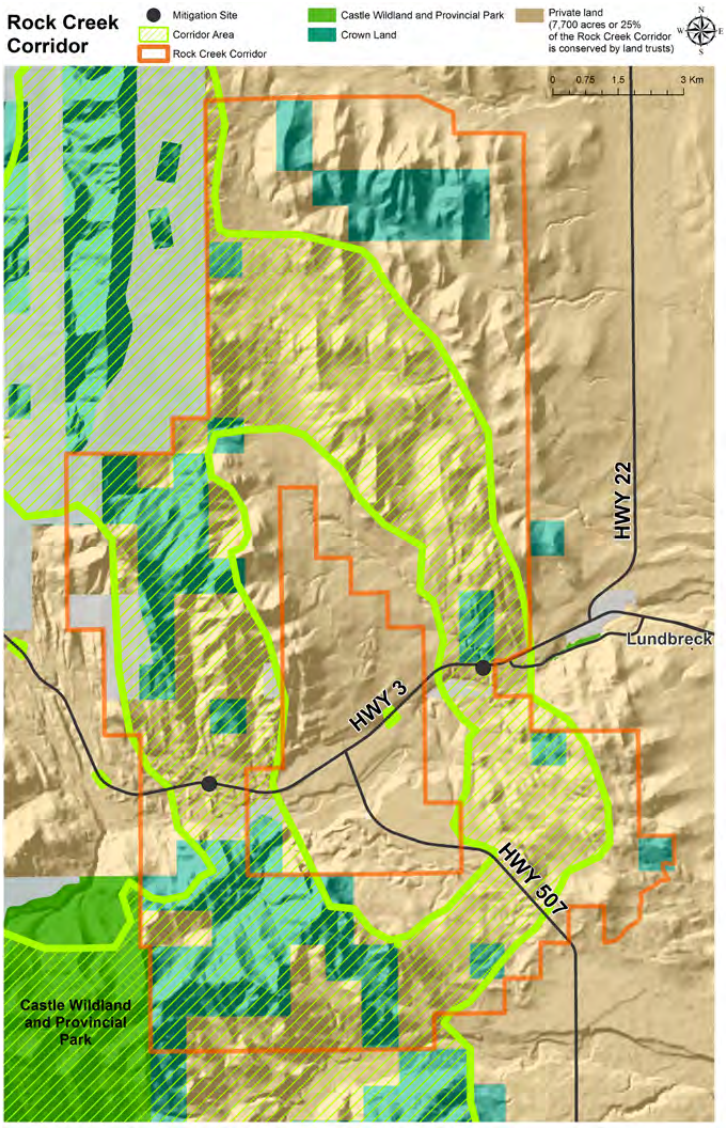


Figure 2. The Corridor (orange boundary) with jurisdictions (crown vs. private land), and animal movement corridor (light with hash marks)

Citizen science has strong potential to contribute data to scientific evaluations while meaningfully engaging communities in knowledge generation and sharing. Two citizen science programs in the Corridor engaged over 150 individual citizens in the Pass to collect information on animal mortalities to better understand the impacts of roads on wildlife. Eighty percent of participants reported sharing their program experiences with family, friends and other community members, resulting in a change in how information about impact of roads on wildlife flows through a community (Lee et al., 2006). Local communications can lead to positive behavioral changes by others who may be motivated by the participant's shared knowledge. For example, volunteer participants reported their family members slowing down in known wildlife vehicle collisions hotspots. Lastly, knowledge exchange included numerous community events such as science cafés, film showings, and public presentations designed to foster dialogue around wildlife connectivity and roads.

LESSONS LEARNED AND NEXT STEPS

The investment of Alberta Transportation in highway mitigation in the 2019 budget could not have occurred without the investment in private land conservation from land trust community and purchase of key parcels by Alberta Environment and Parks near the mitigation site, nor without community support for mitigation generated through the citizen science projects. Over the past 10 plus years of planning and conservation action, the biggest learning is that collaboration is essential. Wildlife connectivity has and will only be preserved in the Corridor through the coordinated actions of many different players working across several jurisdictions. Each partner may have their own agenda, their own tool set, and their own internal processes, but conservation efforts designed to connect landscapes will need to be a multi-faceted approach to achieve success.

Each organization will play an important role in the process and bring different skills to the table, leading to a teamwork approach to reach similar goals. Success is also far more likely if there are one or more champions who continue to move the agenda forward over several years. In the case of the Rock Creek Corridor, there was a shared interest and passion on the part of several organizations and individuals who continued to push and engage all the members of the collaboration in order to keep the yard stick moving. While the efforts to protect wildlife movement in this critical wildlife corridor are not complete, the gains made, and level of engagement achieved is well beyond what those who started the process believed was possible. There is now a critical mass of planning and organizational support for these efforts that its completion and long-term success seems very likely.

There are a number of other important steps that will help ensure the Corridor remains intact, including official recognition of the Corridor by Alberta Environment and Parks, Protective Notions placed on all Crown parcels within the Corridor, and support for rural municipalities to consider wildlife connectivity in development permitting.

- Core habitat and wildlife corridors need to be formally recognised by AEP and made available on Government of Alberta mapping tool or consultants working on environmental assessments may not consider this information during assessments. This could potentially result in development approvals that are within the Corridor or approval of activities that could impact wildlife movement.

- A number of the isolated crown parcels within the predominately private land base still require protective notations to prevent sales or surface dispositions.

- Municipal governments make land use decisions and wildlife connectivity is not often considered in permitting decisions. The creation of tools, such as connectivity guidelines on size specifications and activities that reduce connectivity value would assist municipalities in integrating wildlife connectivity better into discussions and decisions.

Lastly, policy and legislation are limited and reduce the ability of government agencies to maintain or mange for wildlife connectivity. At the highest level, prioritization of road sections for investment in mitigation is focused on areas with the highest costs from AVCs; unfortunately, these do not always align with areas where wildlife need to cross, reducing consideration of wildlife connectivity in road mitigation investments. A policy that enables government agencies, AT and AEP to work together and share data could improve approach to prioritizing investment in road mitigation. Rock Creek has good alignment between high cost of animal-vehicle collisions and animal connectivity which made for easier discussions on investment, but these areas of agreement are limited.

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Jasper, Alberta (Photo by Kevin Mueller)

CHAPTER 3C

The Yellowstone to Yukon (Y2Y) Conservation Initiative

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YELLOWSTONE TO YUKON (Y2Y)

JODI HILTY AND AERIN L. JACOB, YELLOWSTONE TO YUKON CONSERVATION INITIATIVE

Example of Lesson Learned

- While local people or entities can often be very effective advocates for advancing local conservation, they can be subject to local influences that make them hesitant to speak out.
- Local entities can often benefit from even small resources, to help their work advance.
- With foresight and collaboration, local efforts can scale up to be regionally significant.
- Larger entities, such as provincial and federal governments agencies, have multiple roles in connectivity conservation, including legislation/ policy development and program funding.

Example of Recommendation

- Be clear on what roles each entity plays at different levels to avoid such mis-perceptions.

Example of Lesson Learned

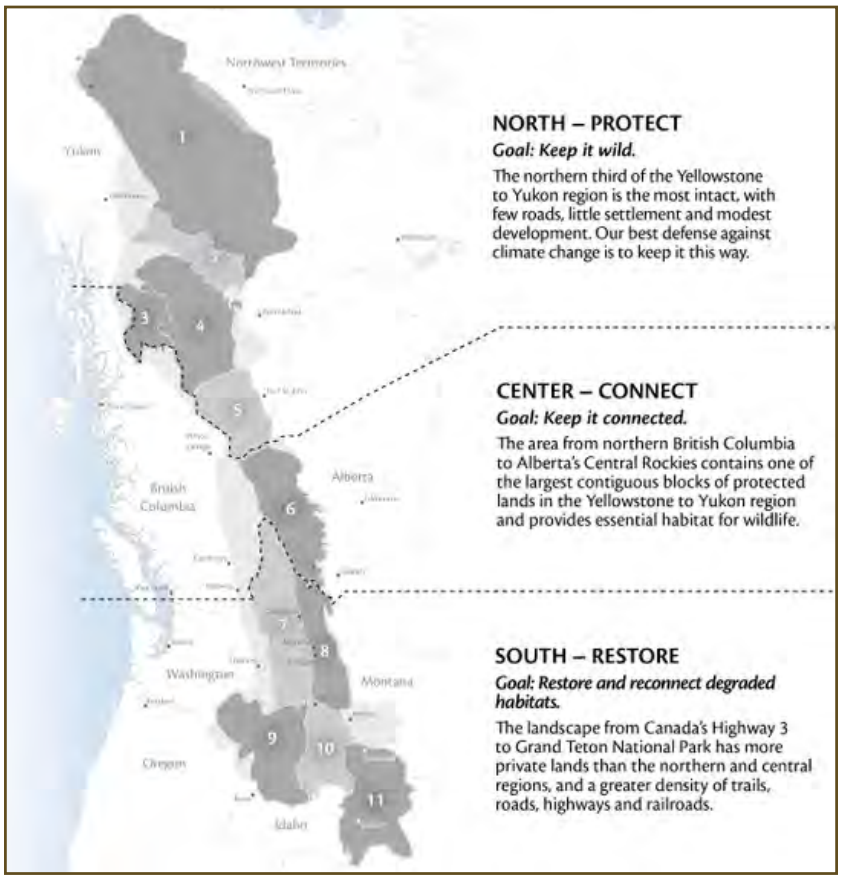
- A lack of unified law or policies at international, federal, or regional levels to designate ecological corridors, combined with different contexts on the ground, means that the approach for each conservation project in the Y2Y region must be uniquely tailored.

Example of Recommendation

- Ultimately, it is hoped that new corridor legislation at federal and/or regional levels will provide a policy framework that helps to enhance collective efforts to designate, restore, and conserve landscape connectivity.

Y2Y VISION

"An interconnected system of wild lands and waters stretching from Yellowstone to Yukon, harmonizing the needs of people with those of nature"



SUMMARY OF THE Y2Y REGION

Stretching 3,200 km and encompassing more than 1.3 million km^2, the Y2Y region is one of the last most-intact mountain systems left on Earth.

It is home to the full suite of large and medium-sized mammal species that existed when European explorers first arrived in the region.

It traverses the traditional territories of at least 75 Indigenous groups including Métis, First Nations, and Native American tribes.

It hosts the headwaters of 13 major rivers that drain into the Arctic, Pacific, and Atlantic Oceans. These river systems are inhabited by 118 species of fish and provide clean, safe drinking water to at least 15 million people in North America.

Maintaining and improving landscape connectivity and ensuring that species can move is one of our best strategies to adapt to climate change.

THE SOCIAL-ECOLOGICAL SYSTEM

Stretching some 3,200 km in length (2,000 mi) and encompassing more than 1.3 million km^2, the Yellowstone to Yukon (Y2Y) region is one of the last most-intact mountain ecosystems left on Earth. It is home to the full suite of large and medium-sized mammal species that existed when European explorers first arrived at the region. Y2Y hosts the headwaters of seven major rivers that drain into the Arctic, Pacific, and Atlantic Oceans, and within which some 118 species of fish swim (Chester. 2006). These river systems are the source of clean, safe drinking water for at least 15 million North American people.

Today the Y2Y region encompasses parts of the Canadian Northwest and Yukon Territories and British Columbia (B.C.) and Alberta provinces as well as large parts of Montana, Idaho, and Wyoming in the United States (U.S.) (with small portions extending into Oregon and Washington). In addition to today's political boundaries, the area is overlaid with the territories of at least 75 Indigenous Peoples including Métis, First Nations, and Native American tribes.

The mountains themselves offer a multitude of altitudes and angles, which means a lot of surface area across the region in each square kilometer. Adding to the topography is a host of different environmental factors ranging from varied temperatures and precipitation to various underlying geologies and fault lines. The resulting landscape contains 31 terrestrial ecoregions and an enormous variety of habitats including alpine and sub-alpine, boreal forests, wetlands, riparian areas, shrublands, grassland, and prairies (Olson et al., 2001; Wilcox et al., 1998).

The relative ruggedness of the landscape has been a safe haven for wildlife over time including many large carnivores that have been extirpated from other parts of their range. Several carnivore species are listed on federal endangered species laws, e.g., grizzly bear (*Ursus arctos*), gray wolf (*Canis lupus*), and wolverine (*Gulo gulo*). Other wildlife species are also facing declines and listing in the region, e.g., caribou (*Rangifer tarandus*), westslope cutthroat trout (*Oncorhynchus clarkia*), and bull trout (*Salveelinus confluentus*) (Figure 1).

The Y2Y region includes the very first national parks for each of Canada and the United States (Banff and Yellowstone) among scores of national, state, and provincial parks, national forests, wilderness areas, wildlife refuges, tribal parks, and other natural areas (Chester, 2006). Other parts of the Y2Y region are a mix of public multi-use lands interspersed with private lands. Much of the activity on non-protected public lands is not well monitored. For example, the extent of user-made and unauthorized recreation trails is largely unknown across these lands; there is approximately 30,000 km of officially recognized and mapped trails in B.C., but an estimated hundreds of thousands of unmapped and unauthorized trails (Province of British Columbia, 2012).

Figure 1. The continued presence of large and medium-sized mammals is one of the biological factors that exemplifies the Yellowstone to Yukon region, including a) grizzly bear, b) mountain caribou, c) wolverine, (Photos: Shutterstock) and d) grey wolf (Photo: Antonio Sunción).

Generally speaking, there is a strong mountain culture across the region, but what that means varies from place to place (Chester, 2006). To visiting tourists, the Y2Y region can be a place of inspiration, rest, and peace. To more recreation-oriented communities, these mountains represent a breadth of recreational opportunities from quiet to motorized and from hiking to caving and hunting. Still, other communities hold more of a traditional ranching set of values having grazed livestock for several generations. Many Indigenous Peoples practice a variety of cultural traditions including hunting, trapping, and gathering, and/or ceremonial and spiritual practices. Other community identities are tied to natural resource extraction activities be it logging, mining, or oil and gas extraction, the latter of which tends to lead to the least stable boom and bust communities (Berger & Beckmann, 2010).

Nature itself has been associated with direct and sizeable economic value in the region. For instance, nature-based extractive and non-extractive activities in eastern B.C.'s the Columbia Headwaters is a significant part of the area's economy, including forestry, mining, tourism and both motorized and non-motorized recreation (Williams & Bull, 2019). As well, expenses related to non-motorized outdoor recreation in Alberta for 2018 alone were estimated at $5.49 billion in Gross Domestic Product (GDP) and the equivalent of more than 77,000 jobs (Nichols Applied Management Inc., 2018).

The north-south delineation of the mountains represents both a natural boundary but also a determining feature of travel routes for people and wildlife. Historically much human travel and trade followed the north-south geography and across the few lower mountain passes across the mountains. That there are few, large east-west breaks across the Rocky Mountains means that they are of particular ecological importance: Crowsnest Pass, the Bow Valley, the Athabasca Valley, the Peace River Valley in Canada, and the Interstate 90 and highway 2 corridors in the U.S.

Many animals, such as bald and golden eagles (*Haliaeetus leucocephalus and Aquila chrysaetos*), have long traveled along the backbone of these mountains in their annual migrations. The Y2Y vision itself is seen as important response to a changing climate, as it incorporates major recommendations from climate scientists on how to help nature adapt such as expanding core protected areas and connecting them, particularly in topographical diverse and north-south systems (Heller & Zavaleta, 2009).

The Yellowstone to Yukon vision: "An interconnected system of wild lands and waters stretching from Yellowstone to Yukon, harmonizing the needs of people with those of nature"

Some people refer to Y2Y and the associated vision as a corridor, but in reality, it is really an ecological network. That is, it is a set of protected areas [and perhaps future Other Effective Area-based Conservation Measures (OECMs)] that we seek to connect across the region (Bennett & Mulongoy, 2006). This means that it will provide significant north-south connectivity at the continental scale, which is made up of much finer-scale corridors. As a whole, the Y2Y vision seeks to protect terrestrial and hydrological connectivity for both species and entire ecosystems.

Figure 2. Growing interest in motorized and non-motorized outdoor recreation, particularly into backcountry areas, can create opportunities for diversified economies but also put pressure on conservation values. (Photos: Shutterstock)

While the system is more intact that many other parts of the world, it is impaired in some parts of the region already and facing increasing threats. Generally speaking, these are different from north to south. In the northern part of Y2Y, the main anthropogenic threats are from mineral extraction and associated road development. The road development leads to increased hunting access and pressure as well as recreation in areas that were previously harder to reach. Further south, additional pressures include forestry, some oil and gas extraction, and significant localized recreational pressures, and in the southern part of the region another additional threat is expanding human developments and the associated larger footprint around these developments. In some areas, poor ranching practices can bring invasive species and riparian and wetland degradation (see below Table 1 for more details).

Table 1. Threats from the International Union for the Conservation of Nature - Conservation Measures Partnership (IUCN-CMP) threat classification system as they relate to the Y2Y region.

Threat Level			Comments as these relate to Y2Y region
1st Level Threat	**2nd Level Threat**	**3rd Level Examples**	
Residential & Commercial Development **(Human settlements or other non-agricultural land uses with a substantial footprint)**	1.1 Housing & Urban Areas	Urban areas, suburbs, villages, vacation homes, shopping areas, offices, schools, hospitals	Localized more intense in southern part of Y2Y
	1.2 Commercial & Industrial Areas	Manufacturing plants, shopping centers, office parks, military bases, power plants, train and shipyards, airports	Minor
	1.3 Tourism & Recreation Areas	Ski areas, golf courses, beach resorts, sports fields, county parks, campgrounds	Localized more intense in southern parts of Y2Y
Agriculture and Aquaculture **(Threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture, mariculture, and aquaculture)**	2.1 Annual & Perennial Non-Timber Crops	Farms, swidden plots, orchards, vineyards, & mixed agroforestry systems	Localized
	2.2 Wood & Pulp Plantations	Silviculture & Christmas tree farms	Minor
	2.3 Livestock Farming & Ranching	Cattle feed lots, dairy farms, cattle ranching, chicken farms, goat and sheep ranching, game ranching	Mostly in southern part of Y2Y
	2.4 Marine & Freshwater Aquaculture	Fin fish aquaculture, hatchery salmon, seeded shellfish beds, & seaweed beds	n/a
Energy Production & Mining **(Threats from production of non-biological resources)**	3.1 Oil & Gas Drilling	Land and marine oil and gas wells	Localized but high impact in some areas such as Peace River region
	3.2 Mining & Quarrying	Coal mines, alluvial gold panning, mineral-based mining (e.g., gold, copper, nickel), rock quarries, deep sea mining	Widespread with cases secondary impacts of roads and access and sometimes water quality and toxicity issues
	3.3 Renewable Energy	Geothermal power production, solar farms, wind farms (including birds flying into windmills), and tidal farms	Localized but cumulative impacts such as of solar with other natural resource extraction can be significant such as in the Peace River region and the Columbia Watershed
Transportation and Service Corridors **(Threats from long, narrow transport corridors, and the vehicles that use them including associated wildlife mortality)**	4.1 Roads & Railroads	Highways, secondary roads, logging roads, bridges and causeways, road kill, fencing associated with roads and railroads	Widespread. Significant impact to local and thus Y2Y connectivity
	4.2 Utility & Service Lines	Electrical and phone wires, aqueducts, oil and gas pipelines, and electrocution of wildlife	Localized… where vegetation is managed and overlap with high rec can lead to human-bear conflicts
	4.3 Shipping lanes	Dredging canals, shipping lanes, ships running into whales, Noise from ships, & wakes from cargo ships	n/a
	4.4 Flight Paths	Low flying aircraft harassment, bird strikes	Recreational heli-tours, heli-skiing and other rec can have major impacts and with it becoming much more widespread
Biological Resource Use **(Threats from consumptive use of wild biological resources, including deliberate and unintentional harvesting effects; also, persecution or control of specific species)**	5.1 Hunting & Collecting Terrestrial Animals	Bushmeat hunting, trophy hunting, fur trapping, insect collecting, honey or bird nest hunting, predator control, pest control, and persecution	Localized challenges such as on wolverines
	5.2 Gathering Terrestrial Plants	Wild mushrooms, forage for stall fed animals, orchids, control of host plants to combat timber diseases	n/a
	5.3 Logging & Wood Harvesting	Clear cutting of hardwood, pulp operations, & fuel wood collection	Widespread and older practices not following best science = problematic
	5.4 Fishing & Harvesting Aquatic Resources	Trawling, blast fishing, spear fishing, shellfish harvesting, whaling, seal hunting, turtle egg collection, & seaweed collection	n/a

Threat Level			Comments as these relate to Y2Y region
1st Level Threat	2nd Level Threat	3rd Level Examples	
Human Intrusions and Disturbance **(Threats from human activities that alter, destroy, and disturb habitats and species associated with non-consumptive uses of biological resources)**	6.1 Recreational Activities	Off-road vehicles, motorboats, jet-skis, snowmobiles, ultralight planes, dive boats, whale watching, mountain bikes, hikers, birdwatchers, skiers, pets in recreation areas, temporary campsites, caving, & rock climbing	Widespread and depending on activity and intensity can have significant impacts on everything from water quality to species distributions and human-wildlife conflicts

TYPES OF PROTECTED AREAS AND PROPERTIES

The jurisdiction and categorization of protected lands and other lands with conservation value is varied and complex across Y2Y. In Y2Y, 16 protected area designations fall within the IUCN categories I through IV. As of 2018, protected lands made up approximate 15% of the Y2Y region (Hebblewhite et al., in prep)). An additional 23 land conservation measures do not provide sufficient protection to be granted IUCN protected area status but may provide some benefit to biodiversity conservation because of partial, seasonal, or interim restrictions on human development, activities, or access (see tables 2-4). Lands with varying levels of improved conservation, some of which are substantial and some of which offer only limited conservation benefits represented another 30% of the landscape as of 2013(Y2Y, 2013).

In addition to the above-mentioned designations, Y2Y also hosts a number of other designations such as the world's first international peace park, Waterton Glacier International Peace Park. Both parks are declared Biosphere Reserves by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and their union as a World Heritage Site. Yellowstone National Park is a Man and Biosphere Reserve and a World Heritage Site, as are the Canadian Rocky Mountain Parks, Head-Smashed-in Buffalo Jump, and Nahanni National Park Reserve.

Beyond protected areas, Y2Y hosts a suite of areas that serve as corridors enabling movement of wildlife and plants. In the southernmost part of the region, in Wyoming the first federally designated wildlife corridor in the United States called Path of the Pronghorn consists of a management designation on U.S. Forest Service land, an agreement between the U.S. Forest Service, the U.S. Fish and Wildlife Service, and the National Park Service; on Bureau of Land Management (BLM) lands, these are Areas of Critical Environmental Concern; and finally on Department of Transportation land, these are designated wildlife overpasses and underpasses (Figure 3a). In other cases, the purchase of private lands or easements on private lands by conservation groups is done in part or in full to protect connectivity. Still in other places, such as around Canmore, the provincial government and the Town of Canmore both recognize lands designated for wildlife corridors to ensure wildlife can get around the towns but allow for recreational activities within these corridors. In some cases, counties in the U.S. consider wildlife movement as they approve (or not) proposed developments. Another designation is the scenic and wild river designation, which helps both instream and terrestrial natural values be maintained and maintain the river corridor. Finally, across the Y2Y region there are more than 100 designated wildlife crossing structures and associated fencing across busy roads that help keep wildlife connected and increase road safety; these can be within protected areas, or outside parks and if outside parks, lands on either side are generally secured from development (Figure 3b). In Banff National Park, highway mitigation has reduced collisions by at least 80 percent and more than 96 percent for elk and deer alone (Parks Canada, 2017).

The so-called 'matrix', or land between protected areas, is a mix of public lands (federal or state/provincial or city) and private lands. For the most part, these places do not have a high degree of protection. While there are a variety of laws that apply to any activity happening on public lands and land-use planning can have an impact on what occurs on private lands; the vast majority of lands do not have strong binding biodiversity or habitat protection (Y2Y, 2013).

One of the biggest gaps is that various jurisdictions are managing each of the patchwork pieces of lands separately. There still is a lack of a coordinated effort to consider what nature needs at the landscape scale that matters. As such, it often falls to non-profit organizations to continue to push forward transboundary or cross-jurisdictional work. For instance, an international review of more than 250 connectivity conservation plans found that partnership was key to successful implementation, particularly from non-governmental organizations (Keeley et al., 2019). Additionally, weak and often changing policies (as different political affiliations come into leadership) make it difficult in some cases to advance consistent conservation. Finally, strong enabling legislation to identify and protect key parcels that advance connectivity would benefit both countries. That said, there remains a proposal for federal legislation on corridors in the U.S., and some states outside the Y2Y region have adopted state level legislation on corridors (e.g., https://www.congress.gov/bill/116th-congress/house-bill/2795, http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200SB1372). Guidance on ecological corridors is also moving forward at the global level through the IUCN Connectivity Specialist Group (Hilty et al., 2020).

Table 2. Types of protected areas and other conservation measures.

Jurisdiction	Land Use or Data Type	Data Source	Data Location
Canada	All federally and provincially protected lands within IUCN categories I-VII.	Canadian Council on Ecological Areas. Conservation Areas Reporting and Tracking System	http://www.ccea.org/download-carts-data/
Alberta	Prairie and Northern Region Private Conservation Lands Database (subset).	Environment and Climate Change Canada	Licensed and accessed under restricted data use agreement made in 2014.
British Columbia	Administrative Conservation Lands.	Province of British Columbia	https://catalogue.data.gov.bc.ca/dataset/conservation-lands
	Old Growth Management Areas.	Province of British Columbia	https://catalogue.data.gov.bc.ca/dataset/old-growth-management-areas-legal-current
	Parks and Ecological Areas.	Province of British Columbia	https://catalogue.data.gov.bc.ca/dataset/bc-parks-ecological-reserves-and-protected-areas
	Management/ Wildland Areas in the Muskwa-Kechika Management Area.	Province of British Columbia	https://catalogue.data.gov.bc.ca/dataset/tantalis-management-areas-spatial
	Ungulate Winter Range	Province of British Columbia	https://catalogue.data.gov.bc.ca/dataset/ungulate-winter-range-approved
	Wildlife Management Areas	Province of British Columbia	https://catalogue.data.gov.bc.ca/dataset/wildlife-management-areas
	BC NGO Conservation Lands Database V2	The Nature Trust of BC and Ducks Unlimited Canada	Licensed under data use agreement made in 2011
	High Conservation Value Forests	Greg Utzig	Personal email 2014
Northwest Territories	Strategic Land Use Plan Conservation Zones	Environment and Climate Change Canada (ECCC) Canadian Protected Areas and Conserved Areas Database (CPCAD)	https://www.canada.ca/en/environment-climate-change/services/national-wildlife-areas/protected-conserved-areas-database.html
Yukon	Parks and Protected Areas	Government of Yukon	http://www.env.gov.yk.ca/publications-maps/geomatics/govdata.php
United States	Protected Areas Database V.1_3	U.S. Government	https://gapanalysis.usgs.gov/padus/
	National Conservation Easement Database - Pacific/Mountain	U.S. Endowment for Forestry and Communities	http://conservationeasement.us/
	Grizzly Bear Recovery Areas	U.S. Government	https://www.fws.gov/pacific/news/grizzly/grizzlybearbkgrnd.htm
	Roadless Rule Lands	U.S. Government	https://www.fs.usda.gov/detail/roadless/2001roadlessrule/maps/?cid=stelprdb5382437
	National Wild and Scenic Rivers	U.S. Government	https://www.rivers.gov/mapping-gis.php
	Montana Legacy Project private conservancy lands	The Nature Conservancy of Montana	http://app.databasin.org/app/pages/datasetPage.jsp?id=0e0f769c7c1d4866999a1c5f6d2f2856
	Path of the Pronghorn administrative designation	Wildlife Conservation Society	Digitized by Gregory Kehm from WCS map in 2014

Figure 3. a) Each year, hundreds of pronghorn (*Antilocapra americana*) migrate more than 200 km across private and public land in Wyoming, moving between their summer range near Jackson Hole and their winter range in the Upper Green River Valley (Photo: Shutterstock); b) wildlife crossing structure (overpass) in Banff National Park, Alberta (Photo: Jodi Hilty).

GOVERNANCE

A suite of different types of entities engage in advancing conservation across the Y2Y region. Various levels of government have the authority to manage land and wildlife to federal, provincial/state/territorial, and municipal government. Likewise, Indigenous Peoples often have authority to manage lands and wildlife directly and/or have Treaty rights that given them a right to have input on the management of nature beyond specific lands that they manage. Today in Canada with the Truth and Reconciliation Framework and a growing number of legal decisions, Indigenous Peoples are now sought out for consultation on proposed activities or management of lands, and a new category of protected areas that are Indigenous-led are being proposed across much of the Canadian Y2Y region (Plotkin & Sreenivasan, 2019). Private individuals and businesses also often own land and influence the landscape through that ownership as do conservation land trusts. In addition, non-profit organizations and volunteer groups often support governments to make conservation-oriented management and policy decisions. One of the challenges that non-governmental organizations (NGOs) face is frequent political change after elections, which can mean a lot of extra work to try to get new elected officials and their staff up-to-speed and owning conservation issues.

Like everywhere, there are so many issues for governments and communities to address, and conservation of nature is just one. Conservation in general sees increasingly lean budgets at national and sub-national levels, particularly relative to natural resource extraction and tourism revenues from the Y2Y region (a notable exception is the $1.3B Canada Nature Fund, created in 2018 to support the Pathway to Canada Target 1).

LEGISLATION AND POLICY

Coordination and/or integration of environment-related laws, policies, and regulations across jurisdictional boundaries can help to ensure that nature is effectively conserved regardless of the borders crossed. As well, adaptive decision-making and sharing lessons learned will help governments and NGOs respond to chronic and emerging threats, ranging from climate change to wildlife-related diseases. There are numerous opportunities for the legal and policy instruments to address issues affecting wildlife and ecological integrity in Y2Y region from sub-national to international levels, including species at risk, impact assessment, and ecological connectivity.

For instance, of all provinces and territories in Canada, B.C. has the greatest biological diversity and the most species threatened with extinction – and no provincial legislation to protect and recover endangered species (Westwood et al., 2019). Scientific and legal experts in species at risk biology, policy, and recovery recently made recommendations to the Province of B.C., including prioritizing the effectiveness of recovery actions, ongoing monitoring and reporting, legal accountability for implementation (or lack thereof), and actions to keep non-listed species from declining. The importance of an independent committee, as well as independent and specialized recovery teams, was emphasized. However, as of the time of writing and despite an explicit mandate and extensive consultation with a range of rights-holders and stakeholders, the provincial government has not tabled such provincial legislation.

The continued lack of legal and policy tools to assess and manage for cumulative environmental impacts is a pervasive issue for conservation values across the Y2Y region. For example, cumulative impacts from human disturbances including mines, energy exploration, development, and transportation, recreational activities, forestry, and roads (from highways to resource roads) contribute to declining conservation values in the Peace River Break region of northeastern B.C. (Mann & Wright, 2018; Apps, 2013); the total length of roads alone is enough to circle the planet more than three times.

There is a pressing need to evaluate how key statutes, policies, and laws collectively contribute to biodiversity outcomes through provisions used to keep habitat

connected and in parks and conserved areas, to restore degraded habitat that will enhance connectivity, and to protect biodiversity connectivity on the intervening landscapes and waterscapes.

ENGAGEMENT, PARTNERSHIP, COLLABORATION, AND TRUST

The organization Y2Y works in partnership across virtually all the projects on which we engage. Since inception of the Y2Y, the organization has partnered with at least 450 other entities (see website for lists). Working cooperatively allows entities with a shared interest to share a vision and an implementation plan to advance specific work as well as apply for shared funding. One example is the transboundary Cabinet Purcell Mountain Corridor project. With scientists helping evaluate where the problem areas for connectivity are in the B.C./Idaho/Montana transboundary region and identifying critical pathways, the collective of 60 entities has advanced securing three identified pinch-point linkages for grizzly bears and other wildlife, measurably improved co-existence, and increased security of core habitat areas among other work over the last 12 years.

As far as building relationship and trust, what has proved the most effective is focusing on common ground, identifying shared goals, and sharing resources to advance toward a common goal. As a non-profit, Y2Y doesn't engage in formal consultation with Indigenous Peoples in the same way as Crown governments. We do, however, seek to support the efforts of Indigenous Peoples that align with the Y2Y vision. Success in doing so again requires building relationships and trusts and making sure that this is understood, valued, and practiced across the organization.

LESSONS LEARNED AND SUGGESTIONS

Local entities can often be the most effective at advancing local issues, but at the same time, they can be subject to local 'bullying' or other factors that make local individuals and entities hesitant to speak out. Also, these local entities can often benefit with even small resources, to help their work advance. The caution is that larger entities and/or government can be perceived solely as a funder, so it is important to be clear on what roles each entity plays at different levels to avoid such misperceptions.

An additional challenge is that some groups have pre-disposed biases against others. This means that although there may be common ground, some groups just won't work together. Also, groups such as Y2Y that do work across a diversity of entities often face criticism from partners about another partners' work. In this particular instance, the key is clear communication about the nature and limitations of the work to ensure that others understand, in the case of Y2Y, that we can only focus on the scope of our vision and that we may or may not support other work of a partner on different projects or circumstances.

SPACE AND TIME

Spatial Context

The Y2Y region stretches across two countries (U.S. and Canada), four provinces and territories (B.C., Alberta, Yukon, Northwest Territories), and five states (Montana, Idahoe, Wyoming, Oregon, Washington; Figure 4).

The region also forms the headwaters of three major drainages into the Pacific, the Atlantic, and the Arctic Oceans. In the Rockies, these are mostly gravel-bed river systems, which are disproportionately important to sustaining biodiversity in all its forms in the region (Hauer et al., 2016). These headwaters also provide the fresh drinking water for, conservatively, 15 million people.

Where ecosystem services are produced by nature versus reach and directly benefit people varies across the Y2Y region. Evaluating both the supply and the provision (i.e., access and demand) for climate regulation (i.e., above- and below-ground carbon storage), freshwater, (i.e., municipal consumption, agriculture, hydropower generation, and industrial activities), and nature-based recreation across Canada, Mitchell et al. (2021) found that the places where ecosystems supply these services only weakly overlap with the places of actual *provision* of those services to people. Furthermore, the current network of protected areas in Canada could more effectively target service provision – and perhaps unsurprisingly, this would require addressing the overlap of areas of ecosystem services supply and/or provision with current and planned resource extraction activities. In Canada, three parts of the Y2Y region stand out as particularly important places where nature contributes one or more of these services to human well-being: the Cabinet Purcell Mountain Corridor in southeastern British Columbia (provision hotspot), the Eastern Slopes of the Rockies in Alberta (provision hotspot), and the headwaters of the Columbia River in eastern BC (both provision and capacity hotspot).

Temporal Context

Land-use planning is complex across the region because of the diversity of jurisdictions from local to national level and public to private lands. Overlaid across this multi-jurisdictional complex are conservation plans at different scales, arguably the largest being the Y2Y conservation vision. The reality for large landscape conservation to move forward is that priorities at the local scale contribute to the larger vision for movement on such a large spatial vision.

PLANNING AND IMPLEMENTATION

Strategic Plans

As an organization, Y2Y updates an overall strategic plan approximately every five years. The current strategic plan has to programmatic areas of focus: 1) connect and protect and 2) Inspire and engage. Within those areas of focus, the plan articulates particular areas that require increases in

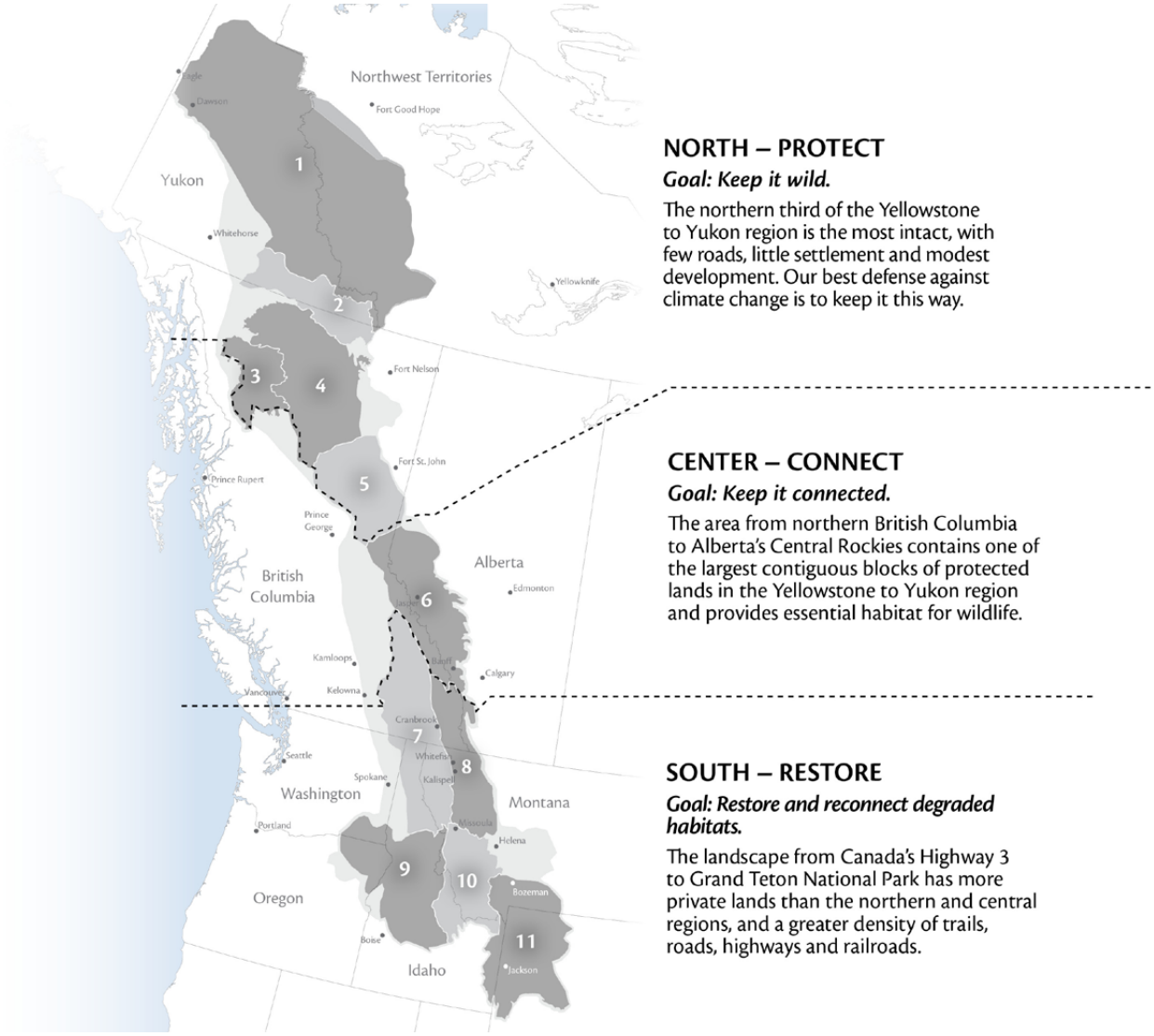


Figure 4. Map of the Yellowstone to Yukon region. The 11 priority areas identified by Y2Y are: 1=Greater Mackenzie Mountains, 2=Upper Liard River, 3=Stikine-Nass-Skeena Headwaters, 4=Muskwa-Kechika Ecosystem, 5=Peace River Break, 6=Central Canadian Rocky Mountains, 7=Cabinet-Purcell Mountain Corridor, 8=Crown of the Continent, 9=Salmon-Selway-Bitterroot, 10=High Divide, 11= Greater Yellowstone Ecosystem. They are divided into "core areas" (1, 3, 4, 6, 8, 9, and 11) and "linkage zones" (2, 5, 7, and 10).

protected areas and places that need to either maintain or restore connectivity between core protected areas (apropos to Aichi Target 11). As related to connectivity, genetic studies and other wildlife work show clearly where current and potential future 'breakpoints' are in the Y2Y region that require advancing connectivity conservation, and these then become the major focus based on this body of science. The plan also considers the broader enabling environment from global biodiversity goals to regional supporting plans. Key to advancing conservation as an NGO, is mapping out what public levers exist that to support advancing conservation. In some cases, advancing the strategic plan entails working within existing policy and management frameworks and in other cases, requires advancing new legislation and/or changes in management on different lands.

While a significant portion of work supports and builds from Canada Target 1 and Aichi Target 11 in Canada, Y2Y uses the plan as an internal guiding framework for three reasons. First, as aforementioned, Y2Y advances work collaboratively and thus needs to be open to the insights and opinions of other entities such that publishing a "road map" without such consultations could be counterproductive to such conversations. Second, some entities that seek to undermine conservation advances might utilize such plans in a negative and again counterproductive way. Finally, connectivity work often involves private landowners, and it is not advisable to publish maps of priority areas that may include private lands for a variety of reasons.

Because Y2Y does not own or manage land the way that private landowners or governments do, it is in the position of seeking to influence the status of lands that others own or manage. To do this at a large landscape scale often requires seeking out collaboration of a variety of different landowners and managers. This is challenging as different

entities have varying mandates. Ultimately, connectivity conservation across multi-jurisdictional lands ought to involve agreements of landowners/managers to manage for an agreed upon connectivity goal in perpetuity. This is still aspirational as much of the private land easement work in the west is focused on stopping development and rarely specifies connectivity let alone biodiversity goals. One hope is that global guidelines for connectivity can push forward both a framework and an approach that can further assist in advancing connectivity conservation in more formal ways (Hilty et al., 2020).

Systems Planning

At the very coarsest level, the Y2Y vision is a systems level plan for maintaining connectivity throughout on the of the most intact mountain ecosystems in the world – and a means to maintain those values far into the future. In the Y2Y region, protected areas are those areas that are focused on conservation of biodiversity. We are fortunate that Parks Canada focuses on ecological integrity of parks as this enabled a significant expansion of Nahanni National Park Reserve. For ecological corridors, the focus of the physical spaces to serve connectivity may or may not be fully intact and maintaining ecological integrity. For example, in some places a natural resource extraction activity, recreation, or ranching at defined levels may still maintain a specific connectivity goal. The key for ecological corridors is to design them to function for today and into the future.

One place where we have seen successful restoration of ecological corridors is the in the transboundary Cabinet and Purcell mountains (B.C., Idaho, Montana). Scientists studied movements of grizzly bears before and after conservation actions including the acquisition and in some cases restoration of private lands. These data showed that the conservation actions definitively increased connectivity for the target species, grizzly bear (Proctor et al., 2018). Unfortunately, we are not always able to monitor target animals such that other indirect measures must be assessed be it forest connectivity restoration or monitoring of species or other biotic indicators that are less expensive.

Management Planning

As mentioned before, even at finer scales, Y2Y projects tend to cross multiple jurisdictions. What we hope to see across these management plans is that these ultimately add up to the recommendations that scientists make to adequately conserve biodiversity, especially during this time of climate change. This includes stitching together of protected areas such that the Y2Y region has large core protected areas. It also is such that on areas outside of protected areas and in key connectivity areas that fire management, resource extraction, recreation and other human activities are managed such that no single activity and total cumulative activities do not forgo connectivity of, in particular, large ranging wildlife.

In the U.S. and in some cases overlapping into Canada, agencies and other entities have moved to considering management of any particular parcel in the context of large landscape conservation. For example, the U.S. advanced landscape conservation cooperatives (LCCs), including a transboundary region in Y2Y. Likewise, transboundary agencies call the Crown Managers Partnership maintain active dialogue and projects in the transboundary region of Y2Y call the Crown of the Continent. In Canada, new direction seems to be considering large landscape conservation and management of any parcel in the larger landscape. For example, the Pathway to Canada Target 1 has initiated a Connectivity Working Group to inform country-wide connectivity work. Similarly, there is great potential for strategic and regional environmental impact assessments to identify, maintain, and even improve conservation values (Westwood et al., 2019). These advances would be very helpful to support conservation at the broad spatial and temporal scales that matter across the Y2Y region and beyond.

Y2Y has recently moved to the Open Standards for Conservation approach (http://cmp-openstandards.org/) for planning. One of the strengths of this approach is the commitment to monitoring, evaluation, and adaptive planning. Open Standards is a publicly available tool with trainers based all over the world, and is used by major big international non-governmental organizations, funders, some US agencies, and likely many others. This approach also offers mechanisms to be transparent about progress such as toward Target 1 and collective evaluations of progress.

Operations Planning

In terms of tools and techniques, there are a plethora of ideas and approaches. As but one example the Network for Landscape Conservation maintains a resource library and websites with various scientific tools and cases studies about (e.g., https://conservationcorridor.org/). Likewise, the IUCN Connectivity Specialist Group is advancing guidelines on ecological corridors and networks (https://www.iucn.org/commissions/world-commission-protected-areas/our-work/connectivity-conservation).

Because of lack any unified corridor legislation at the federal or even regional levels to define how to designate ecological corridors in the Y2Y region, each project and approach different by region and context. It is hoped that ultimately corridor legislation may pass at national and/or regional levels to provide a policy framework that will enhance collective efforts to designate, restore, and conserve enduring connectivity in particular places. Until then, Y2Y's approach is to using existing conservation tools ranging from private land tools, to road crossing and from management planning to various land designations to continue to advance actual on the ground connectivity across the Y2Y region. The challenge with this piecemeal approach is that management plans across multiple jurisdictions are always subject to change, and in reality, connectivity areas need to endure so as not to be severed.

KNOWLEDGE

Managing Knowledge

Y2Y maintains science and data that it has produced striving for greater accessibility across the board. Managing science and other forms of knowledge that others produce is tricky in this day and age because of the sheer quantity of information being generated and that could be collected. Y2Y as an organization has been challenged to maintain and organization information beyond what the organization produces. For example, in the early 2000s, Y2Y commission another non-governmental group to maintain GIS layers. Unfortunately, when funding levels fell, so did the management of that information. Likewise, Y2Y would like to see standardization and sharing of data from scientists beyond Y2Y. We are aware of multiple camera-trapping projects across the Y2Y region. While it would be valuable to ensure that these are made more widely available and are compatible, the barriers to do so feasibly at this time are too high. Various spatial data related to Y2Y are publicly available on the Y2Y Data Basin site (https://y2y.databasin.org/).

In some cases, scientific information, such as locations of endangered species, must be kept in confidence. In the case of Indigenous knowledge and local knowledge, it is paramount to be respectful of the individuals or entities that offer such information as it may not be culturally appropriate to interpret such information out of context, let alone to share it widely or at all.

Another challenge is the propensity of some entities to endlessly seek to collect information. We think that this is not a good use of time without being clear the purpose of collecting information and therefore what information is needed. For instance, increasing remotely sensed information data can be a great way to examine larger trends across very broad regions such as Y2Y, illuminating landscape patterns and changes that can help inform progress and priorities.

Overall, one of the major gaps that we see across the Y2Y region is applied human dimensions work. Specifically, lack of understanding of what local priorities are and how local communities talk about issues (from climate change to conservation) hampers agencies and NGOs to work effectively across communities. Also, understanding issues such as where local communities obtain trusted information is critical for sharing knowledge across communities as another example. Such work should be a higher priority across the country.

Knowledge Exchange

Previously mentioned is the Network for Landscape Conservation, an active knowledge exchange mechanism to exchange information about large landscape conservation among practitioners. Y2Y engages in a number of different networks at different spatial extents, and often one of the purposes is to share lessons learned. Y2Y engages globally in providing support to other landscape and seascape initiatives as well. Likewise, a number of education programs seek to extend knowledge about the need for large landscape conservation (e.g., HHMI BioInteractive https://www.youtube.com/watch?v=rXJ3vmOWATk and Island Press Corridor Ecology lessons https://islandpress.org/books/corridor-ecology-second-edition).

Y2Y also works to promote knowledge exchange within the Y2Y region. This happens in a number of ways from maintaining listserves for active exchange of information; weekly email news that highlights press and relevant science; giving talks and organizing conferences, and supporting documentaries (e.g., see Wild Ways: Corridors of Life a PBS Nova film seen by millions now); videos (e.g., https://www.youtube.com/user/Y2YInitiative), and through social media.

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Elders at a Little Grand Rapids and Pauingassi land use planning open house (Photo Credit Ontario Parks

CHAPTER 3d

The Woodland Caribou Corridor Case Study (Ontario, Manitoba)

Christine Hague, *Ontario Parks, Ontario Ministry of the Environment, Conservation and Parks*

WOODLAND CARIBOU CORRIDOR IN ONTARIO AND MANITOBA

CHRISTINE HAGUE AND LORI SKITT (ONTARIO MINISTRY OF ENVIRONMENT, CONSERVATION AND PARKS)

Example of Lesson Learned

- The collective size of the connected protected areas in this corridor serve to maintain natural processes and provide adequate space for species with landscape-scale habitat requirements.

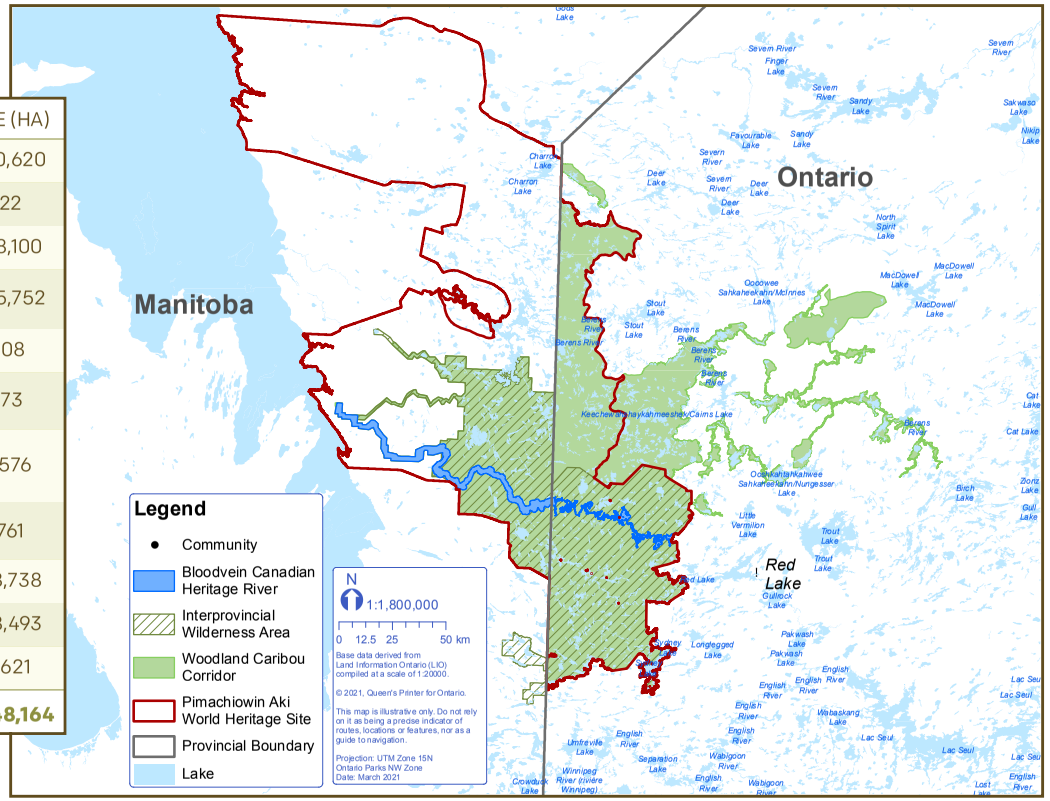
Example of Recommendation

- With the potential for increasing the number of protected areas in or adjacent to the corridor, consideration should be given to the flexibility of park classifications, particularly in respect to cultural landscapes and Indigenous management.

SUMMARY

- The Corridor encompasses connected and adjacent properties in Ontario and Manitoba.
- The Corridor is large, remote, and intact.
- This Corridor includes habitat for iconic boreal species such as moose, black bear, wolves, lynx, beaver, and marten. Fish species include walleye, northern pike, lake trout, and whitefish. Species at risk include woodland caribou, wolverine, and lake sturgeon.
- This area is used by Indigenous peoples who hunt, trap, fish, pick berries, gather medicines, and engage in traditional ceremonies.
- Commercial and resource-based activities are limited to lodges and outposts for fishing and hunting in some areas, commercial trapping, commercial fishing, and wild rice harvest.
- Legislation, land use planning, and management planning limit and inform activities that can occur within each protected area.

NAME OF PROTECTED AREA	TYPE OF PROTECTED AREA	PROVINCE	SIZE (HA)
WOODLAND CARIBOU	PROVINCIAL PARK	ONTARIO	470,620
WOODLAND CARIBOU	RECOMMENDED ADDITIONS	ONTARIO	9,822
ATIKAKI	PROVINCIAL PARK	MANITOBA	398,100
WEESKAYJAHK OHTAHZHOGANEENG	DEDICATED PROTECTED AREA	ONTARIO	265,752
KAHNAHMAYKOOSAYSEEKAHK	DEDICATED PROTECTED AREA	ONTARIO	4,808
SAHKEESUHKUH WEESUHKAHEEGAHN	DEDICATED PROTECTED AREA	ONTARIO	8,873
BEEKAHNCHEEKAHMEENG DEEBAHNCHEEKAYWEEHN EENAHOHNAHNUHN	DEDICATED PROTECTED AREA	ONTARIO	99,576
PAHNGWAHSHAHSHK OHWEEMUSHKEEG	DEDICATED PROTECTED AREA	ONTARIO	57,761
LITTLE GRAND RAPIDS	DEDICATED PROTECTED AREA	ONTARIO	188,738
PAUINGASSI	DEDICATED PROTECTED AREA	ONTARIO	108,493
EAGLE-SNOWSHOE	CONSERVATION RESERVE	ONTARIO	35,621
			TOTAL 1,648,164



INTRODUCTION

This case study addresses the protection of connected ecosystems within the Woodland Caribou corridor located approximately 200 km northeast of Winnipeg, Manitoba and 40 kilometers west of Red Lake, Ontario. A large area of intact ecosystems with high ecological integrity, the corridor is inhabited by people from a number of First Nation communities whose rich cultural history reflects a close and interconnected relationship between society and the lands and waters upon which they depend.

THE SOCIAL-ECOLOGICAL SYSTEM

The Woodland Caribou corridor is made up of eleven adjacent protected areas across the Manitoba and Ontario provincial border. It is located approximately 200 kilometers northeast of Winnipeg, Manitoba and 40 kilometers west of Red Lake, Ontario. Protected areas within the corridor for the purposes of this case study include Woodland Caribou Provincial Park, Woodland Caribou Provincial Park Recommended Park Additions, Atikaki Provincial Park, Weeskayjahk Ohtahzhoganeeng Dedicated Protected Area (DPA), Kahnahmaykoosayseekahk DPA, Sahkeesuhkuh Weesuhkaheegahn DPA, Beekahncheekahmeeng Deebahncheekayweehn Eenahohnahnuhn DPA, Pahngwahshahshk Ohweemushkeeg DPA, Little Grand Rapids DPA, Pauingassi DPA, and Eagle-Snowshoe Conservation Reserve (Figure 1). Protected areas were established based on science and Indigenous knowledge, to protect areas of greater conservation value on the landscape. Types of protected areas, province, and sizes are listed in Table 1.

The corridor is primarily remote access, which largely contributes to the effectiveness of protected area management. Access is by canoe, boat, floatplane, and snowmobile, with roads crossing Beekahncheekahmeeng Deebahncheekayweehn Eenahohnahnuhn DPA prior to protected area establishment. An all-weather road to Bloodvein and Berens First Nation provide access to the west side of Atikaki Provincial Park. Bush roads provide access to the east side of Woodland Caribou Provincial Park. Social and cultural uses include hunting, foraging, fishing, canoeing, and overall enjoyment of the area. Commercial and resource-based activities are restricted to lodges and outposts for fishing and hunting in some areas, commercial trapping, commercial fishing, and wild rice harvest.

This area is largely used by Indigenous peoples carrying out activities across their traditional land use areas. Practices such as hunting, fishing, medicine gathering, berry picking, and ceremonies occur. Evidence of Indigenous use throughout the corridor has been documented as far back as the Paleoperiod (9,000 to 7,000 BP), throughout the Archaic and Woodland Periods (7000 to 400 BP), during European contact, to today. Cultural features are interconnected with ecological features such as water travel routes, wild rice stands, wetlands, animal travel routes, resting and feeding areas, fish migration and spawning sites, etc. Additional features showing human use and spiritual significance include pictographs, thunderbird nests, fish weirs, culturally modified

Table 1. Protected areas within the Woodland Caribou corridor.

Name of Protected Area	Type of Protected Area	Province	Size (ha)
Woodland Caribou	Provincial Park	Ontario	470,620
Woodland Caribou	Recommended Park Additions	Ontario	9,822
Atikaki	Provincial Park	Manitoba	398,100
Weeskayjahk Ohtahzhoganeeng	Dedicated Protected Area	Ontario	265,752
Kahnahmaykoosayseekahk	Dedicated Protected Area	Ontario	4,808
Sahkeesuhkuh Weesuhkaheegahn	Dedicated Protected Area	Ontario	8,873
Beekahncheekahmeeng Deebahncheekayweehn Eenahohnahnuhn	Dedicated Protected Area	Ontario	99,576
Pahngwahshahshk Ohweemushkeeg	Dedicated Protected Area	Ontario	5,7761
Little Grand Rapids	Dedicated Protected Area	Ontario	188,738
Pauingassi	Dedicated Protected Area	Ontario	108,493
Eagle-Snowshoe	Dedicated Protected Area	Ontario	3,5621
Total			**1,648,164**

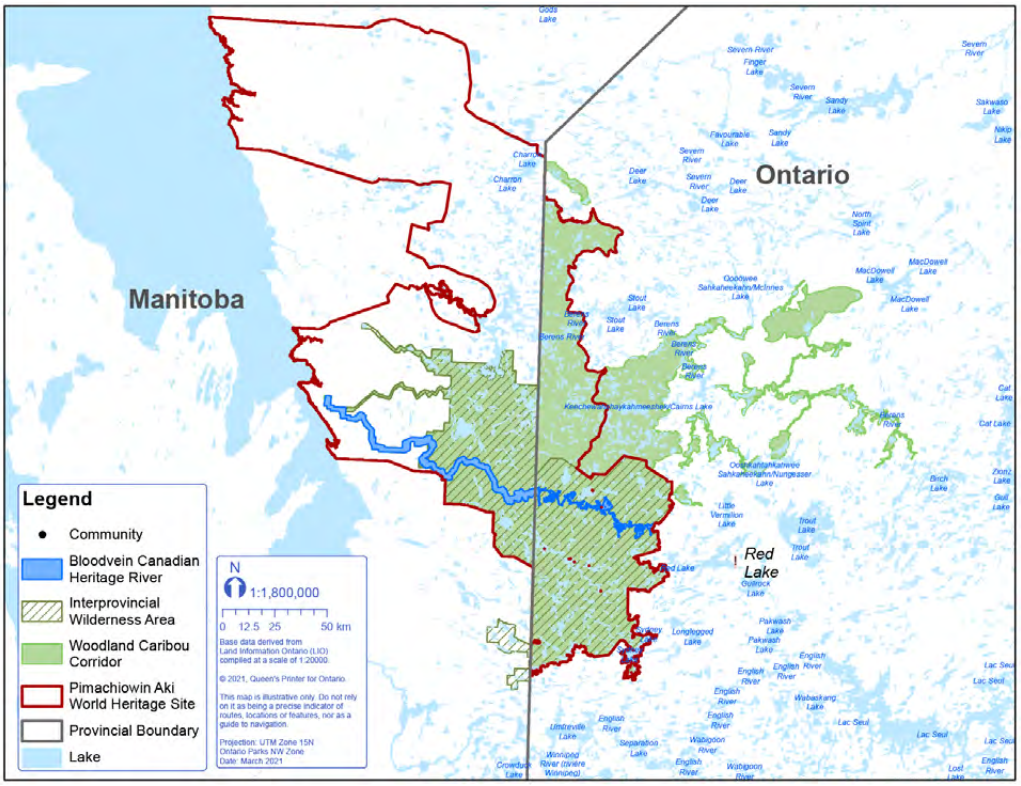


Figure 1. The Woodland Caribou corridor.

trees, harvesting sites, and habitation sites. Archaeological sites have documented pottery, tools, quarries, etc.

The corridor is within the Canadian boreal shield, a mosaic of lakes, rivers, upland and lowland forests with wetlands throughout, defined by its cold climate and variable seasonality. Main forest types include upland jack pine (Pinus banksiana) and black spruce (Picea mariana) conifer stands, upland sparse jack pine and lichen on bedrock, and mixedwood and deciduous stands in areas of more nutrient-rich soils predominantly along river drainage. White spruce (Picea glauca) and balsam fir (Abies balsamea) also occur, specifically where fire has been lacking. Key features within the corridor include drainage for four river systems, sparse upland conifer forests shaped by frequent fire, and interspersed bogs and fens.

This corridor includes habitat for iconic boreal species such as moose (*Alces alces*), black bear (*Ursus americanus*), wolves (*Canis lupus*), lynx (*Lynx canadensis*), beaver (*Castor canadensis*), marten (*Martes americana*), etc. Fish species include walleye (*Sander vitreus*), northern pike (*Esox lucius*), lake trout (*Salvelinus namaycush*), and whitefish (*Coregonidae*). Species at risk include woodland caribou (*Rangifer tarandus caribou*), wolverine (*Gulo gulo*), and lake sturgeon (*Acipenser fulvescens*). All species are significant from an Anishinaabe cultural perspective.

The remote nature, as well as size and intactness of this corridor allow biotic and abiotic functions to occur naturally on a large scale. Common insect outbreaks such as jackpine budworm (*Choristoneura pinus pinus*), spruce budworm (*Choristoneura fumiferana*), tent caterpillar (*Malacosoma disstria*), and white-spotted sawyer beetle (*Monochamus scutellatus*), are left untreated. Wind and heavy snowfall events are regular disturbances. Both insect and weather events also greatly contribute to forest fires, the primary disturbance driver in the corridor. A dry prairie influence and high rate of lightning occurrences create an aggressive fire regime. Forest fires in these protected areas are primarily allowed to occur naturally, unless threatening people, property, or additional identified values.

Fire suppression activities have occurred when fires have threatened communities, such as Pikangikum First Nation in the summer of 2019 and Little Grand Rapids First Nation during the summer of 2018. As forest fires are required to maintain a healthy boreal forest, allowing natural fires is one of the biggest determinants of ecological integrity and supporting a functioning boreal social-ecological system. The size and connectivity of the protected areas within the corridor allow species to carry out their life functions, relatively free of anthropogenic disturbance. This is especially important for the landscape level species at risk, woodland caribou and wolverine.

The size of protected areas combined in this corridor largely allow for natural processes and adequate habitat for landscape species. Given the remoteness of the northern portion of this corridor there is no abrupt difference between the protected areas and the adjacent landscape. For these reasons, it is not a large concern that these protected areas provide specific refuge for species and unnatural distribution. Areas in the south, such as the southern portions of Woodland Caribou Provincial Park and Atikaki Provincial Park where landscape species such as

woodland caribou and wolverine are at the southern edge of their range, may provide a degree of refuge compared to outside of the protected areas.

Legislation, land use planning, and management planning limit and inform activities that can occur within each protected area. Given the permitted and non-permitted uses (as outlined in management plans and the Crown Land Use Policy Atlas) within these protected areas, direct threats to biodiversity are low. The corridor is largely undisturbed by industrial development. Threats related to residential and commercial development, transportation and service corridors, recreational activities, and pollution (household waste and sewage) are minimal. Service corridors and roads that were planned prior to protected area regulation, primarily for servicing far north communities, are required to consider minimal impact to protected areas values. There have been few documented observations of invasive species (ex. Earthworms) however further introduction is always a potential threat. However, climate change is perhaps the most significant threat in the corridor where potential impacts range from varying degrees of habitat modification or replacement to the arrival and establishment of non-native species.

Additional designations associated with this corridor include the Bloodvein Canadian Heritage River which flows through Woodland Caribou and Atikaki Provincial Parks to Lake Winnipeg . The Bloodvein River (Figure 2) was designated as a Canadian Heritage River based on its natural and human heritage as well as its recreational opportunity (CHRS, n.d.). The Manitoba side of the river was designated as a Canadian Heritage River in 1986, with Ontario following in 1998.

A Manitoba/Ontario Interprovincial Wilderness Area including Atikaki Provincial Park, the backcountry land use category portion of Nopiming Provincial Park, Woodland Caribou Provincial Park, and Eagle-Snowshoe Conservation Reserve was established in 2008 (Figure 2). A Memorandum of Understanding identifies its ecological and recreational importance. This area is cooperatively managed by Manitoba and Ontario. Ongoing communication supports mutual research and resource management.

Woodland Caribou Provincial Park, Atikaki Provincial Park, Eagle-Snowshoe Conservation Reserve, Little Grand Rapids DPA, and Pauingassi DPA form part of a larger Pimachiowin Aki World Heritage Site (Figure 2). Pimachiowin Aki ("the land that gives life") was inscribed as a United Nations Educational, Scientific, and Cultural Organization (UNESCO) World Heritage Site July 1, 2018. It was designated as both a natural and cultural heritage site, the only one in Canada, and one of 39 mixed sites and one of 11 mixed site-cultural landscapes in the world (Board of Directors of Pimachiowin Aki Corporation, 2016)). A Board of Directors made up of representatives from four First Nations and two provincial governments oversee the protection and management of the site.

Adjacent land surrounding the corridor includes additional Provincial Parks, Forest Management Units, Enhanced Management Areas, and Far North land use planning areas. Nopiming, Wallace Lake, and Manigotagan Provincial

Figure 2. Artery Rapids, Bloodvein River (Phot Credit Ontario Parks)

Table 3. Protected area, guiding legislation, governing ministry or department, and management authorities within the Woodland Caribou corridor.

Name of Protected Area	Legislation	Ministry	Management Authority	Indigenous Management
Woodland Caribou Provincial Park	Provincial Park and Conservations Reserve Act	Ministry of the Environment, Parks, and Conservation Reserves	Ontario Parks	Engagement over activities within traditional land use area
Woodland Caribou Provincial Park Recommended Park Additions	Public Lands Act (will become Provincial Park and Conservation Reserves Act when Regulated)	Ministry of Natural Resources and Forestry	Red Lake District	Engagement over activities within traditional land use area
Atikaki Provincial Park	The Provincial Parks Act	Department of Conservation and Climate	Manitoba Parks and Protected Spaces	Engagement over activities within traditional land use area
Weeskayjahk Ohtahzhoganeeng DPA	Provincial Park and Conservations Reserve Act	Ministry of the Environment, Parks, and Conservation Reserves	Ontario Parks (with Partnership Agreement)	Pikangikum First Nation (with Partnership Agreement)
Kahnahmaykoosayseekahk DPA	Provincial Park and Conservations Reserve Act	Ministry of the Environment, Parks, and Conservation Reserves	Ontario Parks (with Partnership Agreement)	Pikangikum First Nation (with Partnership Agreement)
Sahkeesuhkuh Weesuhkaheegahn DPA	Provincial Park and Conservations Reserve Act	Ministry of the Environment, Parks, and Conservation Reserves	Ontario Parks (with Partnership Agreement)	Pikangikum First Nation (with Partnership Agreement)
Beekahncheekahmeeng Deebahncheekayweehn Eenahohnahnuhn DPA	Provincial Park and Conservations Reserve Act	Ministry of the Environment, Parks, and Conservation Reserves	Ontario Parks (with Partnership Agreement)	Pikangikum First Nation (with Partnership Agreement)
Pahngwahshahshk Ohweemushkeeg DPA	Provincial Park and Conservations Reserve Act	Ministry of the Environment, Parks, and Conservation Reserves	Ontario Parks (with Partnership Agreement)	Pikangikum First Nation (with Partnership Agreement)
Little Grand Rapids DPA	Far North Act/ Public Lands Act	Ministry of Natural Resources and Forestry	Red Lake District	Joint stewardship
Pauingassi DPA	Far North Act/ Public Lands Act	Ministry of Natural Resources and Forestry	Red Lake District	Joint stewardship
Eagle-Snowshoe Conservation Reserve	Provincial Park and Conservations Reserve Act	Ministry of the Environment, Parks, and Conservation Reserves	Ontario Parks	Engagement over activities within traditional land use area

Parks in Manitoba are connected to the corridor, although allow forms of resource and recreation development, and therefore were not included in the Interprovincial Wilderness Area, except for a backcountry land use category within Nopiming PP. Deer Lake, North Spirit, Poplar River, Bloodvein, Little Grand Rapids, and Pauingassi Land Use Planning Areas, as well as Poplar Hill's traditional land use area, also surround the corridor. The majority of land within Poplar River, Bloodvein, Little Grand Rapids, and Pauingassi's Land Use Planning Areas are designated protected areas and are part of the Pimachiowin Aki World Heritage Site. Enhanced Management Areas adjacent to Woodland Caribou Provincial Park, as well as in the Whitefeather Forest were established to bring additional protection and consideration to remoteness, fish and wildlife, recreation, and area specific direction. This adds to the intactness and connection between protected areas and general use areas. Legislation such as the *Manitoba Provincial Parks Act* (Government of Manitoba, 1993), *Manitoba Endangered Species Act* (Government of Manitoba, 1989), *Manitoba Wildlife Act* (Government of Manitoba, 1987a), *Manitoba Fisheries Act* (Government of Manitoba, 1987b), *Manitoba East Side Traditional Lands Planning and Special Protected Areas Act* (Government of Manitoba, 2015a),

Provincial Parks and Conservation Reserves Act, 2006, Far North Act, Crown Forest Sustainability Act (Government of Ontario, 1994), *Fish and Wildlife Conservation Act* (Government of Ontario, 1997), *Public Lands Act* (Government of Ontario, 1990b), and *Endangered Species Act* (Government of Ontario, 2007b) provide species and ecosystem protection in these areas and allow for landscape level connectivity and management.

GOVERNANCE

Woodland Caribou Provincial Park, Park Additions and Eagle-Snowshoe Conservation Reserve are governed by the Ontario government (Ontario Parks, within the Ministry of the Environment, Conservation, and Parks) (Table 3). Weeskayjahk Ohtahzhoganeeng DPA, Kahnahmaykoosayseekahk DPA, Sahkeesuhkuh Weesuhkaheegahn DPA, Beekahncheekahmeeng Deebahncheekayweehn Eenahohnahnuhn DPA, Pahngwahshahshk Ohweemushkeeg DPA (collectively known as Cheemuhnuhcheecheekuhtaykeehn) are governed by the Ontario government (Ontario Parks) and Pikangikum First Nation through a partnership agreement and disposition protocol. Little Grand Rapids DPA is governed by the Ontario government (Red Lake District, Ministry of Natural Resources and Forestry) with co-management decision making and a disposition protocol with Little Grand Rapids First Nation in Manitoba. Pauingassi DPA is governed by the Ontario government (Red Lake District) with co-management decision making and a disposition protocol with Pauingassi First Nation in Manitoba. Atikaki Provincial Park is governed by Manitoba Department of Conservation and Climate (Manitoba Parks and Protected Spaces).

Dedicated protected areas were established by First Nations and the Ontario government during community-based land use planning processes under the *Far North Act.* Understanding that Indigenous communities are stewards of their ancestral land, resource management decisions are made through disposition protocols, established during land use planning. Pikangikum, Little Grand Rapids, and Pauingassi First Nations manage protected areas within their land use areas through disposition protocols with Ontario Parks and the Red Lake District. Disposition protocols define resource management activities in different categories which then informs the level of review and recommendation required within the communities. Implementation teams have been created for Pauingassi, Little Grand Rapids and Pikangikum community-based land use planning areas, made up of representatives from the First Nations communities as well as the Ministry of Natural Resources and Forestry and the Ministry of the Environment, Conservation, and Parks. Implementation teams meet regularly to discuss activities within the land use planning areas. Decisions are either made by the implementation team, or deferred to the Chief and Council, head trapper, or Elder Steering Group for further input. Additionally, for areas within the Pimachiowin Aki World Heritage Site, the Pimachiowin Aki Corporation is a commenting agency in the disposition review process. Natural resource inventory projects, whether led by the provincial government, Indigenous community or a third party, are reviewed to identify capacity building opportunities. Provincial monitoring initiatives commonly involve staff from the provincial government as well as from associated Indigenous communities. Examples include moose aerial inventories, caribou winter flights, and fisheries assessments. Data is shared between provincial governments and Indigenous communities. In some cases, information such as land values and traditional ecological knowledge is held by the community only.

Management in protected areas that were not part of a community-based land use planning process involve Indigenous communities with ancestral land within the protected area. For Woodland Caribou Provincial Park this includes Wabaseemoong Independent Nations, Grassy Narrows First Nation, Lac Seul First Nation, Wabauskang First Nation, Pikangikum First Nation and Little Grand Rapids First Nation. For Atikaki Provincial Park this includes Bloodvein First Nation and Little Grand Rapids.

Management of protected areas in Ontario is financed by both Ontario Parks and Red Lake District in MNRF's, Regional Operations Division. Staffing and funding are dedicated to the Red Lake cluster of Ontario Parks, which includes Woodland Caribou Provincial Park, Eagle-Snowshoe Conservation Rerserve, and Cheemuhnuhcheecheekuhtaykeehn. Staff support and funding associated with Little Grand and Paungassi management in Ontario is part of the larger Red Lake district responsibilities. Periodically Whitefeather Forest Management Corporation has employed technicians and Land Guardians whose responsibility included Cheemuhnuhcheecheekuhtaykeehn. There has been government funding to support protected area planning initiatives and community staff positions. A sustainable funding source or revenue is required for Indigenous communities managing protected areas within their land use planning areas. Current agreements for joint decision making requires staffing and support within the communities.

The *Provincial Parks and Conservation Reserves Act, 2006* (PPCRA) (Government of Ontario, 2006a) and associated regulations applies to Woodland Caribou Provincial Park, Eagle-Snowshoe Conservation Reserve, and Cheemuhnuhcheecheekuhtaykeehn Dedicated Protected Areas. The *Provincial Parks Act* (Government of Manitoba, 1993) applies to Atikaki Provincial Park. Little Grand Rapids and Pauingassi Dedicated Protected Areas (Ontario) were formed through the *Far North Act* (Government of Ontario, 2010) and has yet to be determined whether these protected areas will be regulated under additional legislation. The Woodland Caribou Provincial Park Recommended Park Additions are legislated under the Public Lands Act, until they become regulated park additions. At that time, they will be legislated under the *Provincial Parks and Conservations Reserve Act, 2006* (Government of Ontario, 2006).

The first objective of the PPCRA is *"To permanently protect representative ecosystems, biodiversity and provincially significant elements of Ontario's natural and cultural heritage and to manage these areas to ensure that ecological integrity is maintained."* (Government of Ontario, 2006, para 2.1.1). This is in line with the holistic Indigenous world view of land

management, and together contributes to the protection of values and processes within these protected areas.

Additional provincial and federal legislation applies in these areas which support values and species protection, such as the *Fish and Wildlife Conservation Act* (Government of Ontario, 1997), *Endangered Species Act* (Government of Ontario, 2007b; Government of Manitoba, 1989), *Heritage Act* (Government of Ontario, 1990c), *Ontario Environmental Protection Act* (Government of Ontario, 1990d), *The Wildlife Act* (Government of Manitoba, 1987a), *The Water Protection Act* (Government of Manitoba, 2005a), *The Wild Rice Act* (Government of Manitoba, 1987c), *The Heritage Resources Act* (Government of Manitoba, 1985) *Fisheries Act* (Government of Canada, 1985; Government of Manitoba, 1987b). These acts contribute to connectivity by providing protection both inside and outside of parks.

Policies provide frameworks, supported by legislation, defining permitted activities within protected areas. Key policies (in Ontario) include *Ontario's Protected Areas Planning Manual* (Government of Ontario, 2014), Ontario's Living Legacy Land Use Strategy (1999), and *A Class Environmental Assessment for Provincial Parks and Conservation Reserves* (Government of Ontario, 2004). Additionally, community-based land use plans under the *Far North Act* provide overarching policy direction to protected area management. Management plans incorporate higher level policies with local site-specific policies, and are developed through processes that include Indigenous and public consultation. Of note, permitted uses within provincial parks is largely based on classification of park (wilderness, nature reserve, historical, natural environment, waterway, and recreational). Cheemuhnuhcheecheekuhtaykeehn was regulated without a park class, as the vision of its direction was not in line with a pre-determined class. Currently permitted uses are determined through legislation and *Keeping the Land: A Land Use Strategy for the Whitefeather Forest and Adjacent Areas* direction (Pikangikum First Nation and Ministry of Natural Resources, 2006). With the potential growing number of protected areas, consideration should be given to the flexibility of permitted uses for specific park classes, particularly in respect to cultural landscapes and Indigenous perspectives.

SPACE AND TIME

Prior to protected area establishment, Indigenous inherent governance over traditional areas provided protection over the landscape. Parts of this corridor had some type of special interest through time (Caribou Game Preserve (1948), Irregular Lake Park Reserve (1967), Woodland Caribou Park Reserve (1972), Atikaki Study Area (1974)). Woodland Caribou was regulated as a provincial park in 1983, Atikaki in 1985, Cheemuhnuhcheecheekuhtaykeehn in 2011, and Eagle-Snowshoe as a conservation reserve in 2003. Little Grand Rapids and Pauingassi Dedicated Protected Areas are not regulated under and Act but were identified in *Little Grand Rapids' Community Based Land Use Plan* (Little Grand Rapids First Nation and Ontario Ministry of Natural Resources, 2011) and *Pauingassi's Community Based Land Use Plan* (Pauingassi First Nation and Ontario Ministry of Natural Resources, 2011). The purpose of the Ontario PPCRA and the Manitoba *Provincial Parks Act* (Government of Manitoba, 1993) is to provide permanent protection for the network of provincial parks and conservation reserves for future continuance. Each protected area within this corridor is in various stages of management planning. Planning processes also have varying levels of progress, largely to do with funding and capacity for staff positions within communities, as well as government priorities and support.

PLANNING AND IMPLEMENTATION

The protected areas within this corridor have varying degrees of management direction. The Ontario PPCRA requires all provincial parks and conservation reserves to have a management plan, in the form of a management plan or management statement. Requirements for dedicated protected area management planning were identified in community land use plans, until further legislative direction. Management plans are required to be in line with relevant legislation and policy, while applying site specific planning and direction meaningful to that location, and are developed through processes that include Indigenous and public consultation. Management plans are typically reviewed every 20 years, although adaptive management is incorporated into most plans and amendments are possible between review times. Some plans are also considered living documents.

Atikaki Provincial Park's Management Plan was approved in 2008 (Government of Manitoba, 2008a), Eagle-Snowshoe Conservation Reserve's in 2007(Government of Ontario, 2007a), Woodland Caribou Provincial Park's in 2007 (MNR, 2007) with a secondary Vegetation Management Plan approved in 2016 (Government of Ontario, 2016). Whitefeather Forest Cheemuhnuhcheecheekuhtaykeehn Management Proposals document was posted for public comment in 2013. A draft preliminary management plan is currently underway. Draft interim management statements are being developed for Pauingassi and Little Grand Rapids Dedicated Protected Areas as precursors to management plans.

Approved and draft management direction within this corridor identify adjacent land use areas, unique values, pressures and required monitoring, species at risk, and well as management of fire, insects and disease, invasive species, vegetation, cultural heritage, water, and recreational and commercial activities. Implementation priorities are identified to further protection and intent of the protected area.

KNOWLEDGE MANAGEMENT

Joint decision-making agreements between government and Indigenous communities allow for co-production of knowledge, including government and Indigenous science. There is a high understanding of values and processes within the corridor, as protected areas have been a part of the Pimachiowin Aki World Heritage Site nomination or gone through a land use planning process where extensive exercises were done to document values and use such as wild rice, hunting, medicines, animal travel corridors, human

travel routes, traditional dwellings, waterfowl nesting areas, spawning areas, etc. Additionally, some protected areas have had life science inventory reports completed that document representative and unique ecological features in the protected area.

Protected areas within the corridor are self discovery protected areas, without formal education programs for the public. Woodland Caribou is the only operating park within the corridor and provides trip planning information and best management practices to park guests. Woodland Caribou and Pimachiowin Aki use social media to provide additional information on area ecology and natural processes. Public outreach for dedicated protected areas has not yet been developed. However, awareness and knowledge sharing are envisioned, particularly through Indigenous cultural and ecotourism opportunities. Initiating and supporting these opportunities are integral to self-sustaining Indigenous protected area management.

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Restoration at NCC's Lake Erie Farms property (2013). (Photo by Mhairi McFarlane)

CHAPTER 3e

Restoring a Highly Fragmented Landscape in Southern Ontario: A Case Study from Long Point

Dan Kraus, *Nature Conservancy of Canada*
Brett Norman, *Nature Conservancy of Canada*
Mhairi McFarlane, *Nature Conservancy of Canada*

RESTORING A HIGHLY FRAGMENTED LANDSCAPE AT LONG POINT, SOUTHWESTERN ONTARIO

DAN KRAUS, BRETT NORMAN AND MHAIRI MCFARLANE, NATURE CONSERVANCY OF CANADA (NCC)

SUMMARY

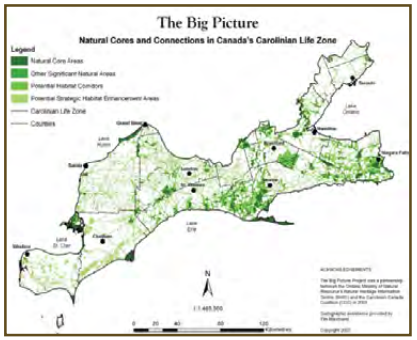
- The study area is in the Lake Erie Lowland Ecoregion (LELE), most of which has been converted to agricultural production and urban areas,
- Only 14% (~46,000 ha) of the LELE remains in natural cover and ~1% is within conserved/protected area in addition to Conservation Authority and municipal properties that are managed for conservation.
- The study area is dominated by the Long Point and Turkey Point freshwater sandpits and marshes.
- Biodiversity includes many "Carolinian" species with a Canadian range that is restricted to southwestern Ontario, many rare plant communities, and over 60 species at risk.
- Threats to connectivity include expanding agricultural and residential areas, road mortality and dams.
- There are four types of connectivity in the study areas that are important for biodiversity conservation:
- Stepping Stone Connectivity: Birds, bats, monarchs, and other insects migrate through the study area and the significance of the region as a stopover site led to many early conservation efforts, including the acquisition and conservation of large areas by private waterfowl hunting clubs.
- Terrestrial Connectivity: The study area has the largest network of interconnected core habitat areas in the LELE and there are continued efforts by groups like NCC and Long Point Basin Land Trust to restore areas that increase forest interior and connectivity. Road mortality is a significant issue in some areas. To mitigate mortality, the Long Point Causeway Improvement Project installed wildlife fencing and ecopassages that improved connectivity between the marshes on Long Point.
- Aquatic Connectivity along Streams: There is an extensive network of streams that flow into Lake Erie, which are fragmented by ~600 dams and perched culverts at road-stream crossings that block the upstream movement of some aquatic species. To date, two dams have been removed and several more are scheduled for removal in the next 5 years.
- Coastal Connectivity: Many fish species use the open lake waters, coastal wetlands and other nearshore habitats. Unlike many coastal wetlands on Great Lakes in the U.S., the wetlands around Long Point remain connected to the waters of Lake Erie. Coastal areas are also critically important for the nearshore transport of sediment that continue to be deposited on Long Point.

Example of Lesson Learned

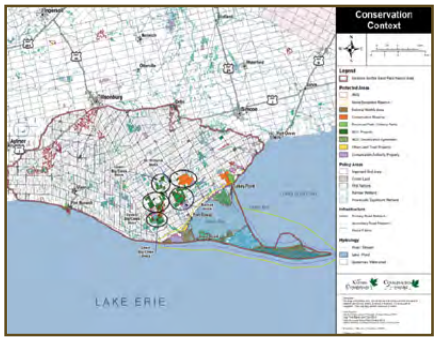
- Three planning initiatives in the study area (Carolinian Canada Big Picture, natural heritage policies in the County of Norfolk's Official Plan, and the NCC Natural Area Conservation Plan) have supported connectivity through the identification of key areas, land securement and restoration. However the study area lacks a clear vision of connectivity within and beyond the region that could encourage private landowners to participate through their own initiatives.

Example of Recommendation

- Optimize opportunities to provide a connectivity vision through the Norfolk County Official Plan and NGO initiatives. Development of a Natural Heritage System as proposed in the County's Official Plan could provide planning direction, but it would need the support of NGOs in implementation, linking the system to the broader landscape and creating a connectivity vision that engages the public.



Regional Cores and Connections



Conservation Context

Road Mortality Study


Dams and Barriers

INTRODUCTION

This case study examines the history and progress of restoring connectivity in one of Canada's most ecologically fragmented landscapes. Long Point is located along the northern coast of Lake Erie in southwestern Ontario, approximately 150 km southwest of Toronto. The case study area includes the Long Point sand spit and associated watersheds. The case study boundary is based on the 1410 km^2 region that the Nature Conservancy of Canada (NCC) has identified as the Southern Norfolk Sand Plain Natural Area (Figure 1) (Nature Conservancy of Canada, 2015). It is primarily within Norfolk County, but also includes part of the Regional Municipality of Bayham (Elgin County) and lands lying south of the Town of Tillsonburg (Oxford County). NCC is focussed on three key areas within this study area: Norfolk Forests and Long Point Wetlands, Big Otter Creek, and Long Point Bay North Shore (Figure 1). For the purposes of this case study, the entire region is considered part of the corridor, recognizing that there are core areas, supporting areas and linkages that are networked in this geography.

The Long Point study is located in the Lake Erie Lowland ecoregion (or Ecoregion 7E). This ecoregion is the southernmost ecoregion in Canada, with its southern limits at the same latitude as northern California and is often referred to as "Carolinian Canada". It is highly influenced by the moderating effect of the lower Great Lakes. The landscape is generally flat with the exception of the Niagara Escarpment. It includes two major rivers (Grand and Thames) and many smaller rivers and streams. Over 130 national species at risk have been documented within the ecoregion, including many that reach their northern range limits. A large portion of the study area (Long Point Walsingham Forest) has been identified as a national priority place under the *Pan-Canadian Approach to Transforming Species at Risk Conservation in Canada* (Environment and Climate Change Canada [ECCC], 2018).

This Lake Erie Lowland ecoregion is within one of Canada's urban and agricultural heartlands. Only 14% of this ecoregion remains in natural cover and approximately 1% is within conserved/protected areas, although additional lands have been protected by Conservation Authorities and land trusts (Figure 2). The Lake Erie Lowlands ecoregion has experienced historic rates of habitat loss to agriculture and urban areas that are among the highest in Canada. The remaining habitat patches are generally small, highly fragmented and degraded. The total population in the ecoregion is 8,324,391 (2016), with a growth of just over 29% in the last 20 years (Kraus et al., 2020). Much of this growth has been concentrated in and around urban centres. This urban growth is increasing the demand for second

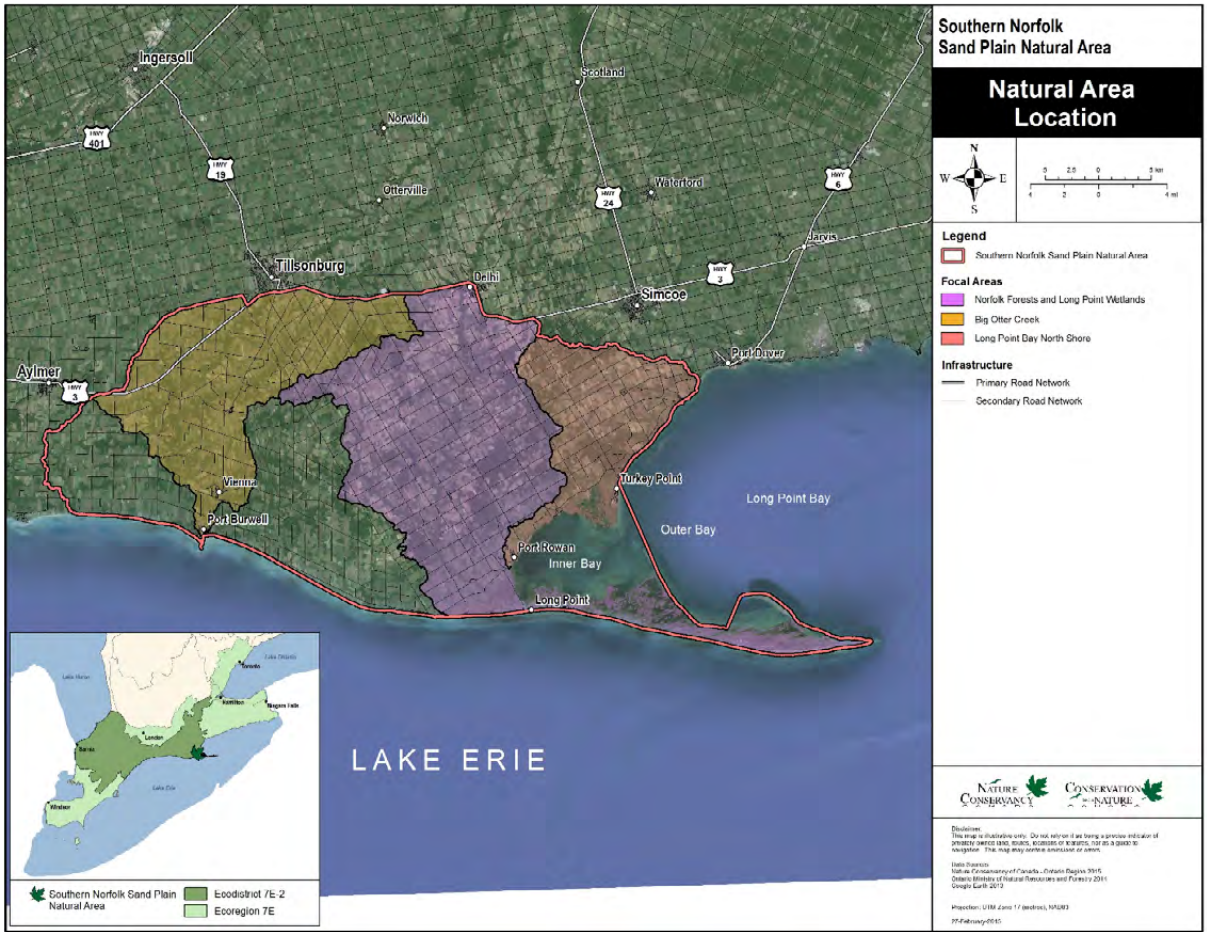


Figure 1. Location of the study area (Nature Conservancy of Canada, 2015).

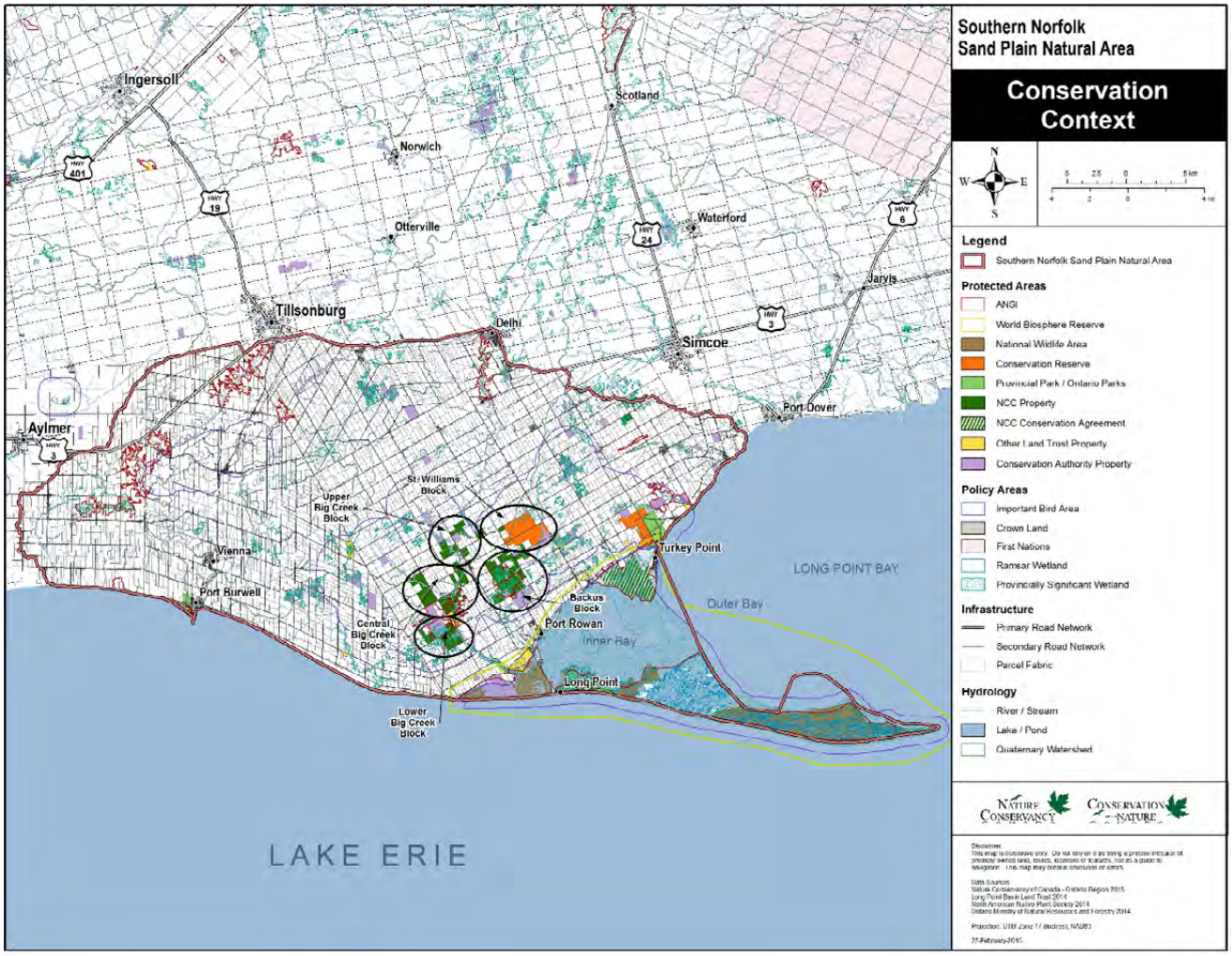


Figure 2. Conservation context – protected and conserved areas and natural heritage designations in the study area (Nature Conservancy of Canada, 2015).

homes and recreational properties in rural areas, including the study area.

HISTORY

The study area is the traditional territory of the Haudensaunee and Anishnaabeg and is covered by the Upper Canada Treaty 3 of 1792. Indigenous peoples in this region farmed, hunted, and fished. Their traditional land stewardship practices, including fire management, played an important role in maintaining biodiversity including the oak savannahs and tallgrass prairie (Rodger, 1998).

Settlers were attracted to the region by the gentle topography, transportation opportunities provided by Lake Erie, and the abundant fish and wildlife, and by 1812, the population of Norfolk County reached 3,000 (Gartshore et al., 1987). Many of the first communities of the Long Point region developed around mill sites that were built on the many creeks. The local economy was primarily founded on agriculture and commercial fishing (Heathcote, 1981).

By the turn of the nineteenth century, as more land was cleared for agriculture and then abandoned when exhausted, large areas of the study areas were left with infertile, eroding sandy soils (Bacher, 2011). St. Williams Forestry Station was established in 1908 in an effort to reforest the area. During the 1930s, severe drought and unsustainable farming practices that left the sandy soils exposed led to severe erosion. As a result, large areas were planted with pines to provide cover on open soils and create wind breaks. Today, many of the century year old plantations are succeeding to oak woodland habitat. The high erodibility of these sandy soils and the many deep ravines limited agricultural land use and contributed to the high amount of natural cover found today.

NATURAL FEATURES

The study area is dominated by Long Point, a freshwater sandpit that extends 40 km into Lake Erie. Long Point is the longest freshwater sand spit in the world and the best example of wetlands and associated dunes in the Great Lakes (Heathcote, 1981). It is a dynamic feature, transforming into a series of islands during high water levels. The marshes of Turkey Point are a similar formation, with a sand spit

extending into the lake and marshes on the lee side of Long Point.

The surrounding Southern Norfolk Sand Plain is matrix of natural and working landscapes. The case study area has approximately 46,000 ha of natural cover, the highest level of natural cover of all Carolinian Canada. The forests are characterized by pine plantations, with oak dominated forests on the tableland, with moist mixed forests in the ravine valleys (Table 1). The natural forests include many "Carolinian" species with a Canadian range that is restricted to southwestern Ontario including black gum, tulip-tree and sassafras. Other vegetation communities include swamps, beaches, marshes and sandy barrens. It includes many rare plant communities and over 60 species at risk. Many of the species that are found in this ecoregion such a Prothonotary Warbler (*Protonotaria citrea*) and Black Gum (*Nyssa sylvatica*) do not occur anywhere else in Canada.

Table 1. Land cover in the study area (Nature Conservancy of Canada, 2015).

Land Cover Type	Area (ha)
Built-Up Area - Impervious	1,009.82
Built-Up Area - Pervious	897.55
Transportation	3,499.04
Extraction - Aggregate	11.72
Tilled	57,124.85
Undifferentiated	21,731.74
Coniferous Forest	327.90
Deciduous Forest	16,874.60
Forest	710.24
Mixed Forest	6,139.58
Plantations - Tree Cultivated	1,310.25
Hedge Rows	1,174.11
Treed Swamp	9,524.55
Thicket Swamp	372.72
Bog	1.61
Marsh	8,548.84
Open Tallgrass Prairie	7.31
Tallgrass Savannah	31.05
Tallgrass Woodland	82.80
Treed Sand Dune	113.08
Open Beach/Bar	103.69
Open Sand Dune	534.22
Open Water	10,915.08
Total:	**141,046.35**

SOCIAL-CULTURAL FEATURES

The primary economic activity in the study area is agriculture, supplemented by manufacturing and tourism. Almost 75% of the total area of Norfolk County, and 14% of Norfolk County's labour force works in agriculture (Nature Conservancy of Canada, 2015). The area is well-suited to agriculture, with a >135 day growing season, 920-980 mm rain/year and average July temperature of 20 degrees C. The well-drained soils are ideal for soybeans, corn and wheat, a well a speciality crops including beans, asparagus, pumpkin, peppers, blueberries, grapes, peanuts and cabbage, and, historically, tobacco.

Manufacturing is the largest employment sector in Norfolk County, employing 19% of the county's workforce. The beaches, ports, towns and villages along the north shore of Lake Erie are popular tourist destinations. Tourism is growing in the study area, with ecotourism a growing sector.

In addition to the biodiversity values of the study area, the forests, wetlands and coastal areas provide significant ecosystem goods and services. Annual visitation to Long Point Provincial Park is over 130,000 (Ontario Parks, 2011), with most visitors attracted to the park's beaches. In addition to the value of timber for private landowners, and the Conservation Authorities, the forests in the study area provide other ecosystem good and services (EGS) including carbon storage, flood attenuation and water quality. The value of a select number of EGS for forests in the study area has been calculated at $19,353 per hectare per year (TD Bank Group & Nature Conservancy of Canada, 2017).

ALUS Canada also plays a key role in integrating the farming community in the protection of ecological services. The program provides payments to landowners to create and restore habitats that provide ecological services such as water purification and pollinator habitat. ALUS Norfolk is the longest continually run ALUS program in Canada. It has engaged over 160 farm families (approximately 10% of the total for the county) and enrolled over 525 ha (ALUS Canada, 2020).

CONSERVATION CONCERNS

A threats assessment for the study area was prepared by NCC and partners during the development of the Southern Norfolk Sand Plain Natural Area Conservation Plan (Nature Conservancy of Canada, 2015), and are categorized based in the IUCN threats classification (IUCN, 2012). The overall threat rank is very high. Four threats were ranked a high (Table 2). These include alterations to hydrology, shoreline hardening, atmospheric deposition of pollutants such a nitrogen that can alter biochemical processes and plant community dynamics, and invasive wetland plants. Key threats that impact connectivity in the study area include expanding

Table 2. Threats in the study area. Bolded threats are directly related to connectivity (Nature Conservancy of Canada, 2015).

Threats \ Targets	Creeks and Riparian Zones	Beaches and Dunes	Coastal Wetland	Carolinian Forest	Inland Wetland	Summary Threat Rating
7.2.1 Surface water diversion, reservoirs, groundwater pumping, drainage ditching, dams, channelization, municipal drains and tile drainage	High		Low	Medium	High	High
7.3.1 Shoreline hardening along Lake Erie		High	High			High
9.5.1 Air-borne pollutants (e.g., N deposition) impacts vegetation communities, and may increase the dominance of non native species such as Phragmites		Medium	High	Medium	High	High
8.1.4 Non-native invasive wetland plants	Low	Medium	High	Low	Very High	High
8.1.1 Non-native invasive trees and shrubs		Low		Medium	Medium	Medium
2.1.1 Existing and incremental fragmentation of natural areas through conversion of land for agriculture	Medium			Medium	Medium	Medium
4.1.1 Road mortality of sensitive species			Medium		Medium	Medium
5.1.1 Collection of turtles for pet trade; persecution of snakes			Medium		Medium	Medium
7.1.1 Lack of natural fire and other natural disturbance leading to changes in community composition (e.g. succession of woody species)				High		
8.2.2 Subsidized meso-predators preying on sensitive fauna	Low	Medium	Medium	Medium	Medium	Medium
9.3.1 Nutrient loading from fertilizer runoff, pesticide runoff and soil erosion	Medium		High		Medium	Medium
11.1.1 Climate change impacts on Lake Erie water levels		Medium	Medium		Medium	Medium
8.1.3 Non-native invasive herbaceous open country plants		Medium		Medium		Medium
8.1.5 Aquatic invasive species such as Zebra Mussel, Carp, Sea Lamprey	Medium		Medium		High	Medium

Threats \ Targets	Creeks and Riparian Zones	Beaches and Dunes	Coastal Wetland	Carolinian Forest	Inland Wetland	Summary Threat Rating
8.1.6 Disturbance and predation of wildlife by feral and outdoor cats.		Low	Low	Medium	Medium	Medium
1.1.1 Impact of existing housing and the over 4,551 lots of record in Norfolk County many of which fall within the NA			Low	Medium	Low	Low
8.1.2 Non-native invasive herbaceous woodland plants	Low			Medium		Low
1.1.2 Redevelopment of existing cottages on Lake Erie shore		Low	Low			Low
1.3.1 Existing and developing tourism industries and recreational features such as resorts and golf courses, and related water pollution	Low	Medium	Low	Low	Low	Low
2.2.1 Tree planting in typically untreed community types				Low		Low
2.3.1 Cattle grazing in forests, nutrient enrichment of waterways	Low			Low	Low	Low
3.2.1 Licensed and unlicensed sand extraction; gas drilling				Low		Low
3.3.1 Current and future offshore sites for wind energy production	Low	Low	Low	Low	Low	Low
4.1.2 Road improvements and roadside maintenance			Low		Low	Low
4.2.1 New utility lines transecting natural areas and impeding plant growth				Low	Low	Low
5.2.1 Collection of plants including Goldenseal and American Ginseng				Medium		Low
5.3.1 Improper removal techniques and overharvesting of timber on private property				Medium		Low
6.1.1 ATV and off-road vehicle use	Low	Medium		Low	Low	Low

Threats \ Targets	Creeks and Riparian Zones	Beaches and Dunes	Coastal Wetland	Carolinian Forest	Inland Wetland	Summary Threat Rating
6.1.2 Recreational boating and associated impact on aquatic habitats and species		Low	Medium		Low	Low
8.2.1 White-tailed Deer population size	Low	Low			Low	Low
9.4.1 Dumping of waste into natural areas	Low				Low	Low
7.3.2 Beach cleaning and mowing	Medium	Low				Low
8.1.7 Invasive insect species including Gypsy Moth and Emerald Ash Borer				Medium		Low
	High	High	High	High	Very High	Very High

agricultural and residential areas, road mortality of sensitive species (e.g. reptiles) and dams.

TYPES OF CONNECTIVITY

This Long Point case study provides examples of four different types of ecological connectivity. It is a "stepping stone" for migrating birds, bats and butterflies. The significance of the region as a stopover site led to many early conservation efforts, including the acquisition and conservation of large areas of Long Point and Turkey Point by private waterfowl hunting clubs. More recently there has been a focus on terrestrial and aquatic connectivity, particularly for species at risk. Connectivity along the nearshore of Lake Erie is also critical in the study area, for it is this transport of sediment that maintains the Long Point sandspit and its associated biodiversity.

Long Point is a well-known migratory bird stopover site and is a globally significant Important Bird Area (IBA) for large concentrations of landbirds and waterfowl during migration. In this context, the study area is a "stepping stone" for migratory birds, and part of an intercontinental network of habitats used by hundreds of different migratory species. In addition to birds, bats, Monarchs and other insects migrate through the study area.

The study area is also providing terrestrial connectivity and has the largest network of interconnected core areas in southwestern Ontario (Jalava et al., 2000). In addition to providing general ecological connectivity, the existing ecological network help to facilitate the movement of several species that are sensitive to habitat fragmentation including American Badger (Taxidea taxus) and Grey Ratsnake (*Pantherophis spiloides*).

While study area has a relatively high amount of natural cover, many species still need to cross roads. Road mortality is thought be the primary cause of premature death for American Badger (Ontario Badgers 2014). Substantial reptile road mortality has been documented on the Long Point causeway road (Ashley & Robinson 1996). For long-lived, late-maturing species such as turtles, the loss of reproductive females can have a disproportionate impact on population size. The pioneering "Long Point Causeway Improvement Project" included extensive wildlife fencing and installation of "ecopassages" and has improved connectivity between marshes which were artificially separated by a road. This project was met with some vigorous public opposition but was ultimately successful in achieving the improvements and has many community supporters (Wilson et al., 2009).

The study area also provides connectivity through its extensive network of streams that flow into Lake Erie. The deeply incised ravines and associated floodplains have protected forested and wetland areas that provide terrestrial connectivity, while the streams provide aquatic connectivity. This aquatic connectivity occurs within the stream systems, but also includes fishes that migrate from Lake Erie. The major barrier to aquatic connectivity is small dams (Figure 3). There are approximately 600 dams in the study area (OMNRF 2006), and perched culverts at road-stream

Table 3. Types of protected areas and natural heritage designations in the study area (Nature Conservancy of Canada, 2015).

Protected Area/ Natural Heritage Designation	Notes	IUCN Category	Area	% of Study Area
National Wildlife Area	Established in 1973 and 1979.	Ib	4,485.13	3.20%
Provincial Park		II	578.68	0.40%
Ontario Parks		II	11.68	0.00%
Conservation Authority		II	3,089.21	2.20%
Conservation Reserve		IV	1,032.61	0.70%
Nature Conservancy of Canada		IV	3,120.00	2.20%
Long Point Basin Land Trust		IV	136.05	0.10%
North American Native Plant Society		IV	20.41	0.00%
Bird Studies Canada		IV	52.27	0.00%
Ducks Unlimited		IV	290.72	0.20%
MNR Land (including Crown Marsh)		IV	533.14	0.40%
Biosphere Reserve		VI	21,803.72	15.50%
Ramsar Wetlands of International Significance		VI	3,279.25	2.30%
Areas of Natural and Scientific Interest		VI	12,817.35	9.10%
Provincially Significant Wetland		VI	19,855.87	14.10%
Important Bird Area		None	53,970.58	38.30%
Ontario Heritage Trust		None	92.34	0.10%

crossings can also block the upstream movement of some aquatic species.

To date, two dams have been removed and several more are scheduled for removal within the next five years. Lowering and removing dams where possible and appropriate will improve habitat connectivity for aquatic and riparian species and will contribute to improved water quality both inland and in nearshore waters of Lake Erie.

Finally, the coastal areas are important for connectivity. Many species of fishes use both the open waters of the lake and coastal wetlands or other nearshore habitats. While many coastal wetlands on Great Lakes have been dyked in the U.S., the wetlands around Long Point maintain their connectivity to the waters of Lake Erie. The coastal areas are also critically important for the nearshore transport of sediment. Erosion of the bluffs along Lake Erie is the source material that has created and maintains the Long Point sand spit. Just like biological connectivity, this nearshore sediment transport connectivity can be reduced by anthropogenic activities. Erosion control and sediment capture structures can "starve" and spit and other depositional features and could result in the loss of the feature and the biodiversity they support. This issue of nearshore sediment transport interruption resulting erosion of sand spits has ben documented elsewhere in the Great Lakes, including at Point Pelee National Park (BaMasoud et al., 2011).

PROTECTED AND CONSERVED AREAS

The study area includes many of the protected and conserved land types, and natural heritage designations that occur in southern Ontario (Gray, 2009). Approximately 8.4% of study area is in conservation ownership (Table 3) (Nature Conservancy of Canada, 2015). The core protected areas have historically been centred on the Long Point National Wildlife Area, Turkey Point, and Long Point Provincial Parks and properties owned by the Long Point Region Conservation Authority. However, the region also has a long history of private land conservation. The protection of Long Point is largely due to the stewardship of the Long Point Company. They have owned and managed a large portion of the Point for duck hunting since 1866. In addition, there are at least five other private waterfowl clubs in the region that have protected important wetland areas.

There are also many natural heritage designations in the study area. In 1986 the Long Point World Biosphere Reserve was established. The study area also includes two IBAs and a Ramsar Wetland of International Importance. A significant portion of the study area also has provincial designations under the *Planning Act* (Government of Ontario, 1990) including Provincially Significant Wetland and Area of Natural and Scientific Interest.

Figure 3. Aquatic habitat connectivity. Watercourses in blue are connected to Lake Erie (Source: https://greatlakesconnectivity.org/fishApp).

GOVERNANCE

As with much of southern Ontario, they are a wide array of organizations that operate within this landscape. The study area is located within the traditional territories of the Haudensaunee and Anishnaabeg and is part of Treaty 3 of 1792. Indigenous peoples make up approximately 3% of the population of Norfolk County (Statistics Canada, 2018). Today, most of the land is privately owned. Land use is dictated by the *Official Plan for Norfolk* (Norfolk County, 2020), which is aligned with the *Provincial Policy Statement* (Government of Ontario, 2020). The Official Plan includes polices that protect natural heritage features including provincially significant wetlands and habitat for threatened and endangered species. The Province of Ontario supports private landowners that these features such as these on their properties through the Conservation Lands Tax Incentive Program (CLTIP). Lands that are included in the program are exempt from municipal property taxes. In addition to its Official Plan, the county also has a tree-cutting by-law (No. 2006-170) that is currently under review.

In addition to governance by provincial and municipal planning policies, there are other organizations that influence decision-making on conservation lands. Indeed, there are few places in Canada with such a wide diversity of government and non-governmental conservation organizations that own and manage lands, provide services to private landowners or manage areas that have been designated for their global or national significance. Table 4 provides a summary of these organizations.

PLANNING AND IMPLEMENTATION

There are three primary planning initiatives related to connectivity in the study area: Carolinian Canada Big Picture, natural heritage policies in the County of Norfolk's *Official Plan* and NCC *Natural Area Conservation Plan (NACP)*. The planning approaches and implementation of each of these is reviewed below, follow by a discussion on their connections, and implementation opportunities and challenges.

Carolinian Canada's Big Picture project was initiated in 2000 to provide a vision of a natural heritage system, and identifies a system of core and supporting natural areas, and potential corridors (Jalava et al., 2000). Corridors were created by combining a least-cost path analysis, the high-valued natural areas adjacent to the connections, and the lands requiring rehabilitation to achieve 200m-wide connections between

Table 4. Active conservation organizations in the study area.

Organization	Type	Land Ownership	Mandate within Study Area
Bird Studies Canada	NGO	No (except headquarters is located in the study area)	Identify Important Bird Areas, develop management plans for IBAs
Alternative Land Use Services (ALUS)	NGO	No	Annual payments to landowners for ecological services
Nature Conservancy of Canada	NGO	Yes	Secure and manage ecologically significant sites
Long Point Basin Land Trust	NGO	Yes	Secure and manage ecologically significant sites
Carolinian Canada	NGO	No	Conservation and awareness
Canadian Wildlife Service	Gov	Yes	Manage national wildlife Areas
Ontario Parks	Gov	Yes	Manage provincial parks
Ontario Ministry of Natural Resources & Forestry	Gov	Yes	Manage conservation reserves
Ministry of the Environment, Conservation and Parks	Gov	Yes	Species at Risk
Long Point Region Conservation Authority	Gov	Yes	Watershed management
Long Point Biosphere Reserve	NGO	No	Protection and promotion of biosphere reserve
Ducks Unlimited Canada	NGO	Yes	Secure and manage ecologically significant sites for waterfowl

the cores. The analysis was updated in 2002 which refined these results (Figure 4a and 4b). The Big Picture depicts the Long Point study area as a large complex of core natural areas that are interconnected with potential habitat corridor and potential strategic habitat enhancement areas. The study area is poorly connected to Niagara region to the east but does have linkages along the Lake Erie coast to the west, and a narrow band of potential corridors that extend northward to southern Waterloo Region and Brant County, and beyond.

Since the inception of the Big Picture, the Provincial Policy Statement was amended to encourage municipalities to develop natural heritage systems. Norfolk County includes several references to this natural heritage system and ecological connectivity:

- *Protect and enhance the quality of the natural environment through a planning framework that conserves and enhances the diversity and connectivity of the natural forms, features and functions of Norfolk's natural heritage, surface water and ground water resources, and that minimizes and mitigates impacts on air quality.* (Section 2.2.2.1)
- *The County may undertake a Natural Heritage System Strategy to identify, map and detail Natural Heritage Features, including the form and function of the identified features, and to identify linkages and connections between these features.* (Section 3.5.3)

However, the county has not initiated planning of a natural heritage system.

NCC first developed a NACP for this region in 2005. The purpose of NACPs is to provide an adaptive planning framework for implementation and follows the *Open Standards for the Practice of Conservation*. This approach to planning has been adopted around the world, including over ten sites in Carolinian Canada (Conservation Measures Partnership, 2013).

The Nature Conservancy of Canada's NACP for the study area does not include explicit connectivity targets. Connectivity is captured in the assessment of the viability of the ecosystem-based "conservation targets" including forests, riparian areas and wetlands. The prioritization of properties for securement also incorporated connectivity through the selection criteria. In particular the criteria that prioritize land parcels that are adjacent to existing NCC properties, and properties with creeks has resulted in the securement of a well-connected network of NCC properties that is linked with other conservation lands. To date, NCC has helped secure over 3,400 ha in the study area, with a focus on creating large core areas around Backus Woods and St. Williams Conservation Reserve.

NCC's land securement effort are complimented by the Long Point Basin Land Trust (LPBLT) that has secured seven properties in the study area. The boundary of the LPBLT includes all of the watersheds draining into Lake Erie from Kettle Creek east towards, but not including the Grand River.

The conservation plan prepared by NCC for the region is reviewed annually and updated every five years. This adaptive planning approach ensures the plan has incorporated new information to reflect a changing and dynamic socio-ecological landscape. In terms of connectivity,

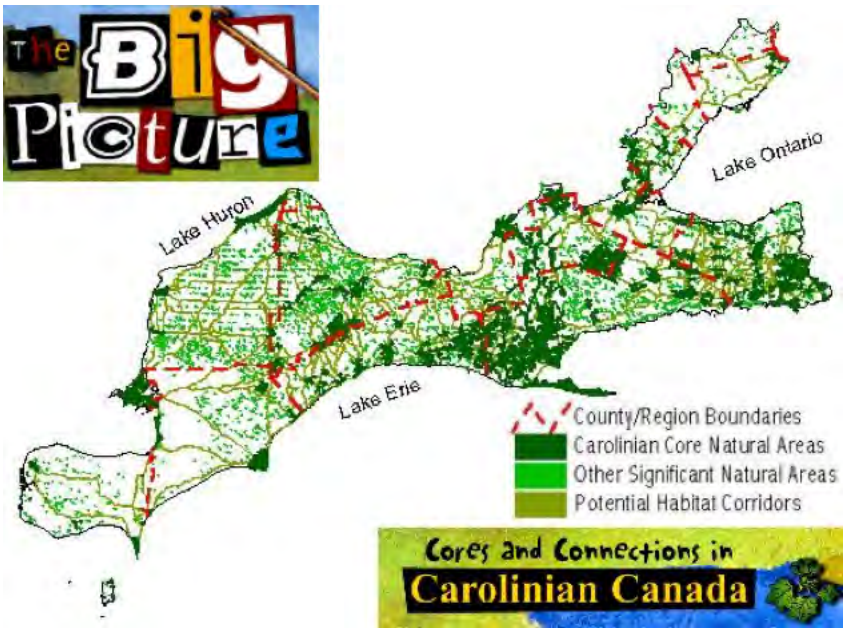


Figure 4a. Big Picture 2000 (Jalava et al., 2000).

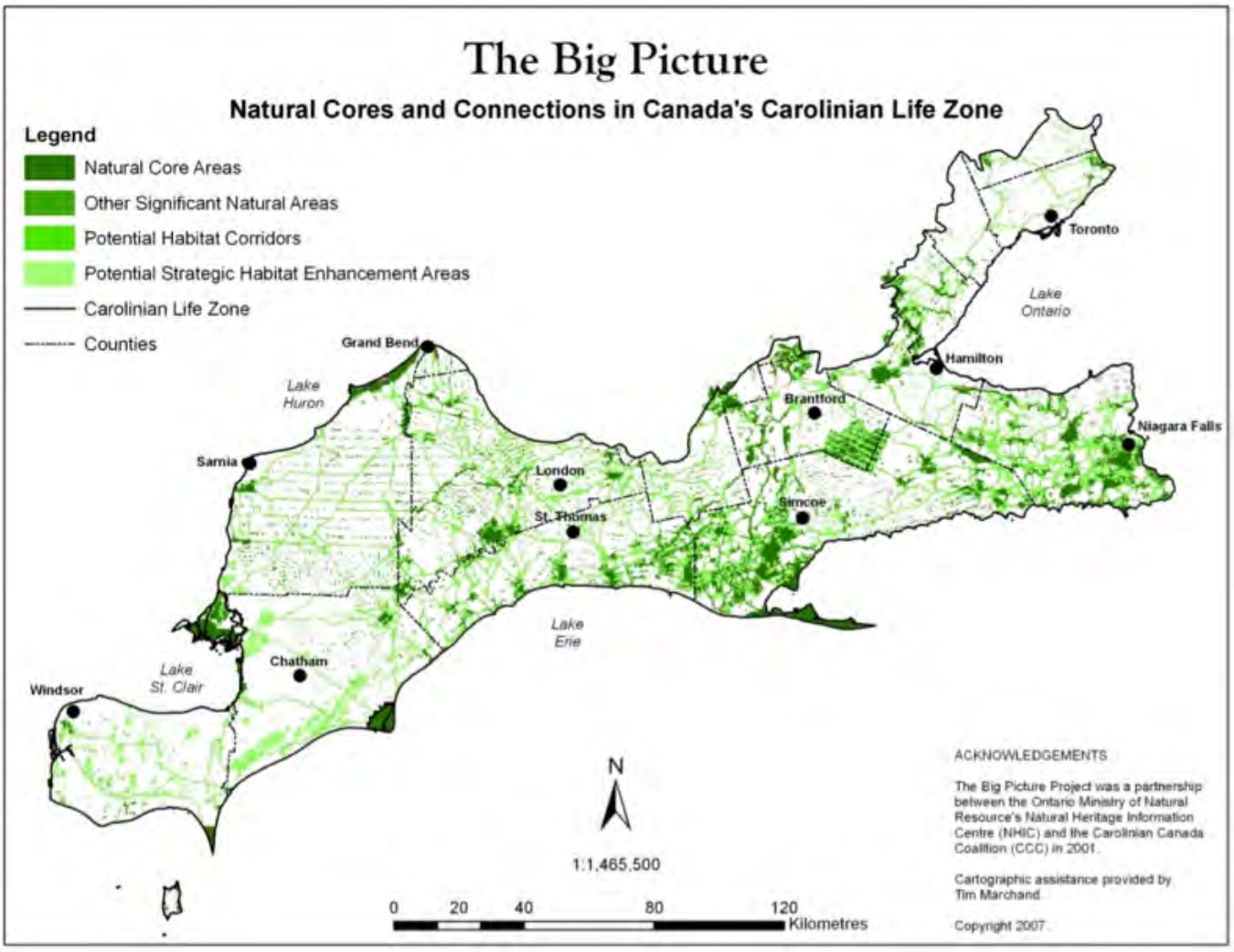


Figure 4b. The Big Picture 2002.

new information could include changes in land ownership or additional information on habitat use by species of conservation. In addition, changes to the Norfolk Official Plan would be incorporated into NCC's conservation plan.

NCC's conservation plan also updates information on conservation output and outcomes. These include both the progress on the actions identified in the plan, and the current state of biodiversity such as the area of conservation lands, area of restoration sites, and changes in natural cover within the study area.

KNOWLEDGE

Knowledge Management

Land securement in the study area by NCC and partners such as the Long Point Basin Land Trust, is based on the prioritization in the NACP. Although the prioritization approach is based on the most important areas for biodiversity and the potential threat, opportunity and community values play a critical role in the implementation and success of any conservation plan.

In addition to identifying and communicating the biodiversity values on secured properties, NCC has been exploring how to measure other contributions of conservation to people. These include natural capital values, quantifying water storage, and the value of the conserved properties for recreational use. Understanding and being able to articulate these values is important for linking conservation to the needs of local communities and maintaining support for conservation.

One of the most significant adaptations to NCC's conservation plan related to connectivity has been the incorporation of a trail network. This network now includes over 23 km of trails and associated facilities including parking lots and interpretive signage. The addition of a systems plan for trails, supports a systems plan for ecological connectivity in this region, and can help the public to appreciate and support the need for linking conservation properties.

Three challenges related to the ecological dimensions of connectivity in the study area include defining and measuring what species or ecological functions connectivity is supporting, linking the nested scales of connectivity and invasive species (in this case aquatic).

While the importance of Long Point as a migratory stopover is well established, the purpose or target species for connectivity is not well defined, and like many connectivity projects there is a lack of models and tools to measure success (Stewart et al., 2019). The exception to this would be the Long Point causeway. This roadway in the Long Point marsh was pinpointed because of the high number and concertation of wildlife mortality (Ashley et al., 1996; Wilson et al., 2009), and remediation measures have now been implemented. The identification of road morality hot-spots for amphibian and reptiles has since been expanded to include much of the Long Point Biosphere Reserve (EcoCare International, 2018) (Figure 5).

Conserving and restoring ecological connectivity within and beyond the study area for a wide variety of species and functions may be warranted as it represents the leading edge for species and vegetation communities that are shifting in response to climate change. Targeting these leading edges is an important adaptation strategy (Gilbert et al., 2019). The Long Point region may be an important nuclei of southern species, and is the southern terminus of perhaps only three potential corridors in Carolinian Canada that could funnel species and habitats northwards.

There does seem to be evidence of connectivity within this broader perspective, with several observations of wide-ranging species mammals in southern Ontario including

Figure 5. Hotspots of reptile road-kill mortality (EcoCare International, 2018).

fisher (*Pekania pennanti*) (2018) and American black bear (*Ursus americanus*) (2018, 2019). These provide limited evidence that wide-ranging mammals from the north can travel to the study area (in the case of the Fisher it may have travelled across Lake Erie from Pennsylvania). It is unknown if southern species, with the exception of birds, are moving northward in response to climate change.

The potential for northward migration is linked to the challenge of nested scale of connectivity. Within the study area there has been progress in implementing many of the original recommendations for the Big Picture (Reid, 2002), including accelerated land securement and ecological restoration and the incorporation of natural heritage systems planning into official plans. NCC and partners are active within the study area, but there are no complimentary and coordinated initiatives outside of the study area, particularly to the north, where a larger corridor initiative could play an important role in maintaining connectivity with southern Ontario and facilitating range shifts of species and ecosystems.

There may be an opportunity for the Long Point Bain Land Trust to lead an initiative related to larger scale connectivity. Their mandate area includes the entire watershed of basin, and these creek valleys would form the backbone of building a regional corridor system. Developing a name for this corridor and more clearly identifying the purpose (including key species) and a vision for this area of connectivity may be necessary for building public and public support. This has proven effective in several other regions of North America including Florida Forever (Coutts, 2016), Yellowstone to Yukon (Hicks, 2017) and NCC's "Moose Sex" project on the Chignecto Isthmus between New Brunswick and Nova Scotia.

The final challenge relates to aquatic habitat connectivity. Increasing aquatic connectivity in the study area require the removal of dams that currently prevent the migration of the invasive sea lamprey to riparian spawning habitats. While removing these dams would provide access to many native fishes, there importance in controlling sea lamprey will prevent dam removal or the installation of fish passages. There are currently six creeks in the study area with barriers that are managed for sea lamprey including Big Creek, Normandale Creek and Venison Creek (Sullivan, 2018).

Knowledge Exchange

Conservation in southern Canada requires collaboration among diverse civil societies, governments and private landowners. This can lead to synergies and partnership opportunities that can accelerate conservation but can also hinder conservation progress if perceived conflicts in mandates and implementation are not addressed.

Within the Long Point study area there are a wide variety and scale of knowledge exchange between organizations. For example, since 2012 the Long Point World Biosphere Reserve Foundation has hosted an annual Research & Conservation Conference, and LBPLT regularly distribute newsletters to inform their supporter and the general community.

Private land conservation and working within communities requires clear communication. Interpretive signage along NCC trails provide an opportunity for help users to better understand and visualize the natural heritage system they are experiencing. In addition to the trail network, NCC's program in the area has also be adapted by increasing the amount and frequency of communication with the public, including a regular community newsletter. Community outreach in the study area also includes volunteer opportunities to help restore conservation properties and property tours. These public events have engaged more than 1000 volunteers, including community groups such as the Lion's Club.

CONCLUSION

The case study provides an example of a fragmented landscape where conservation and restoration have enhanced both the protection of core areas and improved connectivity between them. Conserving connectivity in landscapes with multiple tenure creates unique challenges, and requires integration of private lands into the system (Tack et al., 2019). While connectivity has been significantly increased in the study area through land securement and restoration, the study area lacks a clear vision and blueprint of connectivity that could encourage private landowners to participate through their own initiatives. Two opportunities to provide this vision are through the *Official Plan* and non-governmental organization (NGO) initiatives. Development of a natural heritage system as proposed in the County's *Official Plan* could provide this vision and planning direction. However, there are few examples in Ontario where natural heritage systems developed within the framework of government planning have proved to inspire action, particularly at a local level (The Niagara Escarpment and Oak Ridges Moraine are two notable exceptions; connectivity planning in both of these regions was led by government and continue to be supported by provincial policies). Carolinian Canada's Big Picture provides an inspiring regional blueprint for connectivity, but a vision of corridors within the study area remain vague at a local level.

There remain outstanding questions in the study area about what connectivity is needed for, how to measure it and how much is required. While the importance of the area as a migratory bird stopover site is well known, the purpose and structure of a terrestrial corridor is not well understood. In many cases the restoration of connectivity has occurred by default, as core areas within a priority area are secured, and associated agricultural lands are restored to natural habitats. The Long Point Causeway is the exception in this study area where there was a clear need and location to mitigate a crossing barrier for reptiles. The subsequent analysis should serve as a model for prioritizing key sites to reduce road mortality for threatened amphibians and reptiles (EcoCare International, 2018).

One of the challenges in this landscape is balancing the urgency to protect core areas and species at risk habitat, with the need to restore connectivity. Prices for farmland in the region of the study area have averaged $26,165/ ha in 2018 (Farm Credit Canada, 2019) and are increasing well beyond the rate of inflation increasing the challenges practitioners face in deciding where to direct resources. While, there is evidence that corridors do support diversity and there are benefits to connecting habitat patches (Damschen et al., 2019) some species will persist in small, isolated patches (Fahrig, 2019; Moretto et al., 2019; Watling et al., 2020). Within the study area habitats will continue to be connected through the restoration of agricultural lands that are often included in land parcels that are secured for high quality natural habitats. Creating these local connections and mitigating hotspots of road mortality will benefit many species. However, the long-term benefits of creating and investing a larger corridor network are less certain.

The challenge of planning and implementing connectivity in the Long Point study area are common in conservation plan from around the world (Keeley et al., 2019). Future iterations of connectivity planning could be enhanced by identifying and mapping key linkage areas, explaining the need and benefits of this connectivity (e.g., range shifts) and identifying and leveraging focal species.

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Duffins Creek, Ontario (Photo by Elton Law)

CHAPTER 3f

Oak Ridges Moraine Conservation Plan Case Study (Ontario)

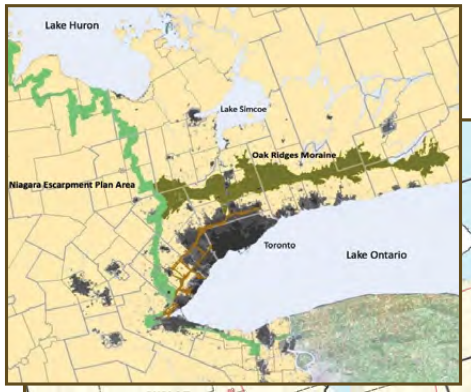
Victor Doyle, *Professional Planner*
Kathy Macpherson, *Greenbelt Foundation*

THE OAK RIDGES MORAINE CONSERVATION PLAN (ORMCP)

KATHY MACPHERSON, GREENBELT FOUNDATION

THE ORCMP

- Landscape-level plan with an integrated suite of mechanisms to maintain ecological integrity with a strong emphasis on connectivity.
- The plan reflects a paradigm shift from an incremental approach to a holistic, inter-disciplinary, systems-based approach to planning.



Example of Lesson Learned

- Multi-scalar networks of connected areas are important to landscape- and waterscape-level biodiversity conservation.

Example of Recommendation

- Ensure connectivity at multiple scales that includes natural and hydrological features in the broader region external to a landscape plan and to individual features within a plan.

Example of Lesson Learned

- Measurable metrics/ performance standards and sub-watershed plans and ecological-based water budgets are important.

Examples of Recommendations

- Engage in collaborative monitoring, including use of NGO and the public.
- Add monitoring targets for next 10-year review and support data collection and analysis.

A PRINCIPLE OF CONNECTIVITY

Underpinning the ORMCP is the principle that maintenance of ecological integrity, biodiversity, and conservation of a healthy, continuous landscape requires a connected system of hydrologic and natural heritage features.

- ~30% forest.
- 2% wetlands.
- Many headwater swamps, 32 kettle lakes and 34 bogs and fens containing rare kettle peatlands.
- 47 provincially significant and 35 locally significant wetland complexes
- 28 provincial and 29 regional Areas of Natural and Scientific Interest.
- 87 Environmentally Significant Areas.
- 1,087 vascular plant species, 125 mosses.
- 74 butterflies, 70 damsel-flies/dragonflies, 56 types of fish, 31 reptiles & amphibians, 166 breeding birds, & 51 mam-mals.
- 77 of these are species at risk either provincially or nationally and over 400 are locally rare.

INTRODUCTION

Provincial land use planning is a principal technique employed to guide decisions respecting the responsible allocation and use of natural assets. In addition, planning outcomes help governments meet international commitments to biodiversity conservation such as Aichi Target 11. Ontario's Oak Ridges Moraine Conservation Plan (Ministry of Municipal Affairs and Planning (MMAH), 2017a) is a landscape-level plan with an integrated suite of mechanisms designed to maintain ecological integrity, including a strong emphasis on connectivity.

At the time of its creation, the Conservation Plan reflected a paradigm shift from a traditional incremental approach to a holistic, inter-disciplinary, systems-based approach to conservation. This shift arose out of two disciplines- conservation biology and landscape ecology – and use of ecologically meaningful terrestrial (i.e., ecodistrict) and aquatic (i.e., watershed) spatial boundaries. The underlying premise is that healthy landscapes and waterscapes are comprised of connected systems of hydrologic and terrestrial natural heritage features and areas – no more 'islands of green' The Conservation Plan accomplishes this through a multi-scalar network of linked core areas on the Moraine with links to features and watersheds adjacent to the Moraine.

This case study highlights the collective efforts of citizens, nongovernment organizations, and governments to protect biodiversity on the Oak Ridges Moraine. It describes elements of the Moraine's ecological, social and historical context, governance, planning and implementation, knowledge, and capacity building. Its purpose is to share knowledge and 'know how' gleaned from this experience with practitioners and decision-makers engaged in similar initiatives.

ECOLOGICAL, SOCIAL AND HISTORICAL CONTEXT

Ecological Context

The Oak Ridges Moraine is located in southcentral Ontario within the Greater Golden Horseshoe, a large and densely populated region that extends along the north shore of Lake Ontario and south to Niagara. Oak Ridges is an inter-lobate moraine with a depth of up to 150 m that formed during the retreat of the Wisconsin glacier about 12,000 years ago. It runs in an east-west direction for 160 km between the Niagara Escarpment in the west and the Trent River in the east and traverses 60 watersheds. The Moraine is the southern watershed divide where lands drain north off the moraine to Lake Simcoe and south off the Moraine to Lake Ontario. Its vast, multi-layered series of aquifers supply drinking water for over 250,000 people and provide up to 50% of the base flow to the headwaters of all major watercourses in the region (Diamond et al., 2002).

Land cover types include pasture/cropland (~60%), deciduous forest (~19%), mixed forest (~7%), coniferous forest (~7%), wetlands (~5%), urban areas and infrastructure

Figure 1 Schematic map of ORM in south central Ontario.

(~2%), and remnant tall grass prairie, sand barrens, and oak-pine savannah/woodlands (0.2%) (Oak Ridges Moraine Land Trust (ORMLT), 2020; Wester et al., 2018). Wetlands include headwater swamps, 37 kettle lakes and 46 bogs and fens containing rare kettle peatlands. There are 1,171 vascular plant species and 125 mosses, 74 butterflies, 70 damselflies/dragonflies, 73 fish species, 30 reptiles and amphibians, 166 breeding birds, and 51 mammals. Of these species, 88 are provincial or national species at risk and 466 are locally rare. The Moraine's ecological importance is highlighted by the shear density of 47 provincially significant and 35 locally significant wetland complexes, 72 life and earth Areas of Natural and Scientific Interest, and 82 Environmentally Significant Areas (Oak Ridges Moraine Land Trust (ORMLT), 2020).

Social and Historical Context

There are 32 municipalities (8 upper-tier regions/counties and 24 lower-tier towns/townships) and parts of 9 conservation authorities on the Oak Ridges Moraine. Awareness of the original threat to the Moraine from agricultural land clearing emerged in the 1940s. Clearing precipitated extensive wind and water erosion that led to the degradation and disappearance of streams, fisheries, and forest cover. In response, major government reforestation efforts were undertaken, which helped to spawn the creation of Ontario's first conservation authorities.

By the 1980s, rapid urban sprawl and associated infrastructure (e.g., sewer, waterand transportation) throughout the Greater Golden Horseshoe threatened the ecological integrity of the Moraine and adjacent areas. In response, a broad coalition of citizen activists, community groups, and environmental organizations initiated a concerted, multi-year effort to protect the Moraine. By 1989, this initiative had coalesced into the STORM (Save the Oak Ridges Moraine) Coalition (Save The Oak Ridges Moraine Coalition (STORM), 2020), an organization of 25 groups from across the Moraine dedicated to preserving its ecological integrity (see https://www.stromcoalition.com). STORM adeptly fostered partnerships and built strategic

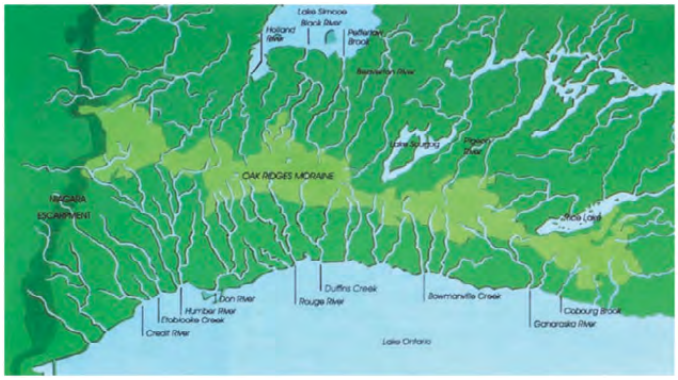


Figure 2 Schematic map of ORM in south central Ontario.

alliances with larger like-minded organizations such as the Federation of Ontario Naturalists (now Ontario Nature), Earth Roots, and the Nature Conservancy of Canada. Advocacy efforts included public campaigns and intense lobbying of provincial politicians to sponsor completion of a science-based landscape-level plan focused on the protection of the Moraine's hydrologic and terrestrial natural features and functions under threat from urban sprawl. Concerned about significant data and information gaps about the Moraine's geology, groundwater hydrology, and terrestrial and aquatic ecology, STORM lobbied for enhanced research and inventory programs to better inform decision-making. To this end, academics and the Geological Survey of Canada initiated studies of the Moraine's complex geology and groundwater assets, which confirmed the importance of the Moraine to the region's water resources and its sensitivity to infiltration disruption and the potential for contamination of the aquifer system (Sharpe et al., 1999, 2000, 2002). This research provided a catalyst for action to protect the Moraine's hydrological functions. The water functions of the Moraine became paramount, particularly in the public consciousness, with STORM cleverly coining the Moraine as 'southern Ontario's rain barrel' (Bocking, 2005).

Concomitantly, practitioners and scientists in government, academia, conservation authorities, and other organizations engaged in a paradigmatic shift to a holistic, multi disciplinary, systems-based approach to ecosystem management at watershed and landscape scales of decision-making. The regional foundation for embracing this new paradigm arose out of the seminal work completed by the Royal Commission on the Toronto Waterfront, which grounded the concept of landscape-level planning and documented the ecological significance of the Oak Ridges Moraine to the 'bioregion' (Royal Commission on the Future of the Toronto Waterfront (RCFTW), 1991). The Commission's work raised public awareness and helped people living in Toronto and other densely populated municipalities along the shores of Lake Ontario develop an appreciation of the Moraine's hydrological assets and the rivers flowing through their communities. The provincial government opted to implement two strategic policy decisions:

- It enabled staff to undertake ecological research and assessments of natural assets (e.g., inventories), and spearhead the implementation of 'systems-thinking' approaches to decision-making (e.g., Riley and Mohr, 1994). Moreover, as knowledge about the significance and sensitivity of the Moraine to anthropogenic disturbance improved, provincial scientists and practitioners increasingly opposed development proposals that would significantly degrade the Moraine's ecology.
- In response to the growing awareness of the Moraine's importance, the provincial government commissioned 'Space for All: Options for a Greater Toronto Greenlands Strategy' (Kanter, 1990), which highlighted the need to protect the Moraine as part of a regional 'greenlands system'. In response, the Ontario government expressed a 'provincial interest' in the Oak Ridges Moraine in 1990.

Although the expression was largely symbolic, it established a policy context for planning and the creation of detailed requirements for the assessment of development applications. Simultaneously, an inter-disciplinary, multi-sector Technical Working Committee and a Citizen's Advisory Committee were appointed to investigate and recommend a comprehensive, long-term strategy to protect the Moraine. The Working Committee commissioned 15 technical background studies, including one focused on a natural heritage system for the Moraine (Geomatics International, 1993) and another on a hydrological evaluation of the Moraine (Hunter and Associates, 1994). With completion of these studies, extensive public discourse, and engagement with representatives of the various sectors, the Working Committee produced 'The Oak Ridges Moraine Area Strategy for the Greater Toronto Area: An Ecological Approach to the Protection and Management of the Oak Ridges Moraine' in November 1994 (Oak Ridges Technical Working Committee (ORTWC), 1994).

In 1995 a newly elected provincial government opted not to support the Oak Ridges Moraine protection initiative. In response and given continued demand for Moraine protection by local residents and community groups, the upper-tier municipalities of York, Peel, and Durham regions created their own strategy, which helped maintain a level of public awareness and a coordinated approach to

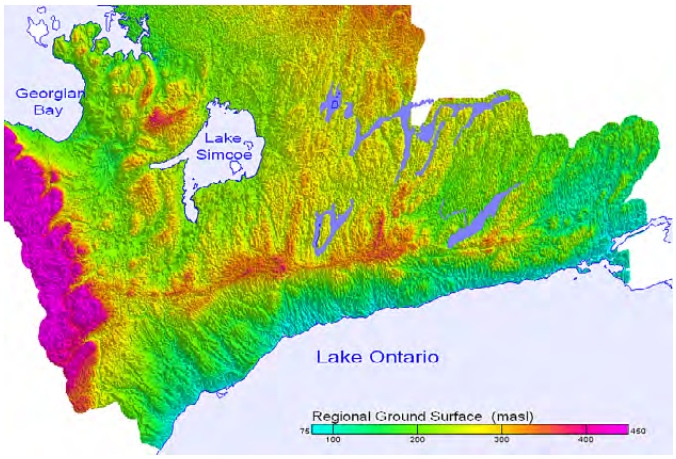


Figure 3 ORM digital elevation model.

monitoring development applications. Despite these efforts, applications for major developments on the Moraine were submitted,including large ones in the Town of Richmond Hill that if approved, promised to sever the east to west natural connectedness of the Moraine's ecosystems. These applications marked 'ground zero', over which local residents, nongovernment organizations, and the City of Toronto focussed their opposition, including massive demonstrations at Richmond Hill council meetings, appeals to and multi-year hearings before Ontario's planning tribunal (i.e., Ontario Municipal Board) and importantly, extensive and ongoing media coverage. As a result of the collective backlash and a pending election in 2001, the provincial government halted all planning applications on the Moraine, enacted the Oak Ridges Moraine Conservation Act (Government of Ontario, 2001a) and initiated work on the Oak Ridges Moraine Conservation Plan (Ministry of Municipal Affairs and Planning (MMAH), 2002).

Key Takeaways

- Advocacy and collaboration among grassroots groups and nongovernment organizations is critical to the creation of a singular voice that can influence the public and government decision-makers;
- Showcase as much of the relevant scientific evidence as possible, and involve pre-eminent and leading-edge experts and research organizations;
- Embrace systems-based approaches, and position proposed linked protected areas within the context of their larger surroundings;
- Support a professional, independent, forward-looking civil service;
- Mobilize local citizens around specific issues (e.g., 'lightning rods') such as major development proposals to gain and maintain attention of the media, politicians, and the public; and
- Strategically use ongoing media coverage.

GOVERNANCE

Governance of the Oak Ridges Moraine Conservation Plan (Ministry of Municipal Affairs and Planning (MMAH), 2002) is mandated and set out under the Oak Ridges Moraine Conservation Act (Government of Ontario, 2001a) with some additional detail provided in the Plan itself, which was enacted via Ontario Regulation 140/02 to provide additional strength to the Plan (Government of Ontario, 2001b). The Conservation Plan builds on the policy framework established in the Provincial Policy Statement (Ministry of Municipal Affairs and Planning (MMAH), 2020a) and is implemented through land use planning decisions and instruments, particularly municipal official plans. Key objectives in the Act are to:

- Protect the ecological and hydrological integrity of the Moraine Area;
- Ensure that only land and resource use that maintains, improves or restores the ecological and hydrological functions of the Moraine Area are permitted;
- Maintain, improve or restore all the elements that contribute to the ecological and hydrological functions of the Moraine Area, including the quality and quantity of its water and its other resources;
- Ensure that the Moraine Area is maintained as a continuous natural landform and environment for the benefit of present and future generations;
- Provide for land and resource uses and development that are compatible with the other objectives of the Conservation Plan;
- Provide for continued development within existing urban settlement areas and recognizing existing rural settlements;
- Provide for a continuous recreational trail through the Moraine Area that is accessible to all including persons with disabilities; and
- Provide for other public recreational access to the Moraine Area (Government of Ontario, 2001a).

Effective governance is fundamental to the success of multi-scalar landscape-level planning initiatives such as the Conservation Plan where ecological integrity (i.e., ecosystem composition, structure, and function) is paramount. As a case in point, the Conservation Plan's overarching policy framework includes a commitment to establish a system of 'Natural Core Areas' connected through a network of 'Natural Linkage Areas' and in some areas by 'Countryside Areas' (Ministry of Municipal Affairs and Planning (MMAH), 2017a). Plan implementation typically requires the ongoing involvement of a broad spectrum of agencies, organizations, and groups that provide complementary expertise, 'know how' and/or eyes on the ground to keep tabs on implementation and enforcement.

Federal Government

Federal government agencies participate in provincial land use planning when federal properties such as national parks are part of the mix and/or when federal scientists and practitioners can provide sound scientific and technical advice. In this case, the Geological Survey of Canada was extensively involved in research designed to provide critical information about the geological and hydrological functions of the Moraine beginning in the mid 1990s. Since that time, its scientists have been providing advice on the effects of development proposals on the Moraine's ecosystems, publishing articles/research results in scientific journals, collaborating with provincial and conservation authority scientists (e.g., source water protection) and engaging in educational outreach and peer review. In more recent years, the federal government donated Moraine land to help establish Rouge National Urban Park. The park was created and is run by Parks Canada in collaboration with the Province of Ontario, the Toronto and Region Conservation

Authority, and several municipalities. Key goals of the park include the maintenance of a north-south ecological connection between the Moraine and Lake Ontario and the provision of access and outreach/ programs for the public.

Government of Ontario

A key construct of the Oak Ridges Moraine Conservation Act (Government of Ontario, 2001a) is a provision that makes the provincial government itself the final approval authority for municipal official plan and zoning by-law amendments, which the Act requires be adopted to bring the official plans and by-laws into conformity with the Conservation Plan. Vesting final approval with the Minister of Municipal Affairs and Housing, including the ability to change municipal documents, and removing appeal rights of a Minister's decision, provides a very high standard of conformity of municipal documents with the Conservation Plan.

Although the Act empowers the Minister to establish a regulatory process for individuals to apply for an amendment to the Conservation Plan, this has never been done. Instead, governments have elected to rely on the Act's requirement that the plan be reviewed at least every 10 years prior ('the 10-year review') to considering any changes or amendments. Both of these legislative constructs were replicated in the Greenbelt Act and used to ensure Conservation Plan continuity and certainty for a substantial period of time. This administrative stability facilitates coordinated and ongoing effectiveness assessment that contributes to an adaptive approach to decision-making and serves to build/maintain public support. The Province also engages in knowledge exchange programs, creation and funding of advisory bodies, education initiatives, and research and monitoring.

Municipalities

Municipalities are responsible for the approvals of land use activities permitted in the Conservation Plan. Once the Minister approves a municipality's conformity amendments under the Oak Ridges Moraine Conservation Act (Government of Ontario, 2001a), the municipal planning agency assumes responsibility for implementation of the Conservation Plan. Municipalities often collaborate on decisions respecting designation and management of the predominant permitted land uses (i.e., agricultural systems and natural heritage systems). Maintaining the traditional decision-making role of municipalities on development applications has helped build community ownership of the Conservation Plan. Moreover, the municipalities help fund conservation authorities and rely on them for scientific advice and the delivery of ongoing management programs.

Conservation Authorities

Conservation authorities are mandated to provide programs and services designed to further the protection, restoration, and management of natural assets other than gas, oil, coal and minerals (Ministry of Natural Resources and Forestry (MNRF), 2017a). Conservation authorities address social-ecological issues that concern local residents, municipalities, and the government of Ontario, including the preparation of watershed/sub-watershed studies and plans, biodiversity conservation, protection of terrestrial and aquatic habitat, Great Lakes shoreline management, flood and erosion control, development regulation, urban stormwater management, collection and dissemination of inventory and monitoring data (e.g., water quantity and quality monitoring), heritage conservation, conservation land acquisition, and recreation and tourism. In addition, conservation authorities own and/or manage a number of properties including conservation areas, most of which are compositionally and/or functionally important for biodiversity conservation. The Conservation Authorities Act (Government of Ontario, 1990) provides the institutional mechanism with which municipalities and the government of Ontario can partner to form a conservation authority within a specified watershed. A conservation authority is a partnership of municipalities that appoint individuals to the Conservation Authority Board to vote and generally act on behalf of the municipalities (Ministry of Natural Resources and Forestry (MNRF), 2017a). During the development and the first statutory review of the Conservation Plan, conservation authorities provided important social and ecological data and information and imparted scientific, technical, and engineering-related advice. They regularly serve as the primary technical reviewer with respect to hydrologic and natural features impact assessment on behalf of municipalities in relation to development and infrastructure applications.

CITIZEN ENGAGEMENT AND PARTICIPATION

Recognizing the important role of nongovernment organizations, community groups, and individuals in stewardship programs across the Moraine, the Government of Ontario established the Oak Ridges Moraine Foundation early in the process and allocated $15 million to support stewardship, education, research, land securement, and trail projects. Between 2002 and 2008, the Foundation distributed more than $14 million in grants and leveraged, in collaboration with moraine partners, an additional $35 million for 177 projects – all of which helped raise the profile of the Conservation Plan among landowners, municipalities and the broader public.

The Government of Ontario also created the Oak Ridges Moraine Land Trust that works to acquire private lands through fee simple purchase or donations, or through conservation easements or conservation agreements. Given that 90% of the Moraine is privately owned, land acquisition is an important technique to ensure the long-term protection of ecologically sensitive lands. The assemblage and designation of the Oak Ridges Corridor Conservation Reserve in Richmond Hill where approval of development applications would have resulted in the severance of connected habitat across along the Moraine, exemplifies the power of leveraging public land ownership (Toronto and Region Conservation Authority (TRCA), 2020a). The Conservation Reserve is a 175 ha property that encompasses mature forests, wetlands, kettle lakes, meadows, and a network of recreational trails. In addition, the government created the Oak Ridges Trail Association

that used funding from the Foundation to complete a 200 km trail along the length of the Moraine.

The Moraine is connected to Lake Ontario via 'Urban River Valley Areas' and 'Protected Countryside Areas' (Ministry of Municipal Affairs and Planning (MMAH), 2017b). The government of Ontario established the Greenbelt Foundation (formerly Friends of the Greenbelt Foundation) and provided $25 million for research, education, and grants. The Foundation's sphere of activity reflected the diversity of its geography and included support for restoration and enhancement of the Greenbelt's natural heritage system and protection of the agricultural system where some of Canada's most productive farmland remains adjacent to its largest urban population. The government also established the Greenbelt Council, a multi-sector advisory group with a mandate to provide advice to the Minister of Municipal Affairs and Housing on matters relating to the implementation and effectiveness of the Oak Ridges Moraine Conservation Plan (Ministry of Municipal Affairs and Planning (MMAH), 2017a), Greenbelt Plan (Ministry of Municipal Affairs and Planning (MMAH), 2017b), Niagara Escarpment Plan (Ministry of Natural Resources and Forestry (MNRF), 2017b), and the Growth Plan for the Greater Golden Horseshoe (Ministry of Municipal Affairs and Planning (MMAH), 2020b).

Key Takeaways

- The creation and funding of the Oak Ridges Moraine Foundation and the Greenbelt Foundation has advanced public and political understanding of the importance of these special landscapes and waterscapes. This has increased support by the public, landowners, and the agricultural sector. For example, today, more than 90% of polled Ontarians strongly support the Greenbelt initiative;
- Mandating statutory 10-year reviews, rather than allowing site-specific amendments to the plan, provides continuity, certainty, and sufficient time for the plan to become ingrained in society and to detect change from the original baseline conditions;
- Vesting approval of municipal conformity amendments with the Minister and restricting appeals leads to a very high standard of compliance;
- Designating municipalities as lead decision-makers respecting the disposition of development applications for permitted uses encourages a sense of ownership at the local level;
- Seek opportunities to raise awareness of the importance of protected landscapes and waterscapes in major urban areas through collaboration and integration with other conservation initiatives; and
- Fund and actively engage arms-length nongovernment organizations on an ongoing basis because they contribute to a broader public understanding of landscape-level plans and can help to attain Conservation Plan objectives.

PLANNING AND IMPLEMENTATION

The provincial government issued the Oak Ridges Moraine Conservation Plan in 2002 (Ministry of Municipal Affairs and Planning (MMAH), 2002) and subsequently published an updated version in 2017 that reflected the results of the 10-year review (Ministry of Municipal Affairs and Planning (MMAH), 2017a). The purpose of the Plan *"is to provide land use and resource management planning direction to provincial ministers, ministries, and agencies, municipalities, landowners and other stakeholders on how to protect the Moraine's ecological and hydrological features and function"* throughout the 190,000 ha that comprise the Oak Ridges Moraine Area (Ministry of Municipal Affairs and Planning (MMAH), 2017a: 3). The strategic vision for the Moraine is that of *"a continuous band of green rolling hills that provides form and structure to south-central Ontario, while protecting the ecological and hydrological features and functions that support the health and well-being of the region's residents and ecosystems"* (Ministry of Municipal Affairs and Planning (MMAH), 2017a: 4). The Conservation Plan builds on the Provincial Policy Statement (Ministry of Municipal Affairs and Planning (MMAH), 2020a) and is implemented through planning decisions and instruments such as municipal official plans. As noted in the Governance Section above, land use planning on the Moraine also accounts for regulations or standards prescribed under federal and other provincial statues such as the Rouge National Urban Park Act (Government of Canada, 2015) and the Conservation Authorities Act (Government of Ontario, 1990). Accordingly, applications, matters, or proceedings related to these other statutes may require consideration of the policies in the Conservation Plan and other provincial plans, where applicable.

Natural Core and Linkage Areas

Ecological integrity is the first primary objective in the Oak Ridges Moraine Conservation Act (Government of Ontario, 2001a), defined in the Act's Regulation to include the following conditions: *"(a) unimpaired by stresses from human activity, natural ecological processes are intact and self-sustaining, and (b) the ecosystem evolves naturally"* (Government of Ontario, 2001b: 15). Ecological integrity depends on the conservation of multi-scaled connected systems of hydrologic and natural heritage features and ecological processes on the Moraine and in the larger region. In the Conservation Plan, *"Connectivity means the degree to which key natural heritage features are connected to one another by links such as plant and animal movement corridors, hydrological and nutrient cycling, genetic transfer, and energy flows through food webs"* (Ministry of Municipal Affairs and Planning (MMAH), 2017a: 14).

Natural Core Areas encompass lands with the greatest concentrations of key natural and hydrologic features (i.e., 50% or more natural features in tracts of 1,000 ha or more) that are critical to maintaining the integrity of the Moraine. Many are centered on the historic, publicly owned forests planted in the 1940s to mitigate the effects of agricultural

Table 1. Mitigation measures prescribed in the Oak Ridges Moraine Conservation Plan Regulation (Ontario Regulation 142/02) (Source Ministry of Municipal Affairs and Planning (MMAH) 2001b: 53).

Natural Heritage and Hydrologic Features	Mitigation Measures	
	Minimum Area of Influence (metres)	Minimum Vegetation Protection Zone (metres)
Wetlands	All land within 120 m of any part of feature	All land within 30 m of any part of feature, subject to clause 23 (1) (d) if a natural heritage evaluation is required
Habitat of endangered and threatened species	None	None
Fish habitat	All land within 120 m of any part of feature	All land within 30 m of any part of feature, subject to clause 23 (1) (d) if a natural heritage evaluation is required
Areas of natural and scientific interest (life science)	All land within 120 m of any part of feature	As determined by a natural heritage evaluation carried out under section 23
Areas of natural and scientific interest (earth science)	All land within 50 m of any part of feature	As determined by an earth science heritage evaluation carried out under subsection 30 (12)
Significant valleylands	All land within 120 m of stable top of bank	All land within 30 m of stable top of bank, subject to clause 23 (1) (d) if a natural heritage evaluation is required
Significant woodlands	All land within 120 m of any part of feature	All land within 30 m of the tree canopy drip line of the outermost trees within the woodland, subject to clause 23(1)(d) if a natural heritage evaluation is required
Significant wildlife habitat	All land within 120 m of any part of feature	As determined by a natural heritage evaluation carried out under section 23
Sand barrens, savannahs, and tallgrass prairies	All land within 120 m of any part of feature	All land within 30 m of any part of feature, subject to clause 23 (1) (d) if a natural heritage evaluation is required
Kettle lakes	All land within 120 m of the surface catchment area	All land within the surface catchment area or within 30 m of any part of feature, whichever is greater, subject to clause 26 (4) (c) if a hydrological evaluation is required
Permanent and intermittent streams	All land within 120 m of meander belt	All land within 30 m of meander belt, subject to clause 26 (4) (c) and subsection 26 (5) if a hydrological evaluation is required
Seepage areas and springs	All land within 120 m of any part of feature	All land within 30 m of any part of feature, subject to clause 26 (4) (c) and subsection 26 (5) if a hydrological evaluation is required

land clearing. The primary Natural Linkage Areas average about 2 km in width and serve as travel corridors for flora and fauna. Given the cumulative effects of urbanization, the core and linkage areas provide east-west travel corridors between Moraine watersheds, which are particularly important to forest interior species.

Key elements of Aichi Target 11 include a 2020 target of 17% of terrestrial and freshwater areas important to biodiversity and ecosystem services conserved through effective and equitable management, comprised of ecologically representative and well-connected systems of protected and conserved areas that are integrated into the wider landscape (Convention on Biological Diversity) (CBD), 2010). Encompassing 24% of the Plan area, Natural Linkage Areas connect Natural Core Areas that cover 38% of the Plan area to create the Moraine's Natural Heritage System – meaning that 62% of the Moraine is part of a connected natural system. Moreover, Countryside Areas (30% of the Plan area) provide an agricultural and rural transition and buffer between Settlement Areas (8% of the Plan area) and the natural heritage system (Ministry of Municipal Affairs and Planning (MMAH), 2017a). It is noteworthy that identification and establishment of core and linkage areas in the Conservation Plan also contribute to the integration of protected areas into the "wider landscape" as prescribed in Target 11 because a number of the primary 2 km-wide Natural Linkage Areas on the Moraine are augmented with smaller linkages that follow headwater streams and valleys to downstream habitat beyond the boundary of the Moraine into the Greenbelt (Ministry of Municipal Affairs and Planning (MMAH), 2017b).

In addition to the Natural Cores and Linkages, the Conservation Plan identifies a suite of key natural heritage and hydrologic features in which no development or site alteration is permitted (e.g., wetlands and woodlands) (Table 1). Implementation relies on practitioners identifying the locations of these features and delineating their boundaries in official plans and zoning by-laws. The Conservation Plan then establishes 'Minimum Vegetation Protection Zones' (generally at least 30 m) and a 120 m 'Minimum Area of Influence' around all defined features (Table 1). These quantified metrics/performance standards provide transparency and consistent and defensible decision-making across the landscape.

Additional Landscape Level Connectivity Policies

In addition to provisions that protect natural and hydrologic features, the Conservation Plan includes specific requirements concerning human activities in four other types of land and water features:

- **Landform Conservation Areas:** The Moraine has hummocky terrain and permeable soils (i.e., primarily sand and gravel) that infiltrate up to 10 times more water than the surrounding till plains. The terrain is characterized by dry kettles (depressions) and kettle lakes, which have no external drainage and enable the highest infiltration rates on the Moraine. To protect this infiltration function, the Conservation Plan identifies large Landform Conservation Areas (Categories 1 and 2) in which the disturbed net developable area of the site (i.e., land outside of protected features and their minimum vegetation protection zone) that is subject to a development application is limited to 25% and 50%, respectively, and impervious surfaces to not more than 15% and 20%, res ectively. In addition to protecting the hydrologic function of the topography, the flora and fauna vary with the unique characteristics of the terrain and thus the landform conservation policies also serve to help protect a range of habitats that are important to a diversity of species and allow for movement between them.

- **Areas of High Aquifer Vulnerability and Wellhead Protection Areas:** Land use activities that pose a high risk of contamination are prohibited because high infiltration rates feed the Moraine's three-level aquifer system, which in turn feeds the headwaters of most streams/rivers in the region and supplies drinking water to 250,000 people. The Geological Survey of Canada confirmed that the aquifers are vertically connected in various places such that surface pollutants could potentially contaminate all three aquifer layers.

- **Sub-watershed Plans:** While the original Conservation Plan had a requirement for sub-watershed plans, this policy has been superseded by an overarching provincial plan, the Growth Plan for the Greater Golden Horseshoe (Ministry of Municipal Affairs and Planning (MMAH), 2020b), which requires watershed planning as part of any proposal to expand urban settlement areas. Moreover, outside of Settlement Areas all development and site alteration of land is prohibited if it will cause the total percentage of the area of the sub-watershed that has impervious surfaces to exceed 10% or any lower percentage specified in the applicable watershed plan or sub-watershed plan.

- **Trail System:** From a social perspective, the Conservation Plan provides for the establishment of a multi-purpose trail system that gives the public access to the Moraine for health and well-being. From a management perspective, the trails help visitors avoid trespassing issues on private land and help managers direct trail users away from sensitive ecological areas.

Development and Other Land Use Policies

The Conservation Plan provides guidance on development applications, including a requirement for the preparation of a natural heritage evaluation (a defined term) for every development and infrastructure proposal within any minimum area of influence: *"Every application for development or site alteration shall identify planning, design and construction practices that ensure no building or other site alterations impede any hydrological functions or the movement of plants and animals among key natural heritage features, key hydrologic features, and adjacent land within Natural Core Areas and Natural Linkage Areas"* (Ministry of Municipal Affairs and Planning (MMAH), 2017a: 38). The evaluation is also used to determine the ultimate vegetation protection zone (provided it is no smaller than the minimum set out in the Plan) and any other mitigation measures.

Specific land use policies also identify planning, design, and development restrictions and requirements that may need to be met for specific uses and activities such as lot creation, agriculture, mineral aggregate operations, wayside pits, excess soil and fill from any development or site alteration, low-intensity and major recreational uses, creation of the recreational trail system, and infrastructure. Of note, campgrounds, golf courses, and ski hills provide recreational opportunities and support local economies. Agriculture is recognized as an important permitted use and allowed to expand, subject to avoiding key natural heritage features. In addition to supporting local economies, farmers are important and active land stewards. Allowing effectively managed farming and recreational opportunities are important to the social fabric of the Moraine and support for long-term landscape level planning in urbanized regions.

Key Takeaways

- Long-term (in perpetuity) protection of landscapes and waterscapes must include large and redundant corridors that meet the life cycle requirements of all flora and fauna ranging from sedentary to slow and fast migrating species;

- Ensure redundancy in and connectivity of natural and hydrological features at multiple scales, including adjacent watersheds outside of the Moraine;

- Provide measurable metrics/performance standards and require mandatory sub-watershed plans and ecologically based water budgets;

- Establish ecological study requirements for development/infrastructure proposals;

- Manage public access to connect people to the protected landscape while simultaneously building societal support in a manner that respects private landowners; and

- In addition to agriculture, permit uses that support use of the landscape by local communities and compatible businesses (e.g., agritourism and recreation), subject to appropriate study requirements and performance standards.

KNOWLEDGE MANAGEMENT

Knowledge management and capacity building are key to the effective implementation of socially acceptable and ecologically meaningful landscape and waterscape-level planning while monitoring and assessment support adaptive management.

Monitoring

Monitoring is used to assess the status of ecosystem integrity, policy effectiveness, and management effectiveness. Data and information are collected and analyzed by the government of Ontario, municipalities, nongovernment organizations, and conservation authorities. For example, every five years, the conservation authorities issue a report card that grades some combination of groundwater quality, surface water quality, forest conditions, and ground cover with recommended actions for improvement in each sub-watershed for which it has responsibility. The grading follows the standardized Conservation Authority Watershed Report Card guidelines developed for watersheds across Ontario (Conservation Ontario, 2011).

A portion of the Duffins Creek sub-watershed of the Toronto and Region Watershed is located on the Oak Ridges Moraine. In the 2018 report (Toronto and Region Conservation Authority (TRCA), 2018a), nitrate and chloride concentrations were used to assess groundwater quality while surface water quality was measured using total phosphorus, *Escherichia coli* (bacteria), and type and number of benthic invertebrates (small aquatic animals that inhabit sediment). High ranks for groundwater and surface water quality are indicative of safe drinking water and provides social, economic, and health to people and wildlife. Results indicate an 'A' ('Excellent') ranking for groundwater quality in the northeastern, unurbanized portion of the Duffins Creek sub-watershed and a 'C' ('Fair') ranking for surface water quality. Sub-watersheds with lower scores (D to F) tend to be in agricultural or urban areas, while sub-watersheds with higher scores (B to C) tend to be in areas with more natural cover, including higher amounts of forest cover.

Forest health was measured using the percentage of forest cover, forest interior, and forested stream edges. Results for the Duffins Sub-watershed indicate a 'C' ('Fair') ranking for forest conditions. Duffins Creek had the highest percentage of forest cover (27%) of all sub-watersheds in the Toronto and Region Watershed. Forest interior provides habitat for many species that do not survive in smaller patches of trees while forested stream edges cool water for native fish, prevent erosion, and reduce contaminants entering streams. The land cover index for the sub-watershed is 42% natural cover, 18% urban, and 40% rural cover.

Assessment

The Conservation Plan is reviewed on a 10-year cycle and is coordinated with reviews of three other complementary provincial land use plans, known collectively as Ontario's Greenbelt Plan (Niagara Escarpment Plan [Ministry of Natural Resources and Forestry (MNRF), 2017b], Oak Ridges Moraine Conservation Plan [Ministry of Municipal Affairs and Planning (MMAH), 2017a], and the Greenbelt Plan (Ministry of Municipal Affairs and Planning (MMAH), 2017b]). These three plans are complementary and reviewed together with the Growth Plan for the Golden Horseshoe (Ministry of Municipal Affairs and Planning (MMAH), 2020b). These reviews were completed in 2017. The Minister of Municipal Affairs and Housing is required to engage the public and consult with affected provincial ministries, public bodies, municipalities, and First Nations and Métis communities. The 10-year review of the Moraine cannot consider removing land from the Natural Core Areas and Natural Linkage Areas and must consider *"…the need to change or refine the boundaries of the Countryside Areas and Settlement Areas; the continued effectiveness and relevance of the Plan's vision, purpose, objectives and policies; the effectiveness of the Plan's policies in meeting the Plan's vision, purpose and objectives; new, updated, or corrected information; new science, technologies, or practices that shall improve the Plan's effectiveness; and, any other matter that the Ontario government deems appropriate"* (Ministry of Municipal Affairs and Planning (MMAH), 2017a: 76). Few changes were made to the first Conservation Plan (Ministry of Municipal Affairs and Planning (MMAH), 2002) as a result of the 10-year review (Ministry of Municipal Affairs and Planning (MMAH), 2017a).

ENGAGEMENT AND CAPACITY BUILDING-THE TEN-YEAR REVIEW OF THE PLAN

The Government of Ontario established a multi-sector advisory panel to lead the 10-year review, undertake broad public consultation, and make recommendations in a public report to the Province. This approach helped foster a transparent and comprehensive review process. As in any public consultation initiative established to review access to and use of natural assets, proponents in favour of more access, the status quo, or less access were engaged in a variety of consultative processes (e.g., public meetings and workshops) designed to provide stakeholders fair opportunity to express their ideas and preferences. For example, the provincial government sponsored 17 Town Hall meetings across southern Ontario that were attended by 3,000 people (Lura Consulting, 2015). Of note:

- Several groups (i.e., STORM, EcoSpark, Ontario Nature, and Earthroots) created the Oak Ridges Moraine Partnership as a means to provide more coordinated, broad based and cost-effective input to the review. They also helped engage the public under the banner of 'The Moraine Can't Wait' campaign. This helped to renew public interest and generate advocacy that encouraged the provincial government to maintain and/or strengthen the Conservation Plan.

- In 2011, the Oak Ridges Moraine Foundation released eight reports that measured the success of the implementation of the Oak Ridges Moraine Conservation Plan and the achievements of the Foundation. The reports assessed stakeholder awareness, support and concerns for the plan's implementation, the health of the Moraine within a watershed context, the health of the Moraine within a landscape and municipal context, improvements to the Moraine trail, achievements in land securement, achievements in land stewardship, achievements in education and research, and assessing compliance of policy and regulatory agencies to the plan's requirements. These reports were used to inform 10-year review deliberations.

- In 2000, nine conservation authorities across the Oak Ridges Moraine created the Conservation Authorities Moraine Coalition to advocate for and protect the Moraine. The Coalition focuses on the need for comprehensive policy, planning, and management approaches designed to sustain the health of the entire Moraine (Toronto and Region Conservation Authority (TRCA), 2020b). The coalition collects, shares, organizes, and stores data at the watershed level of planning. These data were used to inform the 10-year review. For example, in 2015 the Coalition released a Report Card on the Environmental Health of the Oak Ridges Moraine and Adjacent Greenbelt Lands (Conservation Authorities Moraine Coalition (CAMC), 2015a). Nine indicators were employed to assess the environmental health of the Moraine: forest conditions (% forest cover, % forest interior, and % riparian zone forested), surface water quality (total phosphorus and benthic macroinvertebrates), groundwater quality (nitrate and chloride concentrations), presence of coldwater fish species, and stream temperature (Conservation Authorities Moraine Coalition (CAMC), 2015b).

Key Takeaways

- Consider landscape-level ecological plans as living documents requiring regular review;

- Develop and implement a robust monitoring strategy to assess and publicly report on the effectiveness of plan implementation, including clearly articulated roles and responsibilities, funding for data collection and analysis, and support for collaboration among monitoring organizations; and

- Consider publicly transparent review process(es) to facilitate participation and foster trust.

Education and Training

Knowledge exchange is paramount in the effective implementation of landscape level plans that reflect scientific, traditional, and community knowledge. It is important to educate and train practitioners (e.g., ecologists, biologists, and planners) and ensure that representatives of nongovernment organizations and politicians understand the mechanics and implementation of the Conservation Plan. As a case in point, following the release of the Oak Ridges Moraine Conservation Plan and the Greenbelt Plan, provincial government staff provided education and training programs for practitioners employed by municipalities, conservation authorities, and private sector organizations. These training sessions were informed by Oak Ridges Moraine and Greenbelt technical papers (see links in Ministry of Municipal Affairs and Planning (MMAH), 2007) and definitions and criteria for key natural heritage features (Ministry of Natural Resources (MNR), 2012), which provide detailed guidance on how to meet the terms and conditions of policies in both plans, including the size and characteristics of natural heritage and hydrologic features (e.g., tree diameter and density metrics for defining a significant woodland, wetland size, and thresholds). Provincial government staff also engaged in the transfer and ongoing provision of ecological data sets, which are digitized and made available as open data through the Ontario Geospatial Data Exchange and NatureServe (Government of Ontario, 2017).

Key Takeaways

- Provide documents and hands-on technical training for practitioners working in all public and private sectors who are involved in implementing landscape level plans and/or reviewing development and infrastructure proposals; and

- Provide public and private sector agencies and organizations access to government data sets at no cost.

Challenges and Opportunities

Complex, multi-scalar landscape and waterscape-level planning initiatives bring a variety of challenges, some of which have been explored in the Sections above. The summary in Table 2 explores some of the challenges and associated opportunities or options available to mitigate or eliminate issues that can negatively impact the long-term implementation and/or objectives of landscape level plans.

CONCLUSIONS

The Oak Ridges Moraine Conservation Plan is a tested example of a landscape level, ecologically based plan that employs a network of connected (linked) core areas and features to achieve the key objectives in the Oak Ridges Moraine Conservation Act, including the protection and restoration of the ecological and hydrological integrity of the Moraine (Government of Ontario, 2001a). The scientific and practical expertise provided and explained by federal, (e.g., Geological Survey of Canada and Parks Canada), provincial (e.g., Ministry of Municipal Affairs and Ministry of Natural Resources and Forestry), municipal (e.g., municipalities/ conservation authorities), and academic (e.g., University of Toronto) experts provided a sound decision-making platform upon which to effectively engage stakeholders. Nongovernment organizations, citizen groups, and individuals worked collaboratively on a number of key issues to voice their support for and/or concern about many proposals and

Table 2. Challenges and opportunities identified for the Oak Ridges Moraine conservation planning process.

Challenges	Opportunities
Public Awareness	
Provincial government attention can wane over time and some municipalities may start approving development applications that do not adhere to all plan requirements.	Continue to fund/support arms-length organizations like the Greenbelt Foundation and Greenbelt Council to engage in ongoing public dialogue, education and monitoring.
Restoration	
Important portions of the Natural Linkage Areas remain denuded of natural vegetation/forest as a result of insufficient funds for restoration.	Coordinate with all relevant partners to establish restoration plans with annual targets and funding envelopes (e.g., 'The Positively Green' program of the 'Greenbelt Golden Horseshoe Conservation Authority Collaborative' (Toronto and Region Conservation Authority (TRCA), 2018b). Leverage other funding sources (e.g., the federal government recently announced a nation-wide tree planting commitment) (Government of Canada, 2019).
Emerging Issues	
Excess fill from urban development and infrastructure projects is being deposited on the Moraine, particularly in old gravel pits. This can lead to contamination and/or disruptions to local ground water flow, which in turn can interfere with the function of local wetlands, streams, and discharge zones.	Continue to employ the ongoing provincial initiative to regulate the disposition of excess fill, which includes detailed hydrological assessments of potential receiving sites.
Weakening of complementary legislation (e.g., Ontario's Endangered Species Act) has collateral impacts on Moraine biodiversity conservation strategies.	Document the effects of the statutory changes on biodiversity conservation and provide these examples to the public, auditor general, working groups, and committees. Include the documentation in submissions to panels or agencies engaged in statutory reviews of any legislation that affect the ecological integrity of the Moraine.
Monitoring	
There are no baseline condition targets upon which to identify social and ecological trends.	Encourage government agencies to develop baseline targets as part of effectiveness management programs for integration into the Conservation Plan. Explore opportunities for multi-agency collaborative monitoring that uses indices based on scientific, traditional, and community knowledge requirements to inform adaptive management. Explore opportunities to engage nongovernment organizations and the public (e.g., a citizen science program sponsored by a Foundation) in monitoring programs. The background research on baseline condition targets should be initiated as soon as possible.
Data collection programs that populate social and ecological metrics require a long-term commitment to robust field programs. This type of monitoring can be costly to maintain.	Continue to lobby government agencies to support monitoring programs. During the next 10-year review period, promote the need to identify and establish monitoring targets and support data collection and analyses. The background research and assessment should be initiated as soon as possible.
New Technologies	
Emerging technologies (e.g., wind turbines and solar farms) are not addressed in the 2002 and 2017 versions of the Conservation Plan.	During the next 10-year review period, promote the inclusion of policies for current and emerging new technologies. The background research and assessment should be initiated as soon as possible.
Inter-ministerial Coordination	
Inter-ministerial coordination designed to optimize biodiversity conservation is insufficient because the agencies responsible for managing land use programs (e.g., transportation and energy corridors and new energy infrastructure) are not integrated into the ongoing Moraine management planning process.	Promote integrated planning and decision-making among provincial ministries. Use examples of integrated planning in Ontario and elsewhere, such as the integrated design team that employed elements of an ecosystem approach to the planning, design, construction, operation and maintenance of the Rt. Hon. Herb Gray Parkway in Windsor (Auditor General of Ontario, 2014; Convention on Biological Diversity) (CBD), 2010; Liegler, 2019).
Climate Change	
The escalating pace and severity of climate change highlights the importance of the Oak Ridges Moraine in the mitigation of threats to biodiversity (e.g., connected habitat), human safety (e.g., flood attenuation), and long-term security and health (e.g., carbon sequestration).	Employ education and stewardship programs to help the public and decision-makers understand the value of caring for and sustaining the Moraine's ecosystem services

were instrumental in convincing politicians to act on behalf of the ecological integrity of the Moraine. Conservation Plan implementation, monitoring, and oversight issues remain, which will presumably be addressed under the auspices of the government's commitment to adaptive management as part of the plan review cycle. A high level of public awareness must be maintained.

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Madawaska Highlands, Ontario (Photo by David Miller)

CHAPTER 3g

The Algonquin to Adirondacks (A2A) Corridor

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ALGONQUIN TO ADIRONDACKS (A2A) CONNECTIVITY PROGRAM

GARY BELL, DAVID MILLER, ALGONQUIN TO ADIRONDAK COLLABORATIVE

SUMMARY

- The A2A corridor is the most extensive, least degraded north-south corridor east of Lake Superior, connecting the Appalachian forests of the northeastern US to the extensive boreal forests of the Canadian Shield.
- A critical pathway that allows species to move and disperse in response to habitat needs and climate change.
- Key threats include habitat loss and fragmentation (e.g., the Frontenac Arch is a bottleneck where major transportation corridors currently fragment the Region's connectivity).
- The A2A Collaborative is a volunteer-led charitable non-profit conservation organization.
- The A2A's mission is to "...connect lands and people across the Algonquin to Adirondack region to conserve and enhance a critical corridor for ecological integrity and resilience in Eastern North America".
- Governance is complex on the Canadian and US sides, comprised of local to federal agencies and NGOs such as the A2A Collaborative and land trusts.
- Connectivity planning tools have been applied, such as The Nature Conservancy's assessment of habitat 'flow' along a continuum from poor to high connectivity and the A2A Regional Connectivity Mapping Project.
- Agencies and land trusts strategically plan land acquisition programs to add important connectivity habitat into the mix.
- Most agencies tend to look inward at their mandates and areas of jurisdiction as opposed to taking a larger view of the A2A ecological corridor, and the A2A Collaborative works to bridge this gap by bringing a "big-picture" perspective to local efforts through provision of resources such as connectivity mapping and conservation action planning.

Example of Lesson learned

- Many tools and techniques are available to identify potential and known corridors, and to integrate them into local to regional land use planning.

Example of Recommendation

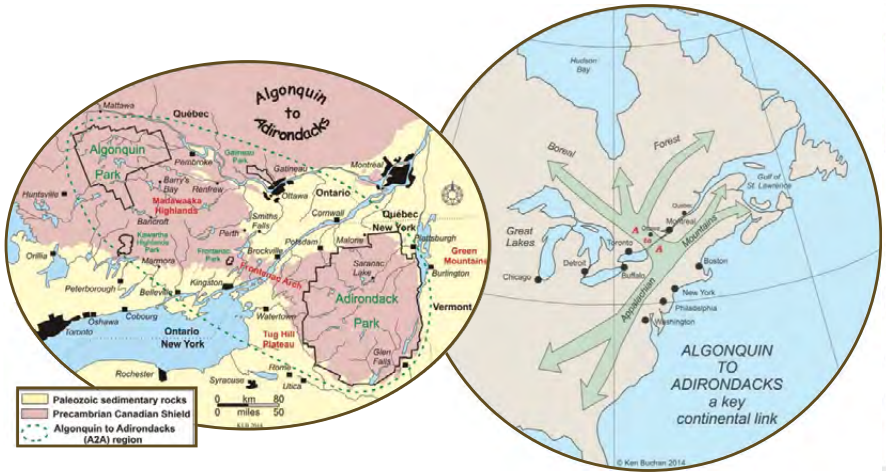
- Prioritize land acquisitions that enhance existing networks of connected protected and conserved areas.

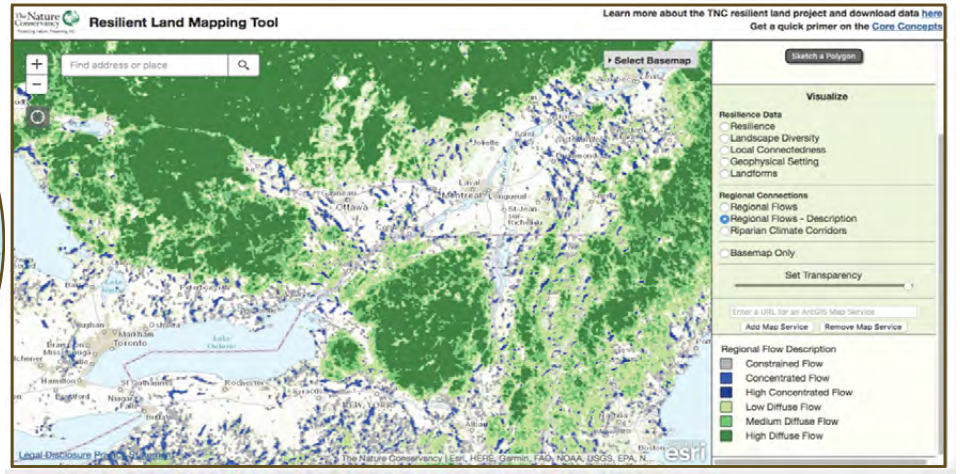
Example of Lesson Learned

- Tracking the movement and genetic dispersion of species use of corridor habitats is important to protection and management policies.

Example of Recommendation

- While species level monitoring is more expensive and challenging than landscape level analyses, it is necessary to fully understand the importance and dynamics of regional scale ecological connectivity dynamics.





INTRODUCTION

The Algonquin to Adirondack (A2A) corridor is the most extensive, least degraded north-south corridor east of Lake Superior, connecting the vast boreal forests of the Canadian Shield to the deciduous and coniferous forests of the Appalachian Mountains that extend into the southeastern United States. The A2A Corridor provides a critical pathway through which flora and fauna can move between habitats in order to meet their annual life cycle requirements, disperse at the population level, and migrate in response to disturbance such as climate change. Moreover, the heart of the A2A region comprises some of the most biologically diverse ecosystems of eastern North America as northern and southern forest zones mix. The A2A Collaborative, a non-government organization comprised of partners from First Nations, Canada and the United States, works to maintain and enhance biodiversity by promoting the protection and/or restoration of interconnected landscapes that extend from Algonquin Provincial Park in Ontario to Adirondack Park in New York State. The continental significance of the corridor is illustrated in in Figure 1, while Figures 2 and 3 provide a regional perspective.

Figure 1

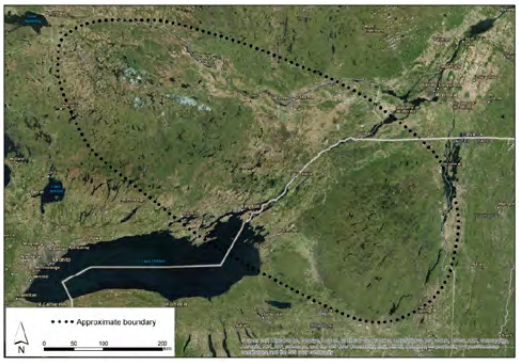


Figure 2

Figure 3

THE SOCIAL-ECOLOGICAL SYSTEM

Social Context

With one full-time Executive Director, the A2A Collaborative is largely a volunteer-led organization that supports community-based conservation and stewardship initiatives throughout the A2A Corridor (see http://www.a2acollaborative.org/). The collaborative is a charitable non-profit organization registered with the Canada Revenue Agency that works at regional levels of governance and planning to identify opportunities and synergies that complement efforts of local groups and agencies. As a partner-based organization, the collaborative supports in-situ partners such as First Nations, land trusts, conservation organizations, and land management agencies in their work to identify potential properties suitable for biodiversity conservation within connected networks of protected areas by providing data, mapping services, and scientific advice.

Vision and Mission

The A2A Collaborative subscribes to a strategic vision and mission:

- **Vision:** *"We envision a resilient, ecologically interconnected landscape that sustains a full range of native wildlife and enhances people's quality of life for generations to come."*
- **Mission:** *"We connect lands and people across the Algonquin to Adirondacks region to conserve and enhance a critical corridor for ecological integrity and resilience in Eastern North America"* (A2A Collaborative, 2018: 7).

Threats

The A2A Corridor is a disturbed landscape with a fragile, relatively undisturbed natural link - the Frontenac Arch or Axis - at its core (Keddy, 1995). Examples of significant threats to biodiversity conservation in the corridor include:

- **Habitat Loss or Modification:** Habitat fragmentation resulting from parcel severance and development of recreational homes and subdivisions, agriculture, increased access to forested areas, existing and expanding road networks, mining and quarrying, dams and alteration of natural waterways, and removal of shoreline vegetation.
- **Climate Change:** Warming temperatures force aquatic and terrestrial wildlife species to adapt to changing habitat conditions. Many species are responding by tracking their preferred temperatures northward. Species that are able to meet their thermoregulatory requirements in the new warmer conditions may encounter other threats such as new invasive species such as parasites and diseases or species that compete for food.
- **Pollution:** Pollution in the St. Lawrence River.

- **Invasive Species:** Invasion by introduced non-native (exotic) species and climate change-induced migrations.
- **Human-wildlife Conflicts:** Accidental direct road mortality (Keddy 1995; A2A Collaborative, 2018, 2019).

ECOLOGICAL CONTEXT

The A2A Corridor in Canada

The Canadian portion of the A2A Corridor is encompassed by two ecoregions, the Georgian Bay Ecoregion in the north and the Lake Simcoe-Rideau Ecoregion in the south (Wester et al., 2017).

Located in the Ontario Shield Ecozone, Ecoregion 5E is located on the southern edge of the Precambrian Shield, with variable topography that alternates between undulating hills and rugged terrain. The underlying bedrock is primarily migmatitic gneissic and felsic igneous rocks covered with variable depths of morainal material. Glaciofluvial deposits are commonly associated with large river valleys and outwash deposits. Lakes such as Muskoka, Lake of Bays, Opeongo, Golden, and Big Rideau are prominent features in the A2A portion of the ecoregion. Situated within the Great Lakes Watershed, numerous river systems (e.g., Madawaska, Mississippi, Ottawa, and St. Lawrence) rapidly drain the ecoregion.

A mix of temperate and boreal flora and fauna inhabit Ecoregion 5E. Primarily forested, typical tree species include eastern white pine (*Pinus strobus*), red pine (*Pinus resinosa*), eastern hemlock (*Tsuga canadensis*), eastern white cedar (*Thuja occidentalis*), sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis*), and large-toothed aspen (*Populus grandidentata*). In the north or on cooler-than-normal sites, black spruce (*Picea mariana*), trembling aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*), white spruce (*Picea glauca*), jack pine (*Pinus banksiana*), American larch (*Larix laricina*), and balsam fir (*Abies balsamea*) are more common. American beech (*Fagus grandifolia*), American basswood (*Tilia americana*), black cherry (*Prunus serotina*), white ash (*Fraxinus americana*), and bur oak (*Quercus macrocarpa*) are more common in the south. Red spruce (*Picea rubens*), once a component of many forests across the landscape, occurs less frequently due to silvicultural practices (Gordon, 1992). Examples of characteristic fauna include black bear (*Ursus americanus*), moose (*Alces alces*), beaver (*Castor canadensis*), broad-winged hawk (*Buteo platypterus*), pileated woodpecker (*Dryocopus pileatus*), veery (*Catharus fuscescens*), rose-breasted grosbeak (*Pheucticus ludovicianus*), gray treefrog (*Hyla versicolor*), snapping turtle (*Chelydra serpentina*), and ring-necked snake (*Diadophis punctatus*). The rivers and lakes provide habitat for lake trout (Salvelinus namaycush), yellow perch (*Perca flavescens*), rock bass (*Ambloplites rupestris*), bluntnose minnow (*Pimephales notatus*), and northern redbelly dace (*Phoxinus eos*). About 1% of the area is devoted to settlement and associated infrastructure. Industrial and commercial activities include service industries, agriculture, logging, aggregate extraction, recreation and tourism, and some mining. Formally designated protected and conserved areas in Ecoregion 5E, including Algonquin Provincial Park, encompass about 17.6% of the area (Wester et al., 2017).

Located in the Mixedwood Plains Ecozone, Ecoregion 6E is underlain by Paleozoic bedrock, except for the Frontenac Arch (Axis) in the Charleston Lake Ecodistrict (6E-10), which consists of a mixture of Precambrian and Paleozoic bedrock. The Frontenac Arch is a unique and ecologically important feature of the A2A Corridor because it is located at the crossroads of the north-south migration route that stretches from Ontario's Algonquin Highlands to the Adirondack Mountains in New York State, and an east-west route along the St. Lawrence River that links the Great Lakes to the Atlantic coast (Stephenson 2001; Wester et al., 2017). With more than 72% forest cover (the highest in southern Ontario), the Frontenac Arch is comprised of relatively intact and connected forest and wetland ecosystems that provide habitat for migratory and wide-ranging species (NCC, 2019).

The Precambrian bedrock formation, a southern extension of the bedrock in Ecoregion 5E, extends into northern New York State. Within Ontario, the terrain is gently undulating to rolling. Glaciomarine surficial deposits are found in the A2A portion of the ecoregion. Located in the Great Lakes Watershed, prominent lakes include Devil Lake, Charleston Lake, and Lake Ontario. River systems (e.g., Bonnechere, Rideau, Mississippi, Ottawa, and St. Lawrence) rapidly drain the ecoregion. Lakes (e.g.,) are prominent features in the A2A portion of the ecoregion. While more than half of the land within Ecoregion 6E has been converted to cropland and pasture, agriculture is a relatively minor land use in the ecodistricts within the A2A Corridor.

Forest cover is comprised of deciduous and mixes of deciduous/coniferous species. Key upland forest tree species include sugar maple, American beech, white ash, and eastern hemlock. In poorly drained areas, typical species include green ash (*Fraxinus pennsylvanica*), silver maple (*Acer saccharinum*), red maple (*Acer rubrum*), and black ash (*Fraxinus nigra*). Wetlands are common in the north. Characteristic mammal species include white-tailed deer (*Odocoileus virginianus*), striped skunk (*Mephitis mephitis*), and woodchuck (*Marmota monax*). A variety of habitats support bird species such as wood duck (*Aix sponsa*) and great blue heron (*Ardea herodias*) in wetlands, field sparrow (*Spizella pusilla*) and eastern meadowlark (*Sturnella magna*) in open upland habitats, and wood thrush (*Hylocichla mustelina*), scarlet tanager (*Piranga olivacea*), and rose-breasted grosbeak in upland forests. Characteristic reptiles, amphibians, and fish include the American bullfrog (*Lithobates catesbeianus*), red-spotted newt (*Notophthalmus viridescens*), northern water snake (*Nerodia sipedon sipedon*), smallmouth bass (*Micropterus dolomieu*), yellow perch, and pearl dace (*Margariscus nachtriebi*).

About 1.6% of the area is devoted to settlement and associated infrastructure. Industrial and commercial activities include service industries, agriculture, logging, aggregate extraction, recreation and tourism, hydro-electric power, wind power generation, and some mining. Overall, formally

designated protected and conserved areas encompass only about 1.3% of the ecoregion (Wester et al., 2017).

The A2A Corridor in the Unites States

The ecological characteristics described for Ecoregion 6E extend into the United States as far south as Albany, New York. This lowland ecoregion surrounds the Adirondack Mountains, which are approximately bounded by Adirondack Park (Wiken et al., 2011). The A2A corridor encompasses deciduous forests (e.g., maple-beech-birch) with a Carolinian affinity (e.g., oak-hickory) in low lying ecosystems and a mix of and maple-beech-birch forests with boreal affinities (e.g., balsam fir-spruce) in the foothills of the Adirondacks (Keddy, 1995). The park is a part of New York's Forest Preserve system, established in 1892 for watershed protection, recreation, and timber supply. Unlike most state parks, about 52% of the land is privately owned. State lands within the park are classified as Forest Preserve. Land use on public and private lands in the park are regulated by the Adirondack Park Agency (Adirondack Park Agency, 2014).

The Frontenac Arch

Extending from Westport, north of Kingston in Ontario to the Indian River lakes area in upper state New York, the Frontenac Arch (Axis) is a 50 km-long extension of exposed Precambrian Shield overlain with relatively intact forest, riverine, and emergent and open water marsh ecosystems (A2A Collaborative, 2019; NCC, 2019). The Arch is a fragile link or "bottleneck" across the Thousand Islands area that connects habitats in the Algonquin Highlands to habitats in the Adirondack Mountains and functions as a migration and dispersal corridor for many species, especially forest-obligate birds and wide-ranging mammals, and is known for its rich, southern-influenced forests and its high diversity of reptiles, amphibians and birds.

The Arch is inhabited by globally significant and rare and imperilled species. For example, of 54 designated species at risk (SAR) inhabiting the Ontario portion of the Frontenac Arch area, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) lists 16 as Endangered, 25 as Threatened, and 13 as species of Special Concern. In addition, the Committee on the Status of SAR in Ontario (COSSARO) lists 17 species as Endangered, 18 as Threatened, and 19 as species of Special Concern. Moreover, there is significant overlap between northern species and southern species at the northern end of their ranges (NCC, 2019).

Types of Protected and Conserved Areas

While the A2A corridor is sparsely populated on both sides of the international border and many ecosystems at the north (Algonquin Park) and south (Adirondack Park) ends are protected, in Canada the area between Algonquin and the St. Lawrence River is not as well protected nor connected through formally designated areas. Habitat connectivity requirements throughout the A2A corridor

Table 1. Protected and conserved properties in the Frontenac Arch area in Canada (A2A Collaborative, 2019).

Public and Private Land Ownership	Protected and Conserved Areas	
	Area (ha)	% of Frontenac Arch Area
Parks Canada – Thousand islands National Park	2,247.71	1.31
Ontario Parks – Charleston PP (with NCC Sheffield partnered property) and Frontenac PP	7,629.12	4.45
Gananoque Provincial Wildlife Area	533.12	0.31
Conservation Authority (CA) properties managed by the Cataraqui Region CA and the Rideau Valley CA	1,487.40	0.87
Rideau Watershed Land Trust, Land Conservancy of Kingston, Frontenac, Lennox & Addington, and the Thousand Islands Watershed Land Trust	820.59	0.48
Ontario Nature	193.68	0.11
Nature Conservancy of Canada	1,964.56	1.15
Queens University Biological Station	3,238.61	1.89
Kingston Field Naturalists	186.63	0.11
The Ontario-St Lawrence Development Commission	45.57	0.03
County Forest	76.40	0.04
Crown Land	26.42	0.02
Total	**18,449.79**	**10.75**

is a key impetus behind conservation work, particularly within the Frontenac Arch because of its importance as a forested linkage for migratory and wide-ranging species (A2A Collaborative, 2019). Of note, while a comprehensive database of protected and conserved areas located within the A2A corridor is not available, 10.75% of the Frontenac Arch is protected through a mix of public and private properties (Table 1).

GOVERNANCE

Governance in the A2A Corridor is multi-scalar, complex, and requires a high degree of social connectivity that facilitates and empowers engagement and partnership. Federal agencies tend to engage over matters involving international relationships (e.g., treaties) and commitments (Aichi Targets), and some domestic programs (e.g., national parks, species at risk legislation, and tax incentive programs). Provincial and state agencies provide overall direction and guidance on land use planning (e.g., policies an guidelines) and on specific matters of interest (e.g., provincial and state parks, wetlands policy, tax incentive programs, and species at risk legislation). In addition to being landowners, Ontario's Conservation Authorities (CA) (e.g., Rideau Valley CA, the Mississippi Valley CA, and the Cataraqui Region CA) provide scientific and technical services to local residents, municipalities, counties, and the provincial government that address social-ecological issues at the watershed-level such as flood control, hazard management, and conservation programs. Both the Canadian and U.S. portions of the A2A Corridor are governed by two-tier systems at the county and municipal levels of authority. Counties are legislatively mandated to prepare and update 'official plans', which translate policy into action.

Table 2. A2A Demographics by county in Canada and the United States.

County	A2A Demographics		
	Number of Municipalities	Population	Population Density People/km²
A2A Counties in Canada[1]			
Leeds and Grenville	13	100,546	29.7
Lanark	9	68,698	22.6
Frontenac	4	26,667	39.7
Renfrew	10	88,512	13.7
A2A Counties in the United States[2]			
Jefferson	10	109, 834	35.4
St. Lawrence	15	107,740	16.1
Lewis	11	26,296	8.2

[1] Statistics Canada (2016)
[2] United States Census Bureau (n.d.)

First Nation roles and responsibilities for governance are rapidly evolving in the A2A Corridor, particularly in the northern area where an important outcome of the Algonquin Land Claim Settlement involves the transfer of responsibility for the management of significant areas of Crown land in the Madawaska area to the Algonquins of Ontario (Algonquins of Ontario Agreement in Principle, 2015). Given the importance of social networking to successful engagement and collaboration, the Eastern Ontario First Nations Working Group is exploring future relations between the Algonquin and Mohawk (Akwesasne) nations and other conservation stakeholders in the area.

Non-government organizations (NGOs) and Queens University have acquired a number of quality properties that make significant contributions to the biological integrity of ecosystems in the A2A Corridor (Table 1). Collectively, the land trusts, Nature Conservancy of Canada (NCC), Kingston Field Naturalist Club, and Ontario Nature have acquired 4,286 ha in Ontario and the three land trusts in New York have secured at least 5,250 ha (Tables 1 and 3). Equitable and transparent land acquisition programs that suit the needs of the landowner and the buyer range from fee simple purchase or donation to conservation easement or agreement. Land trusts throughout the A2A Corridor employ strategic approaches to establish priorities for land acquisition. For example, the Thousand Islands Land Trust employs a science-based approach to prioritize the acquisition of connector properties to fill conservation gaps between protected areas in the St. Lawrence and Thousand Islands area.

Table 3. Land area acquired in the A2A corridor by Canadian and U.S. Land Trusts.

Land Trusts	Land Area Secured in the A2A Corridor (Ha)			
	Own	Easement	Other	Total
Land Trusts in Canada[1]				
Rideau Watershed Land Trust	439.8	0.16	12.96	452.92
Thousand Islands Watershed Land Trust	6.9	183.04	-	189.94
Land Conservancy for Kingston, Frontenac, Lennox & Addington	133.25	26,667	-	219.11
Mississippi Madawaska Land Trust	317.52	88,512	-	1,078.92
Land Trusts in the United States[2]				
St. Lawrence Land Trust	10	109, 834	35.4	
Thousand Islands Land Trust	15	107,740	16.1	4,270
Indian River Lakes Conservancy	11	26,296	8.2	930

[1] OLTA 2020

Conservation authorities, stewardship councils (e.g., Leeds and Grenville Stewardship Council; (http://www.lgstewardship.ca/), and the Frontenac Arch Biosphere Reserve (FAB) engage in a variety of in-situ stewardship programs focused on tree planting, species protection, restoration, and invasive species control. Provincial and state parks, conservation authorities, the FAB, and some county level programs provide extension and education services to the public as well.

The A2A Collaborative serves to support biodiversity conservation initiatives in the multi-scalar matrix of government, NGO, and university stakeholders with its 'big picture' perspective and the provision of technical services such as connectivity mapping, conservation action planning, and partner information sessions.

SPACE AND TIME

Spatial Context

Successful biodiversity conservation in the A2A Corridor requires sound knowledge about the distribution and abundance of flora and fauna in relation to the terrestrial and aquatic habitats upon which they depend. Habitats are multi-temporal and multi-scalar entities with aquatic and terrestrial elements that combine to meet unique needs of each species. Hierarchical ecosystem classification systems that provide the spatial platform for ecologically meaningful decision-making have been developed with a terrestrial focus (e.g., ecoregions) and an aquatic focus (e.g., watersheds). Unfortunately, terrestrial classification systems do not adequately provide the spatial context to identify and map the physical boundaries of hydro-geo-biological requirements of aquatic organisms and vice versa (Woodley et al. 2012; Juffe-Bignoli et al., 2016). Some planning programs employ both aquatic and terrestrial classifications. Moreover, planners and decision-makers are often required to integrate knowledge about ecosystem composition, structure and function into jurisdictional boundaries that have little ecological meaning. For example, the A2A Corridor is located in two countries and four sub-national jurisdictions (i.e. New York, Vermont, Ontario and Quebec) that are principally delineated with straight-line boundaries and a few ecological boundaries (e.g., St. Lawrence River) (Table 4).

Fortunately, in the last 20 years a variety of connectivity mapping tools have been developed, tested, and employed to support ecologically meaningful planning (see the Knowledge Management section below). These tools enable practitioners to apply combinations of aquatic and terrestrial values (variables) to identify and map connectivity. The A2A Collaborative works to support the use of connectivity mapping that augments and enhances the conservation mapping programs used by local and regional governments, Conservation Authorities, and land trusts. For example, the collaborative supported a connectivity analysis of Ecodistrict 6E-10 ecosystems in both Ontario and New York to map terrestrial and aquatic core areas and linkages (Henson and Teller, 2014).

Table 4. Jurisdictional representation the A2A Corridor (A2A, 2018).

A2A Corridor and Jurisdiction	Area (km²)	% of A2A Corridor
Canada	127,095	60
United States	84,825	40
Total A2A	211,920	100
New York	79,340	37
Vermont	5,485	3
Quebec	17,233	8
Ontario	109,862	52

Temporal Context

Ecosystems function along a continuum of time ranging from seconds to millennia and going forward, recognition of the varying temporal scales and lag-effects that characterize ecosystem processes is important in ecologically meaningful planning. Globally, current trends for biodiversity are generally negative, and timely commitments to mitigate the effects of ongoing trends is a primary objective of the Convention on Biological Diversity (CBD, 1992) and subsequent agreements, including the long-term visions in the 2050 Vision for Biodiversity (United Nations, 2018). Spatial analyses completed for the A2A Corridor indicate that the designation of intact and connected habitats for aquatic and terrestrial species is still possible.

PLANNING AND IMPLEMENTATION

A variety of strategic, systems, and management planning initiatives have been completed by agencies and organizations working in the A2A Corridor. While some organizations and agencies recognize the importance of connected systems of protected and conserved areas at the landscape- and waterscape-level of biodiversity planning, there are significant gaps in the identification and creation of connected natural heritage systems (Garret et al., 2016; A2A Collaborative, 2018).

Strategic Planning

Pertinent strategic plans to the A2A Corridor have been prepared at all levels of government. Key guidance in Canada's biodiversity strategy includes the reconnection of *"…fragmented ecosystems where practical and necessary, providing corridors and protecting habitats for isolated species or populations"* (Environment Canada, 1995: 21). A principle in Ontario's biodiversity strategy denotes that habitat *"… connectivity is essential at local, regional and wider scales"* (OBC, 2011, p.33) and effective in-situ programs serve to re-connect fragmented landscapes and maintain intact landscapes (OBC, 2011). The province's wetland strategy recognizes the importance of setting priorities to maintain connectivity and/or restore wetlands (MNR, 2017a, b) and the Cataraqui Region Conservation Authority

stresses the significance of research that is focused on a better understanding of the water cycle and the general interconnectedness of the components of natural resources in the watershed (CRCA, 2001).

NGOs have prepared a number of strategic statements and/or plans that focus on the A2A Corridor. Conservation Action Planning (CAP) is a method for planning, executing, and evaluating environmental conservation initiatives within ecoregions that has been applied and tested in many countries. To optimize biodiversity conservation in the A2A Corridor, the A2A Collaborative has embraced the CAP methodology to facilitate a landscape-level perspective at local levels of planning based on the principles of employing a landscape-scale context, a focus on cores and corridors, application of strategic stewardship and partnerships, anticipatory approaches to identifying future threats, and important and innovative ways of 'knowing' (A2A Collaborative, 2018). Under the auspices of its CAP, the A2A Collaborative explored approaches to optimize ways to assist future local CAP initiatives and techniques to include a landscape-scale perspective in future conservation planning efforts. Key roles can include work to:

- Facilitate gatherings with First Nations to build relationships and to allow for true engagement and cross-cultural collaboration to develop;
- Facilitate gatherings where local and regional partners can engage with each other, including in areas where potential ecological linkages have been identified;
- Facilitate and co-sponsor funding applications to fund local CAPs; and
- Work with local CAPs to provide a larger-scale perspective (A2A Collaborative, 2018).

As a case in point, the A2A Collaborative has completed an assessment of the landscape and related threats and provides strategic direction for land protection and acquisition priorities for the Frontenac Arch (A2A Collaborative, 2019). Connectivity-related goals in the strategy include to:

- Maintain forest extent and diversity in 65% of the Frontenac Arch (forest connectivity supports viable populations of wide-ranging native fauna and the dispersal needs of native forest flora); and
- Ensure connectivity of aquatic systems is sufficient to allow native fish and herpetofauna to meet all of their lifecycle requirements (connectivity includes unimpeded water flow as well as naturally vegetated riparian buffers and strategies to achieve this goal may involve a combination of dam decommissioning, water level regulation that emulates natural fluctuations, and other forms of mitigation such as fish ladders) (A2A Collaborative, 2019).

Every A2A land trust endorses a strategic approach to land acquisition denoted by a vision and mission statement. For example, the Mississippi-Madawaska Land Trust's mission is *"To legally protect and steward private lands having ecological, biodiverse, aesthetic, and cultural value and to foster engagement with wilderness"* (Mississippi Madawaska Land Trust, 2020) and the St. Lawrence Land Trust's mission is to *"…work with landowners to conserve the ecological, recreational, historical, and cultural values of their property, for benefit of the landowner and the community"* (St. Lawrence Land Trust, 2020). The Land Conservancy for Kingston, Frontenac, Lennox and Addington issued a strategic plan in 2014 with a *"…goal of protecting representative significant natural habitats, supporting biodiversity and connecting natural areas across the counties"* by focusing on three objectives: *"preserve more land for nature, raise funds to support land acquisition and stewardship, and increase our organizational strength"* (LC-KFLA, 2014, p.2).

Systems Planning

Systems planning has been employed in Ontario and New York for decades. In recognition of the need to manage for the increasing impacts of human activities on landscape-level ecosystems in southern Ontario, systems planning was implemented in the 1990s to protect ecologically significant areas and mitigate the cumulative negative effects. Counties and municipalities must prepare Official Plans and related zoning and bylaw measures that conform to the Ontario Planning Act (SPlanning Act, 1990) and the Provincial Policy Statement (PPS) (MMAH, 2020). In addition to formally designated protected areas such as parks, the PPS requires that regional, county, and municipal Official Plans protect significant features and consider the assemblage of connected corridors. To this end, a number of OPs include a Natural Heritage System (NHS). An NHS can include unique mixes of public (e.g., provincial and national parks) and private lands (e.g., land trusts), including a variety of natural features that are important to biodiversity conservation such as significant wetlands, fish habitat, significant woodlands, significant valleylands, habitat of endangered and threatened species, significant wildlife habitat, Provincially Significant Wetlands (PSW), and Areas of Natural and Scientific Interest (ANSI) (MMAH, 2020). For example, Frontenac County, in which a portion of the Frontenac Arch is located, has created an NHS *"…of connected, or to be connected, green and natural areas that provide ecological functions over a long period of time and enable movement of species"* (County of Frontenac, 2016, p. 61). The NHS is comprised of Earth and Life Science ANSIs, PSWs, moose aquatic feeding areas, deer yards, linkage areas, and provincial parks. These natural linkages and biodiversity areas are also connected to natural heritage features in adjacent counties (Dillion, 2012; County of Frontenac, 2016).

Planning methods include the engagement of stakeholders, use of a science-based approach supported by manuals (e.g., MNR, 2010, Lemieux, 2011), allocation targets made in the context of ecological boundaries, computerized decision-support tools, and digitized map layers that represent a variety of ecological and social themes. In New York, the Department of Environmental Conservation provides direction for planning and support for conservation organizations. For example, the New York State Open Space Conservation Plan Space provides overall direction at the state level and notes that *"Open*

space corridors complement urban and community forests, helping densely populated areas maintain green spaces and streetscapes" (New York State, 2016, p.10).

MANAGEMENT PLANS

Management plans translate legislation, policies, and strategic planning targets into action -- they prescribe how valued assets will be allocated and the scale and type of permitted human activities within the boundaries of designated areas and planning regions. Government agencies and NGOs employ management planning. At the national level, Parks Canada manages Thousand Islands National Park habitats that are part of a continentally significant north-south corridor that enables wildlife movement and gene flow and an east-west aquatic corridor along the St. Lawrence River. The park is the only ecologically intact connection between habitats on the Canadian Shield and in the Adirondack Mountains, and serves as a key link through the A2A corridor. One of the four key strategies in Parks Canada's ten-year management plan is to collaboratively work with partners to re-establish connectivity across the broader landscape (Parks Canada, 2019). In Ontario, the province employs an ecosystem approach to provincial park management planning to maintain or restore ecological integrity (i.e., ecosystem composition, structure and function) within the boundaries of the park or conservation reserve and to collaborate with other agencies and organizations in the care of natural assets outside of park boundaries (MNR, 2016a, b). The Land Conservancy for Kingston, Frontenac, Lennox and Addington (LC-KFLA) employs a Natural Heritage Plan to guide Land Conservancy habitat protection activities and provide information to other conservation partners (LC-KFLA, 2018). The plan lays out a strategy for land acquisition and stewardship activities in the County of Frontenac, the County of Lennox and Addington, and the rural part of the City of Kingston. The Plan provides guidance for the identification of core areas and landscape connections throughout the LC-KFLA study area.

MANAGING KNOWLEDGE

In addition to a strong commitment to ecosystem integrity of which connected networks of protected and conserved areas is a primary characteristic, effective use of scientific, traditional, and local knowledge and practical 'know how' is a prerequisite for positive outcomes. Agencies and organizations secure knowledge and experience through research, assessment, and monitoring. A2A partners have collaboratively completed research and assessment projects designed to inform sound social and ecological decision-making about the allocation of natural assets in the A2A Corridor. Three key areas of interest are the development of ways and means of engaging local managers in big picture planning, connectivity mapping techniques, and aspects of species ecology. Moreover, extension programs designed to help partners foster public support for the A2A initiative are encouraged.

- **Big Picture Planning:** The A2A Collaborative employs the CAP methodology to facilitate a landscape-level perspective at local levels of planning based on the principles of ecologically meaningful landscape mapping, a focus on cores and corridors, use of strategic stewardship and partnerships, anticipatory approaches to identifying future threats, and important and innovative ways of 'knowing' (A2A Collaborative, 2018). Work continues.

- **Conservation Corridor Analysis:** In one of the earlier connectivity studies, Quinby et al. (1999) assessed the suitability of landscapes between Algonquin Park and Adirondack Park to function as travel corridors for wolves. Several conservation corridors were identified based on the percentage of wolf habitat along least-cost corridor pathways.

- **Natural Heritage System Mapping:** Team members of the Sustaining What We Value Initiative, a collaborative of local groups, municipal representatives, provincial agency staff, and an A2A Collaborative representative, identified natural heritage system scenarios for Frontenac, Lanark, Leeds and Grenville Counties with GIS and 'linkage' mapping. The scenarios provided optional core and corridor objectives within this area of the A2A Corridor (SWWVPT, 2011).

- **Nature Conservancy Resilient and Connected Landscape Mapping and Analysis:** The NCC completed 'flow and resistance' analyses across landscapes and demonstrated the importance of the A2A Corridor as an area of highly diffuse ecological flow (Anderson et al., 2016). The mapping is available at https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/resilience/Pages/default.aspx.

- **Connectivity Analysis of Ecodistrict 6E-10:** The A2A Collaborative provides connectivity mapping to augment and enhance the more geographically limited conservation mapping efforts of local governments, Conservation Authorities, and land trusts. The connectivity mapping project provides accessible GIS mapping tools to analyze core natural features and least cost path connections between core natural areas (Henson & Tellier, 2014). The mapping tool has been distributed to partners. KMZ and GIS versions are available from the collaborative to enhance local mapping efforts and are available on the A2A website (http://www.a2acollaborative.org/mapping.html) (Henson & Teller, 2014).

- **Landscape Connectivity in the Great Lakes Basin:** Bowman and Cordes (2015) used 'Circuitscape' analysis to plot connectivity in the Great Lakes Basin including the Canadian portion of the A2A Corridor. The analysis confirms that there is a high degree of connectivity in the Corridor.

- **Road Ecology:** Fragmentation resulting from the construction of highway and road corridors is a principal impediment to connectivity in the A2A Corridor. In partnership with Queen's University

and the Ontario Road Ecology Network, the A2A Collaborative has been engaged in a multi-year initiative to assess road mortality along three major corridors (Thousand Island Parkway, Highway 401, and Highway 2) in the Ontario portion of the A2A Corridor. After several years of research to identify hot spots, the research team has delineated critical travel corridors and potential mitigation approaches such as fencing to manage the distribution of turtles (http://www.a2acollaborative.org/road-ecology.html).

- **State of the A2A Science Symposium - Species Distribution and Abundance:** At the April 2019 State of the A2A Science Symposium convened by the A2A Collaborative in Clayton, New York in April 2019, 90 participants listened to presentations from experts including Roland Kays who described efforts to track species movement at regional and international scales. Although connectivity options in the A2A Corridor are understood and accepted at the landscape level, little is known about species behaviour, preferences, and movement patterns in part because of the high cost involved in conducting species-specific studies.

- **Inventory and Monitoring:** Two ecological systems within the Frontenac Arch are tracked by the Ontario Natural Heritage Information Centre (NHIC): Pitch Pine Treed Granite Barren (G3G5 S1) and Graminoid Coastal Meadow Marsh (G2 S2). The importance of the Frontenac Arch to biological diversity is exemplified by the "very high" diversity of priority breeding bird species.

- **Supporting Conservation Science with the A2A Trail initiative:** Public awareness of, and support for, connectivity initiatives is important to the effective implementation of land and water protection and acquisition programs. Lack of public awareness of the A2A program is a concern. For example, results from a survey of A2A awareness and support in New York indicated that few landowners are aware of the fact that their property is located within the A2A Corridor, and once the A2A program was explained, support for corridor-level conservation was mixed (Brown & Harris, 2005). Overall, "… respondents felt very unsure about A2A, and they were uncertain about personal involvement in the planning process". To increase support and awareness, the A2A collaborative elected to support its conservation science efforts with a trail initiative – 'The A2A Trail – A Pilgrimage for Nature'. The A2A trail utilizes existing trails and travel routes to define a multi-model trail connection between the two parks. The A2A Trail approximately follows the route of Alice the Moose that was radio collared and released in the Adirondacks and travelled about 650 km along the corridor to Algonquin Park. The trail is designed to raise awareness about the ecological value of the corridor, promote conservation ethic and outdoor activity as people travel along the trail, and encourage local economic development. Hikers and cyclists are encouraged to see themselves as part of a larger corridor as they travel local segments of the trail (http://www.a2acollaborative.org/a2a-trail.html).

LESSONS LEARNED

Protecting and re-establishing ecosystem integrity throughout the A2A Corridor is critical to biodiversity conservation in eastern North America. To this end, social and ecological challenges requiring redress include:

- A lack of conservation science related to verification and quantification of corridor functions, especially as it relates to species distribution and abundance.
- A lack of public awareness and appreciation of landscape scale regional corridors because of a tendency of agencies and the community to focus on local issues and challenges.
- Perceptions that obstacles like highway corridors, major rivers, and development make corridors impossible.
- Public concerns that corridor conservation efforts will lead to regulations and restrictions within rural areas and working landscapes.

The A2A Collaborative and its partners note that important lessons learned to address these challenges include:

- It is important to tell stories that people can relate to such as the adventures of Alice the Moose. People need to be engaged and interested rather than threatened.
- Property acquisition near or adjacent to existing conservation lands through transparent and fair (1) fee simple purchase or donation, or (2) easement or agreement is important to the incremental assemblage of connected natural heritage systems.
- Access to tools and techniques with which people working at the local level can relate to connectivity at the landscape level of planning. Mapping tools, strategic initiatives, communications, and extension programs contribute to work designed to inform and engage people working at all spatial scales.
- A strategic, ecologically meaningful approach to network design that enables A2A partners to prioritize land acquisition initiatives. Experience shows that adding new properties that are adjacent to or near existing conservation lands enhances the chances of successful acquisition.
- Effectively explain the known and potential effects of climate change and other threats to biodiversity conservation. This knowledge will help the public understand the idea that connectivity and regional scale corridors are important to those wildlife species that adapt by searching for new habitats.
- Focus on stewardship (agriculture, forestry, hunting and fishing) projects that build on the principle of

enhancing permeable landscape values (e.g., regional scale ecological corridors can function through rural and working landscapes interspersed with natural areas and corridors) within existing socio-economic systems. Integrated approaches to stewardship and acquisition/protection are mutually reinforcing.

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Wildlife Underpass, Quebec (Photo credit Ministère des Transports du Québec)

CHAPTER 3h

The Three Borders

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TWO COUNTRIES, ONE FOREST (2C1FOREST)

LOUISE GRATTON, M. SC. CONSERVATION CONSULTANT

Example of Lessons Learned

- Never underestimate the time it will take to obtain buy-in from stakeholders, especially if you are an "outsider" because different social and cultural realities will influence how a project will unfold.

Example of Recommendation

- Initiating a connectivity project with strong local stakeholder involvement is time consuming. Maintaining momentum is even more difficult, and an important element of success is contingent on funding to support human resources that provide strategic planning, awareness activities, and communications with a broader public.

Example of Lesson Learned

- Funding for connectivity projects is a constant concern, often requiring significant investment by government.

Example of Recommendation

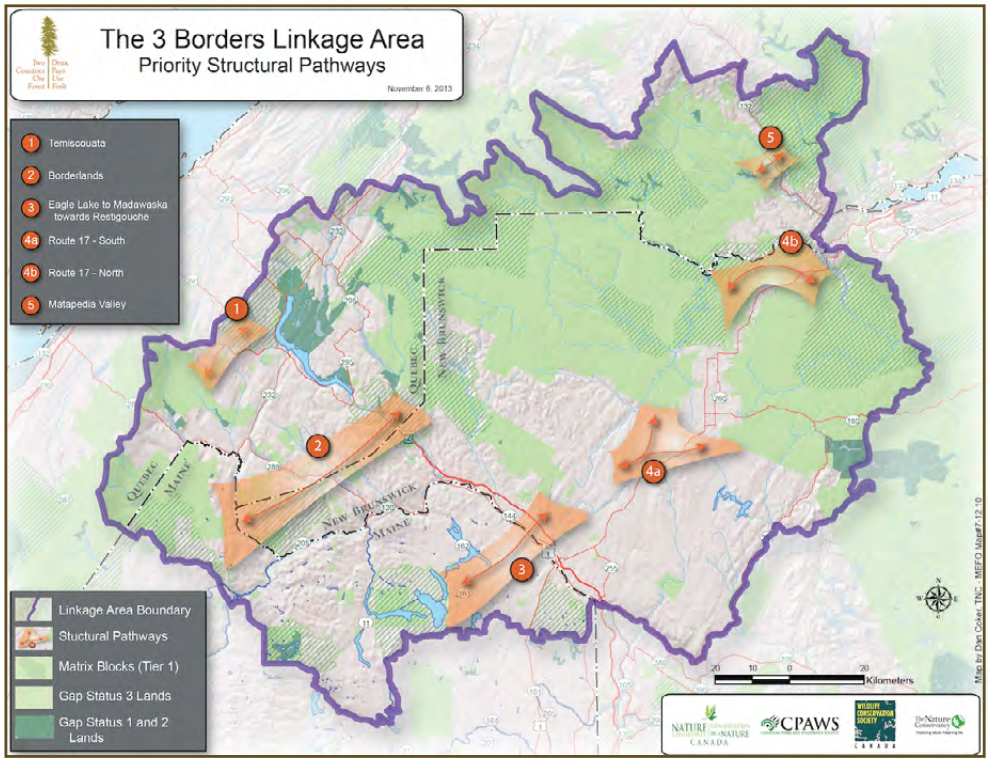
- Government funds for land protection often focus on property acquisition or easements. While various tax incentives are important, they tend to focus on the protection of natural areas on private land. However, successful landscape-level connectivity initiatives also require funding for the protection of managed forest on public land and the restoration of degraded lands and waters.

SUMMARY

- 2C1Forest ('Three Borders') is a US/Canada collaborative project to restore and protect the natural heritage of the Northern Appalachian and Acadian Ecoregion.
- The Three Borders (23,273 km^2) linkage area straddles the Canada/US border encompassing the southern portions of the Bas-Saint-Laurent and Gaspé regions of Quebec as well as parts of northern New Brunswick and Maine.
- The 2C1Forest project promotes ecosystem connectivity that enables wildlife movement across large landscapes.
- Threats to connectivity include climate change, intensive use, expansion and upgrades of the road network, forestry practices, and, to a lesser degree, expansion of urban and commercial areas, and expanding recreational activities.
- In Quebec, most connectivity projects are led by NGOs and land trusts, which secure land within key corridors through land purchase, donation or easements.

SCOPE

This case study is focused on the Quebec portion of the Three Borders Linkage Area, where significant efforts have been invested in the last 5 years to engage local stakeholders in maintaining wildlife corridors.



THE SOCIAL-ECOLOGICAL SYSTEM

Two Countries, One Forest (2C1Forest) is a US/Canadian collaborative working to restore and protect the natural heritage of the Northern Appalachian & Acadian Ecoregion and build a strong science-based conservation movement toward realizing this vision. Over the last 2 decades, it has succeeded in raising the profile of this exceptional and distinctive geography by convening an extensive network of partners to share information and experiences. It also maintains an online atlas (2C1Forest, 2019) created to render conservation science generated by 2C1Forest and partners in an open and accessible form. 2C1Forest has been a powerful catalyst for transboundary conservation, promoting ecological connectivity essential for wildlife movement across large landscapes in the face of increased development pressure and the great uncertainties posed by climate change.

A rough assessment of connectivity in the Northern Appalachian and Acadian Ecoregion was first drafted by 2C1Forest in 2012, with the help of several organizations including The Nature Conservancy (TNC), Nature Conservancy Canada (NCC) and the Wildlife Conservation Society (WCS). It was based on the regional analysis by Trombulak et al. (2008) of priority locations for conservation. The Three Borders Natural Area (hereafter named the Three Borders) was delineated with subsequent integration of biological and land use information using Geographic Information Systems (GIS) technology. It became one of eight key linkages identified by partners that are critical for landscape-scale connectivity in the ecoregion (SCI, 2012) (Figure 1).

The Three Borders (23,273 km²) straddles the Canada/US border encompassing the southern portions of the Bas-Saint-Laurent and Gaspé regions of Québec as well as parts of northern New Brunswick and Maine, thus its name. The project's boundaries were initially based on watershed and physiographic units that best encompassed forest matrix blocks identified by Anderson et al. (2006) in their conservation assessment of the ecoregion. Connectivity analyses based on more recent data by TNC showed this to be the most highly connected region in eastern North America, further underscoring its ecological significance (Anderson et al. 2016).

Prior to 2C1Forest's interest in the linkage, the TransCanada Highway had undergone major changes. In 2013, the upgrade from a two-lane (route 185) to four-lane highway (route 85) was almost complete except for a 100-km stretch in Québec where there still existed a great potential to better plan for wildlife corridors and crossing structures. The present case study thus focuses on the Québec portion of the Three Borders, where significant efforts have been invested in the last five years to engage local stakeholders in

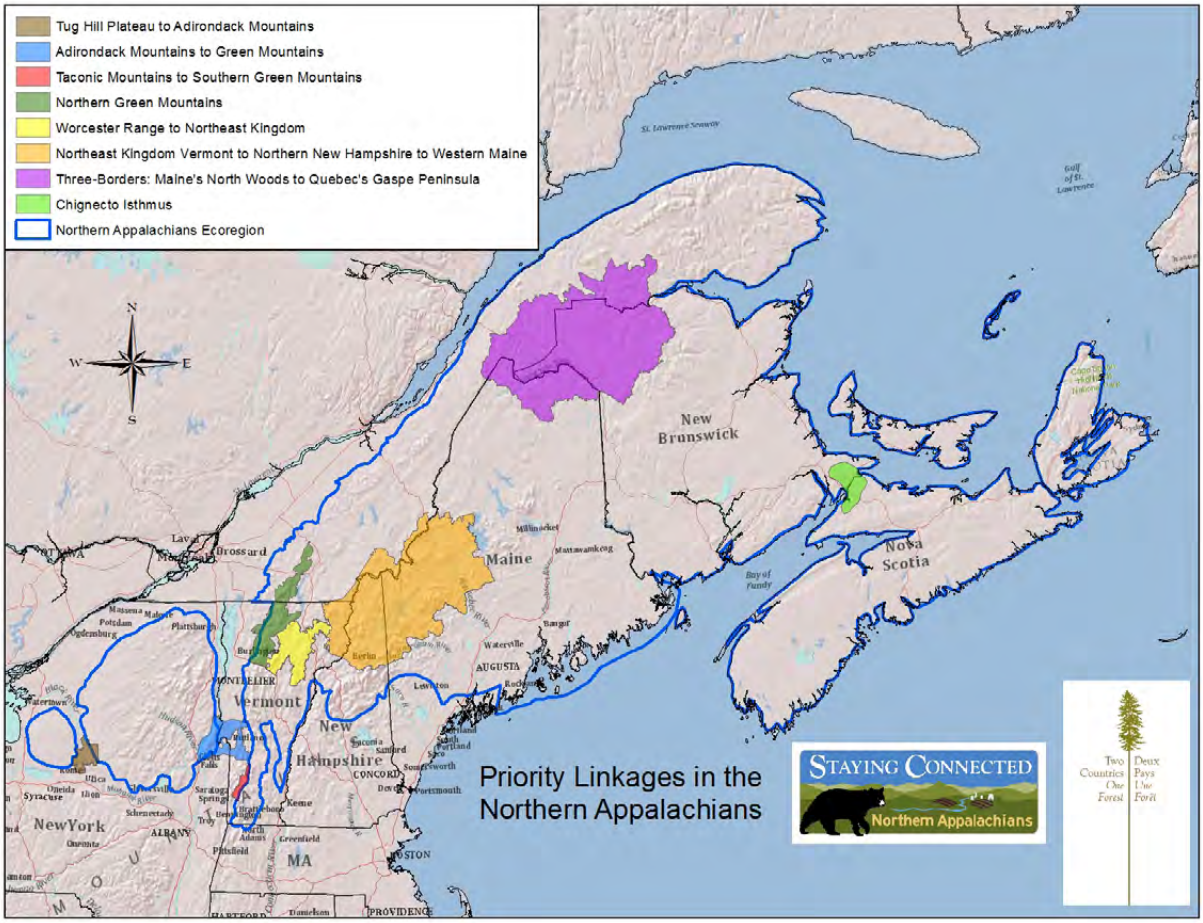


Figure 1. The eight key linkages in the Northern Appalachian and Acadian Ecoregion.

maintaining wildlife corridors. Unless mentioned otherwise, the following text refers to the Québec portion of the Three Borders.

The Three Borders is located in the central part of the Northern Appalachians range, also known as the Notre-Dame Mountains, a series of narrow hills interrupted by plateaus and valleys. The Area lies at the foothills of these mountains and features three large valleys: the Témiscouata, Matapédia, and Restigouche. The rugged topography limited human settlement to valley bottoms along major rivers and lakes that were historically used to travel from the shores of the St. Lawrence River to Maine, New-Brunswick, and the Baie des Chaleurs. Thus, the area remains mainly forested, with agriculture and settlements restricted along the rivers. It belongs to the northern temperate zone and the bioclimatic domain of the Balsam Fir-Yellow Birch Forest (Ordre des ingénieurs forestiers du Québec, 1996). Although this dominant forest type is well represented in the Area, the varied topography, associated micro-climates and human use is expressed in a complex mosaic of forest communities. Industrial logging in the past century also resulted in major changes to forest age structure and composition (Boucher et al., 2009).

The vast expanse of forests is important habitat for wide-ranging species such as moose (*Alces americanus*), white-tailed deer (*Odocoileus virginianus*), black bear (*Ursus americanus*), Canada lynx (*Lynx canadensis*), and American marten (*Martes americana*). A whole suite of forest interior birds is found, several of which are of high priority in the Bird Conservation Region 13 (Dettmers, 2003) including species at risk in Canada such as Bicknell's thrush (*Catharus bicknelli*), Canada warbler (*Cardellina canadensis*), olive-sided flycatcher (*Contopus cooperi*), eastern wood-pewee (*Contopus virens*) and rusty blackbird (*Euphagus carolinus*) (Gratton et al. 2014; Committee on the Status of Endangered Wildlife in Canada, 2019).

Watercourses belong almost entirely to the St. John's and Restigouche watersheds, the most important rivers being the Madawaska, Matapedia and Restigouche. Aquatic and riparian habitats also provide food and breeding grounds for species at risk such as the bald eagle (*Haliaeetus leucocephalus*) in Québec (Ministère des Forêts, de la Faune et des Parcs, 2019), and the inner St-Lawrence population of Atlantic salmon (*Salmo salar*) and the wood turtle (*Glyptemys insculpta*) in Canada (COSEWIC, 2019). Many species of waterfowl use the lake and river systems as well as the small wetlands mostly associated with valley bottoms, depressions, ponds and shorelines. In forested landscapes, their occurrence is often associated with American beaver (*Castor canadensis*) activity (Canards Illimités Canada, 2008).

Protected areas on public and private land

Protected areas that belong to categories I to III of the International Union for Conservation of Nature (IUCN) occupy 2.19% (190 km^2) of the Three Borders area. These are Lake Témiscouata Provincial Park and Exceptional Forest Ecosystems on public land. An additional 3.24% (282 km^2, categories IV and VI) of protected areas is represented by designated wildlife habitats on public land associated with deer yards (sheltered areas where deer congregate during winter) and Atlantic salmon rivers (MELCC, 2019).

In 2013, the government of Québec engaged in a wide public consultation to submit several candidate sites to expand the protected area network in the Bas-Saint-Laurent region, several of which are in the Three Borders (Ministère de l'Environnement et de la lutte contre les changements climatiques, 2019). However, none is designated yet. Although not considered protected areas, several large tracts of public land are dedicated to natural resources and wildlife management (in particular, forestry, angling and hunting). They represent or 22.5% (1,954 km^2) of the area (Gratton et al. 2014).

The only private protected area (11.12 ha) is owned by the Société d'aménagement de la rivière Madawaska et du lac Témiscouata and protects part of the wood turtle's critical habitat (Gratton et al. 2014). Finally, the Bas-Saint-Laurent Private Forests Agency works with landowners who sign voluntary agreements to keep out of and protect wetlands during logging activities (Agence de mise en valeur des forêts privées du Bas-Saint-Laurent, 2019).

Current threats

Threats to the Three Borders' biodiversity were assessed by Gratton et al. (2014) using the classification system developed by the IUCN and the Conservation Measures Partnership (IUCN-CMP, 2006a). Of the 21 threats reported, the ones likely to significantly disrupt connectivity in the near future are: intensive use, expansion and upgrade of the road network; forestry practices; and, to a lesser degree, expansion of urban and commercial areas, and expanding recreational activities.

1. Roads

The 2019-2025 upgrade of the Trans-Canada Highway 85 from a two-lane to a four-lane highway is by far the most important threat to connectivity in the area. Both the physical structure and traffic affect wildlife populations in numerous ways, including habitat loss and fragmentation, barriers to movement, and direct mortality from vehicle collisions. In rural and suburban areas of North America, accidents with wildlife, mostly large ungulates, are a major safety concern (Clevenger and Huisjer 2011).

2. Logging and Wood harvesting

Past industrial logging, semi-industrial operations, and wood collection for fuel modified the forest mosaic to varying degrees. In a large part, public land is governed by forest management contracts (contrats d'approvisionnement et aménagement forestiers or CAAFs) with the Québec government (Gratton et al. 2014). Forestry activities, although decreasing in the area, are still likely to impact biodiversity at the site scale by modifying forest structure and composition as well as the associated species. The presence of logging roads and the improved access they provide to the backcountry for a variety of different uses such as timber production, recreation, and enforcement

(e.g., forest fire control, access for conservation officers) is highly correlated with changes in species composition and populations (Betts and Forbes, 2005). It is not clear how and to what level the presence of logging roads and improved access to resources impact connectivity. Extensive logging and forest fragmentation in eastern forests could reduce breeding habitat for some species requiring more sheltered habitats or old forests. These roads also increase access to predators such as coyote (*Canis latrans*) and black bear that prey on fawns during the first few weeks of life. Movement may be restricted for wide-ranging mammals such as Canada lynx and American marten (Fortin, 1996; Bourgeois, 1996).

3. Residential and Commercial Development

Expansion of urban areas is not considered a serious threat to wildlife movement in the area. However, this situation could change. The highway upgrade is likely to bring commercial and industrial development along it, thus increasing its footprint. Attractiveness of large lakes and major rivers rendered more accessible could increase concentrations of cottages, fishing lodges, and second homes along their shores. Roads and their surroundings are not necessarily barriers to its movement, though they can be when natural habitats either side of the road become developed or disturbed by human activities and when traffic is too dense (Fortin, 1996). Canada lynx, for instance, is wary of road traffic.

There are also other potential threats, listed below, which may increase fragmentation of the forested landscape. It is not clear how they impact connectivity in the area.

4. Recreational activities

All-terrain vehicles and snowmobiles are already very popular means of recreation in the Three Borders; supported by an extensive provincial, regional, and local trail network, this recreational activity represents almost 10% of tourism expenses in the Bas-Saint-Laurent region (Ministère des Ressources naturelles et de la Faune, 2010) and is likely to increase. The effects of motorized recreation on terrestrial wildlife are well documented (Naidoo and Burton, 2020).

5. Renewable Energy Development

There are no wind farms in the Three Borders at present, but the Bas-Saint-Laurent region presents high potential for the production of this type of renewable energy. At least five locations in its uplands host wind-measuring towers erected to assess potential wind energy (MRNF, 2010). Access roads to these infrastructures, often in otherwise remote and intact areas, can increase forest fragmentation.

6. Utility & Service Lines

Three major power lines cross the northeastern portion of the linkage, but no additional line development is planned in the short term (Hydro-Québec, 2011). Pipelines represent a higher risk. For the time being, this threat has been assessed as low since the TransCanada Pipeline project, which intended to move crude oil from Alberta's tar sands to New Brunswick via the Temiscouata Valley, has been abandoned. The construction of a pipeline would affect wildlife through the removal, alteration, and fragmentation of habitat, as well as noise, changing access and sightlines for predators, and the creation of barriers to movement (William, 2012).

GOVERNANCE

Institutional Culture and Function

In Québec, almost all connectivity projects are led by non-governmental organizations (NGOs and land trusts) that secure land within key corridors through land purchase, donation, or easements. A handful of municipalities have also included connectivity in their urban plans, including the Montreal Metropolitan Community, though it remains to be seen how successful these will be knowing that plans can easily be modified as administrations changes.

- Lessons learned: having local government include connectivity in their urban plan is going to be a huge challenge if there is no significant incentive for them to do so.
- Needs/suggestions going forward: The Three Borders project being in its early stage, there is no designated management authority yet. However, in the future, landownership implies that management will need to be addressed by an overarching organization comprised of representatives from the provincial government, Maliseet First Nation, land trusts, Québec's Ministry of Transportation (MTQ), municipalities, and landowners.

Legislation and Policy

No legislation or policy in Québec collectively contributes to biodiversity outcomes through provisions to keep habitat connected between parks and conserved areas, to restore degraded habitat in order to enhance connectivity, or to protect connectivity on landscapes and waterscapes. However, pressured by conservation organizations, some important actions took place in recent years suggesting that, in the face of ongoing habitat fragmentation and species range shifts caused by climate change, connectivity is gaining support.

Following on the 2011-2020 *Strategic Plan for Biodiversity* and its Aichi Targets (Convention on Biological Diversity, 2011), Québec's Ministry of Environment published governmental orientations for biodiversity (Minstère du Développement durable, de l'Environnement et de la lutte contre les changements climatiques, 2013). The document does mention that one of the most efficient means to maintain and restore functional ecosystems and increase ecological services is to establish ecological corridors. It acknowledges that creating a linkage network requires multiple partnerships with municipalities, conservation organizations, businesses, landowners, and ministries (MDDEFP, 2013). The Ministry of Environment also funded research on connectivity in the St. Lawrence Lowlands where remaining forest cover is less than 30 % (Gonzalez et al. 2014). The Québec Government's 2013-2030 *Strategy for Climate Change Adaptation* furthermore recognizes that protected

areas and managed ecosystems will need to be linked to maintain landscape scale connectivity and safeguard species' access to suitable habitats (MDDEP, 2012). However, there is no consideration yet for connectivity conservation in any of Québec's legislation that could influence land use planning and management.

In August 2016, Resolution 40-3, the *Resolution on Ecological Connectivity, Adaptation to Climate Change, and Biodiversity Conservation* was adopted at the 40th Annual Conference of New England Governors and Eastern Canadian Premiers. The Resolution recognizes the importance of ecological connectivity for the adaptability and resilience of ecosystems, biodiversity and human communities in the face of climate change. It also stresses the importance of working across borders to advance efforts to conserve and restore ecological connectivity (New England Governors/ Eastern Canada Premiers, 2016; St-Pierre et al. 2018). The implementation of this Resolution is ensured by a working group co-chaired by the governments of Québec and Vermont. Until 2020, the working group will focus its activities on promoting ecological connectivity actions. Outcomes have yet to be announced.

ENGAGEMENT, PARTNERSHIP, COLLABORATION AND TRUST

At a very early stage, it was recognized that the Three Borders had no local or regional organization to dedicate the efforts required to initiate a connectivity project in the area. 2C1Forest stepped in as project coordinator, raising funds and engaging partners in its implementation. At the outset, 2C1Forest teamed up with the Maine Chapter of TNC, the New Brunswick chapter of the Canadian Parks and Wilderness Society (CPAWS) and the Québec and Atlantic regional offices of NCC, with technical support from WCS Canada. Their shared goal was to develop, promote, and implement conservation strategies that conserve ecological connectivity in the Three Borders.

In accordance with 2C1Forest's own evaluation, NCC's overall assessment of threats suggested that connectivity in the area was highly threatened in the short term by the upgrade of Highway 85. Mitigating this threat became the top priority in its strategic conservation plan for the Three Borders. 2C1Forest took the lead with two main objectives:

1. Ensure that connectivity and wildlife crossing become a priority for the provincial and state transportation agencies; and,
2. Build the motivation, capacity, and knowledge base of organizations and agencies to promote connectivity conservation.

As early as 2009, 2C1Forest convened a small group of stakeholders from Québec, New Brunswick, and Maine with knowledge and interest in the Three Borders Linkage. With maps of the region, participants worked to identify important conservation areas and, based on local knowledge, the potential pathways for connectivity. The 2C1Forest project team used this information to draft a conceptual map illustrating potential corridors between large wildland blocks (Figure 2) for the whole the Three Borders Linkage area. This was used as a talking piece to communicate, raise awareness, and initiate discussions with stakeholders in all three jurisdictions.

The first steps towards starting a corridor project in this area are essentially those Keeley et al. (2018) describe. It started with a 2C1Forest coordinator meeting with the regional and national departments of the MTQ in 2013. Building on expertise gained from the Appalachian Corridor connectivity project in the Northern Green Mountains (Gratton, 2014; Corridor appalachien, 2019) and learnings from the Staying Connected Initiative (SCI), the case for wildlife crossing structures in this key linkage was made and very well received. The Staying Connected Initiative is a visionary partnership working to restore and enhance landscape connections for the benefit of people and wildlife across the Northern Appalachian/

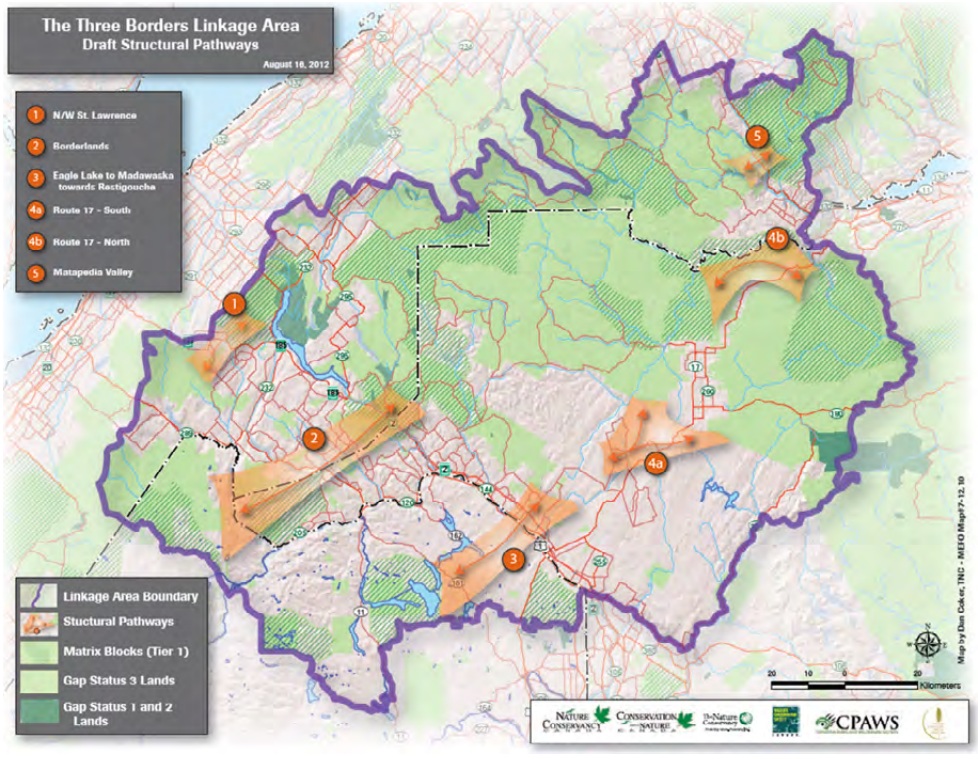


Figure 2. Potential pathways for connectivity in the Three Borders Linkage Area.

Acadian region of the eastern U.S. and Canada (see http://stayingconnectedinitiative.org/).

Other regional stakeholders were also individually met to be made aware of this initiative and gather their support. These included representatives from regional environmental and watershed groups, the regional private forests agency, NCC Québec, the regional department of Québec's Ministry of Forest, Wildlife and Parks (MFFP), the Lake-Témiscouata Provincial Park, and the Université du Québec à Rimouski (UQAR).

A meeting of all these groups was organized by 2C1F to improve their understanding of the need for and approach to connectivity conservation and discuss next steps. Highlighting the importance of regional leadership to promote and support this connectivity project, first outcomes included: NCC Québec offered to write a natural area conservation plan for the Québec portion of the Three Borders Linkage; the possibility of a research grant from the MTQ for a project to better understand large ungulate movement in the vicinity of Highway 85, improve measures to prevent vehicle collisions with moose and white-tailed deer, and facilitate wildlife movement. This meeting triggered several other meetings and discussions between stakeholders.

NCC-Québec published its *Three Borders Natural Area Conservation Plan* in 2014 (Gratton et al. 2014). The strategies within this plan were developed in collaboration with local groups and have guided conservation actions in the area up to now.

UQAR researcher, Dr. Martin-Hugues St-Laurent, professor in animal ecology, and 2C1Forest coordinator Louise Gratton drafted a proposal to the MTQ that was, after several revisions, accepted. The study was undertaken by a graduate student under the supervision of Dr. St-Laurent and a monitoring committee made up representatives from 2C1Forest, the MTQ as well as other regional government agencies, the Maliseet First Nation, environmental NGOs. The study aimed at developing a methodology to model and validate wildlife corridors as part of roadwork projects using the upgrade of Highway 85 as an example (Laliberté and St-Laurent, 2019). Recognizing that none of the existing groups in the Bas-Saint-Laurent had the mission and capacity to take on the project lead, a new conservation organization, Horizon Nature Bas-Saint-Laurent (HNBSL), was created with NCC and 2C1Forest acting as advisers.

- Lessons learned: Never underestimate the time it will take to get a buy-in from stakeholders, especially if you are an "outsider"; different social and cultural realities will influence how a project will unfold; keep an open mind.; listening to local communities' point of views and adapting accordingly your own objectives while aiming for the same overarching goals is key to the project's success.
- Needs/suggestions going forward: Starting a connectivity project and getting local stakeholders engaged is time consuming. Keeping them on board is even harder. For that to happen, connectivity project funds must include support for human resources to provide strategic planning, awareness activities, and communications with a broader public. Government funds for land protection often focus on land acquisition or easements. Tax incentives through the federal Ecogift Program are aimed at protecting "pristine" natural areas. However, for connectivity to happen, it may be required to protect managed forest land and restore degraded lands.

SPACE AND TIME

Spatial Context

The Three Borders area is located in the Northern Appalachian & Acadian Ecoregion. It sits entirely in the Temiscouata Hills/St. John Uplands-North subregion used in the ecoregional assessment done by Anderson et al. (2006). According to Québec's land classification system (MELCC), the Three Borders Natural Area encompasses the highlands of the Lower St. Lawrence Appalachian Complex natural region (A03) and a part of the Gaspé Peninsula natural region (A04) (MELCC, 2019).

The Three Borders straddles two administrative regions and four Regional County Municipalities (RCMs) (including 46 local municipalities), one First Nation territory, and 13 unorganized territories most of which are found in the foothills. Small towns and villages are established in valleys along rivers and major roads (routes 132, 185, and 289). The largest towns are Témiscouata-sur-le-Lac, Dégelis, and Pohénégamook. Public land represents 62% of the area; its proximity to inhabited areas makes it accessible and well used by local communities (e.g., for hunting, trapping, and recreation) who play an active role in land use and natural resources management, contributing to a strong sense of belonging to the region (Gratton et al. 2014).

Forest is at the heart of the Bas-Saint-Laurent region's economy; in 2005, logging and related activities employed more than 5,000 workers and represented 9% of the regional gross domestic product (GDP). Timber from private land accounts for 55% of the total volume harvested in the region. Wood supply taken from public forests is greatly influenced by US policies on timber exports and several businesses have turned to added-value products such as densified wood logs and composite panels (MRNF, 2010).

Agriculture is the second-most important economic sector in the Bas-Saint-Laurent region (6% of GDP). However, on the foothills of the Appalachians, topography and soils are not particularly favourable for growing crops and raising livestock and agriculture is predominantly linked to maple syrup production.

The backcountry wilderness offers great opportunities for outdoor activities and almost $7 million is spent annually in the region by outdoor enthusiasts and visitors (MRNF, 2010). Hunting, angling, and trapping represent together the third-most important industry in the Bas-Saint-Laurent. Salmon

rivers in the eastern part of the Bas-Saint-Laurent region and Gaspésie region within this Natural Area are world-renowned for angling. However, non-harvesting activities attract the largest number of outdoor enthusiasts in the region. Hiking, biking, snowmobile, and off-road vehicle trails are found mostly on public lands (Gratton et al. 2014).

Over the last ten years, the region has engaged in several approaches to diversify its economy including exploring its wind-energy potential as well the great opportunities that public lands offer for ecotourism.

Temporal Context

Land use planning and management is under the responsibility of RCMs and local municipalities on private land and the government of Québec on public land. As mentioned earlier, some municipalities in Québec independently took the initiative to include corridors in their land use planning and regulations. However, none of these are in the Three Borders.

PLANNING AND IMPLEMENTATION

The only "official" strategic plan is NCC's aforementioned *Natural Area Conservation Plan for the Three Borders* (Gratton et al. 2014). Its overarching vision, goals, objectives, and strategies important to connectivity are summarized below.

Vision statement: Internationally renowned for its healthy population of Atlantic salmon, the Three Borders Natural Area is also recognized as having protected and restored over time a functional linkage for wide-ranging species, key in maintaining connectivity in the Northern Appalachian & Acadian Ecoregion. The mixtures of temperate and boreal forests and numerous wetlands as well as the species they support, are adequately conserved in a network of protected areas. Through collaboration and mutual respect, landowners, conservation partners and stakeholders take pride in the rich cultural and natural heritage found in the Three Borders and economic development is driven by sustainable land use.

Goals relevant to connectivity are:

1. Protect sites key to the conservation of wildlife corridors to maintain functional ecological linkages between secured forests blocks as well as existing and future protected areas;
2. Promote sustainable use of resources and best practices on public and private land to protect wildlife corridor features;
3. Implement stewardship actions as well as biodiversity and ecological integrity monitoring programs in protected areas; and,
4. Strategies and objectives are referred in NCC's planning as conservation actions and classified according to the IUCN-CMP classification (IUCN-CMP, 2006b).

Of the 25 actions proposed, those met or partly met since its inception are:

1. Land/Water Protection
1.2 Resource & Habitat Protection
1.2.3 By the end of 2014, identify structural corridors for wide-ranging mammals between forest blocks and known key habitats.
4 Communications, Education & Awareness
4.3 Awareness & Communications
4.3.2 By 2019, disseminate information to the general public on biodiversity conservation issues and best management practice in the Natural Area (NA).
4.3.3 By 2019, attend at least one workshop per year organized by partner organizations regarding conservation issues in the NA.
6 Stewardship – Livelihood, Economic & Other Incentives
6.1 Linked Enterprise & Livelihood Alternatives
6.1.1 By 2019, attend at least five meetings with stakeholders involved in sustainable economic and tourism activities to evaluate and minimize the environmental impacts of such activities.
7 Philanthropy, Marketing and Capacity Building
7.2 Alliances & Partnerships
7.2.1 By the end 2015, build and strengthen partnerships with at least five conservation organizations and three government agencies working in the NA.
7.2.2 By 2019, build and strengthen partnership with universities and other institutions to identify research needs to better conserve biodiversity in the NA.
7.3 Conservation Finances
7.3.1 By 2019, raise funds to implement all conservation actions outlined in this NACP.

For lack of resources at NCC, implementation of the plan's actions related to site protection and management has been slow. However, the conservation plan did help 2C1Forest in successfully leveraging funds from private foundations towards three connectivity-specific actions. Regional and local connectivity analyses helped get a better grasp at potential structural corridors for wide-ranging mammals (moose and white-tailed deer) between forest blocks and known key habitats (action 1.2.3) (Morrison and Noseworthy, 2016; Raymond-Bourret and Nadeau, 2018). It also helped build and strengthen partnerships with local conservation organizations, government agencies and universities (actions 7.2.1 and 7.2.2).

NCC also received a large grant from the Fonds vert, as part of the Action-Climat Québec program of Québec's

Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques, resulting from their 2013-2020 *Climate Change Action Plan* (MDDEP, 2012). NCC's three-year project (2017-2020) targets ecological corridors specifically as a climate change adaptation strategy. To build a common vision for connectivity in southern Québec, the project is being deployed in partnership with seven other key organizations in five areas deemed critical for connectivity, including the Three Borders. NCC is also collaborating with more than 50 experts from various governmental and non-governmental organizations, research institutions, national parks, other land managers (including municipal and forestry representatives), and the public (NCC, 2018). Meetings with stakeholders raised awareness on the concept of connectivity and encouraged local communities to consider direct action to protect and restore ecological corridors as a climate change adaptation solution (actions 4. 3.2, 4.3.3, and 6.1.1). NCC's *2014-2019 Three Borders Conservation Plan* is due to be revised. The next iteration should be drafted in collaboration with Horizon Nature Bas-Saint-Laurent (HNBSL) and is bound to be more driven by "action on the ground".

Five years on, the overall project's outcome is that a first corridor within the Three Borders was identified by stakeholders and proposed for further action. It will link the Pohénégamook deer yard, Lake-Témiscouata provincial park, and Duchénier wildlife reserve. Its exact location still needs to be refined from connectivity analysis using existing data, location of current wildlife crossing structures, and ground-truthing.

- *Lessons learned:* Active communication and project planning between partners has helped think creatively about advancing the connectivity project through funding opportunities.
- *Needs and/or suggestions going forward:* Having funding programs aimed specifically at corridor conservation planning and monitoring. Continued scientific support is needed, specifically to assess crossing structures efficiency and best management practices on adjacent land to preserve their long-term use by wildlife.

Systems Planning

The MTQ is committed to engage in monitoring and evaluation the crossing structures already in place. It would be highly relevant that these activities be expanded beyond the structures themselves, their efficiency being also intrinsically linked to unobstructed access by wildlife. However, this would need to be recognized as key issue by the MTQ and other stakeholders. Funds to address monitoring and evaluation costs are rarely and more often nonexistent in actual funding opportunities.

Management Planning

Needs/suggestions going forward: It would be interesting to learn more about how multi-stakeholder corridors are managed elsewhere. More specifically, how to keep stakeholders' interest once wildlife crossings are in place. They are definitively a more attractive goal in the beginning steps towards achieving connectivity but ensuring that functional corridors and access to wildlife are maintained for the long term are key to the project's overall success.

Operations Planning

Next steps within a three-year timeframe include:

- Identify key land parcels by spring 2021 within in a 1-km buffer along the 100-km stretch of Highway 85 where wildlife crossings are found.
- Outreach to all of important private landowners completed by the end of 2022.
- Engage 30 landowners in land stewardship agreements (including signed voluntary agreements to land easements or donation) by the end 2023.
- Have all municipalities commit to include ecological corridors in their management and urban plans.

Have government adopt forestry practices that promote and maintain connectivity on public lands. Thanks to funds granted by private and public foundations, most of these short-term goals will undoubtedly be achieved. However, in the case of most landscape scale conservation projects, full completion relies on stakeholders' long-term commitment that can span over several decades.

KNOWLEDGE

Knowledge Management

Many local, regional, and national connectivity plans exist but implementation has been slow (Keeley et al. 2018). In Québec, only the Appalachian Corridor (Corridor appalachien, 2019) in the Northern Green Mountains of southern Québec and the Forillon Corridor at the tip of the Gaspé Peninsula (Pelletier-Gilbert and Breich, 2009) have significantly engaged in securing land parcels in linkages. The failure to translate connectivity research and scientifically informed plans into conservation actions is referred to as the research-implementation gap or planning-implementation gap (Keeley et al. 2018). In more populated areas, development pressure and land costs are even more of a hindrance to implementation.

In the Three Borders, the highway upgrade project provided early impetus to help guide connectivity conservation. As mentioned earlier, concerns about its impact on connectivity triggered several actions for mitigation. First and foremost, the grant by the MTQ to UQAR'S researchers helped identify the main factors influencing the spatiotemporal distribution of vehicle collisions with moose and white-tailed deer and develop appropriate location and mitigation measures to limit the risk of wildlife-vehicle collisions and maintain connectivity. Habitat quality indexes were developed specifically for the Bas-Saint-Laurent that boosts one the highest density of moose in Québec to better inform connectivity analysis done with Circuitscape

(Laliberté and St-Laurent 2019). The MTQ used this analysis to integrate a total of 22 wildlife crossings structures along the 100-km stretch of upgraded highway, 8 for large mammals and 14 for small and medium size mammals (Figures 3 and 4). Once road construction is completed, fences will be installed to channel wildlife movement towards the underpasses. Monitoring of crossing structures efficiency is planned by the MTQ.

Figure 3. Shelved culvert for small to medium size mammals on Highway 85 (Credit: Ministère des Transports du Québec).

Figure 4. Multispecies underpasses on Highway 85. (Credit Ministère des Transports du Québec).

Results from all the relevant data and connectivity analyses generated by the research project were shared with NGOs, including the regional Private Forests Agency that produced the first comprehensive connectivity analysis for the whole Bas-Saint-Laurent region (Raymond-Bourret and Nadeau, 2018).

2C1Forest and local partner organizations convened a small group of stakeholders with knowledge and interest in the Three Borders. With maps of the region, participants worked to identify important conservation areas and, based on local knowledge, the potential pathways for connectivity. This was followed by two separate workshops, organized by HNBSL and conducted by a professional moderator as part of the NCC's Action-Climat project, where a larger group of local stakeholders shared their knowledge and intrinsic values of the Three Borders area.

Data and information gathered through research, analysis and workshops engaging the community will form the bases for mapping, designing and planning the implementation of a first corridor either side of Highway 185 connecting the Pohénégamook deer yard and the Lake-Témiscouata provincial park. Funding to achieve this is already partly secured.

There has been no assessment of ecological goods and services, or social/cultural research in support of effective biodiversity outcomes related to the Three Borders project. It is too early for ecological and social monitoring program to be established for functional connectivity to be confirmed.

Lessons learned: The participation of land use planners, local elected officials, and public forest managers was instrumental to the workshops' success and enhanced the feeling that all stakeholders could work together to maintain connectivity.

Needs/suggestions going forward: A better understanding of the social and economic impacts for the corridor's establishment would benefit the project's implementation strategy. Funding for this analysis by the same sources that supported the project is unlikely, their general scope of interest being focused on wildlife conservation issues.

Knowledge Exchange

During the period that spanned the research project, the monitoring committee was informed of project advancement, results and their integration to support decision-making by the MTQ. Public bulletins were shared with the community and researchers were invited to share their findings at several public venues outside the regular monitoring committee meetings. The researchers also published papers in scientific journals.

The final report from the research team to the MTQ was shared with committee members. Once the MTQ will make its mitigation plan public, social media and outreach program will unfold to gain support for the corridor project. No formal training was offered to local practitioners. They rely on 2C1Forest coordinator and NCC's project manager and science coordinator as advisors.

- *Lessons learned:* Up to now, the project moved forward thanks to a handful of individuals. Unless there is a more active engagement (funds, resources, etc.) from local, regional, and national institutions and agencies, its implementation will be challenging.
- *Needs/suggestions going forward:* It is strongly recommended that organization and institutions

engage more earnestly with the Staying Connected Initiative as it offers a vast knowledge base from its multiple partners. Again, limited financial resources often prevent small organizations' participation.

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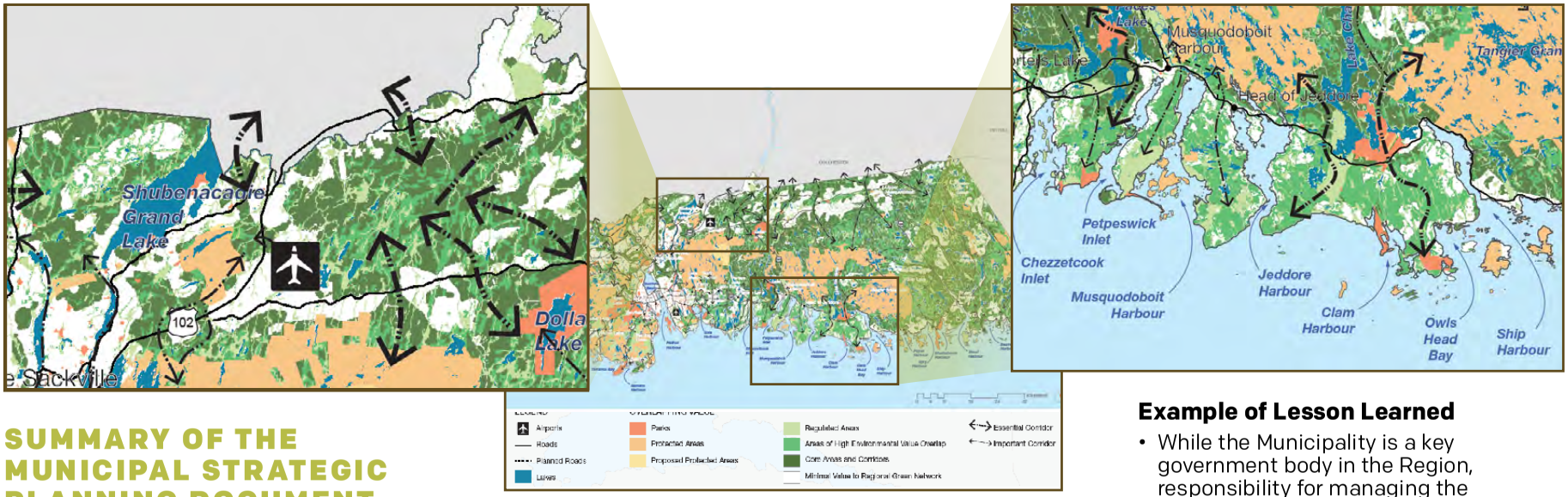
CHAPTER 3i

Halifax Green Network Plan

Ben Sivak, *Community Policy Program Manager, Halifax Regional Municipality*

HALIFAX GREEN NETWORK PLAN (HGNP), 2018

BEN SIVAK, COMMUNITY POLICY PROGRAM MANAGER, HALIFAX REGIONAL MUNICIPALITY



SUMMARY OF THE MUNICIPAL STRATEGIC PLANNING DOCUMENT

- The HGNP defines an interconnected open space system for the entire municipality, highlights ecosystem functions and benefits, and outlines strategies to manage open space.
- The HGNP provides land management and community design direction to:
  - Maintain ecologically and culturally important land and aquatic systems.
  - Promote the sustainable use of natural resources and economically important open spaces.
  - Identify, define and plan land suited for parks and corridors.

LEGISLATIVE CONTEXT

- Halifax Regional Municipality Charter (Statutes of Nova Scotia 2008)
- Regional Plan (2014-2031) (City of Halifax, 2014)
- Municipal Planning Strategies and Land Use Bylaws
- Priorities Plans

PLAN IMPLEMENTATION

- 79 actions to support the plan's vision, goals and objectives:
- 27 actions provide immediate and on-going direction to municipal operations and decisions.
- 52 actions associated with short (1-2 year), medium (2-4 year) and long (4-7 year) timelines.

Example of Lesson Learned

- While the Municipality is a key government body in the Region, responsibility for managing the environment is shared between multiple levels of government, and therefore the cultivation of partnerships is important to carrying out many of the objectives identified in the HGNP.

Example of Recommendation

- Enhance engagement with First Nations and other underrepresented groups in the long-term planning process.

FIVE MANAGEMENT PLAN THEMES

- Key objectives and actions in the final HGNP are organized according to five theme areas: Ecology, Working Landscapes, Community Shaping, Outdoor Recreation, and Cultural Landscapes.

INTRODUCTION

The Halifax Green Network Plan (HGNP) is a municipal strategic planning document that defines an interconnected open space system for the entire municipality, highlights ecosystem functions and benefits, and outlines strategies to manage open space (HRM, 2018). Specifically, the HGNP provides land management and community design direction to:

- maintain ecologically and culturally important land and aquatic systems;
- promote the sustainable use of natural resources and economically important open spaces; and,
- identify, define, and plan land suited for parks and corridors.

Halifax Regional Council approved the HGNP in 2018 and provided direction to use it as a framework for amending the existing Regional Plan and Secondary Planning Strategies. As part of its approval, Council also provided direction to carry out the actions contained in the HGNP through the multi-year budgeting and business planning process. The following sections review the Halifax Regional Municipality (HRM) context, the HGNP planning process, key HGNP actions, implementation tools, and lessons learned. The full HGNP and related reports can be found at: https://www.halifax.ca/about-halifax/regional-community-planning/community-plans/halifax-green-network-plan

HALIFAX REGIONAL MUNICIPALITY CONTEXT

The Halifax Regional Municipality (HRM) is located in Nova Scotia and is Atlantic Canada's largest urban centre. With a population of 403,131 (2016 census), the HRM represents approximately 44% of the total Nova Scotia population (Statistic Canada, 2016). At 5,490 km^2, HRM is also one of the largest municipal jurisdictions in Canada, comparable in size to Prince Edward Island.

HRM includes a broad range of land cover types, with extensive urban development in and around Halifax Harbour, giving way to expanding suburban and exurban residential areas, farms, and forest. HRM has substantial areas of undeveloped lands covered by large patches of Acadian forest, interspersed with wetlands and rock barrens. The underlying physical geography together with historical natural disturbances including major storm events, have created a mosaic of varying cover types and age classes. Remnants of old growth forest are found in isolated stands throughout the area. An extensive network of rivers, streams, and lakes is found in the region, and most areas are within a short distance of riparian vegetation. The extensive coastline provides many important and unique habitats, producing a highly diverse set of local upland and lowland ecosystems.

Most of HRM has underlying soils of low agricultural productivity (State of the Landscape Report, 2015). The exception is the Musquodoboit Valley, consisting of soils appropriate for arable agriculture and having the majority

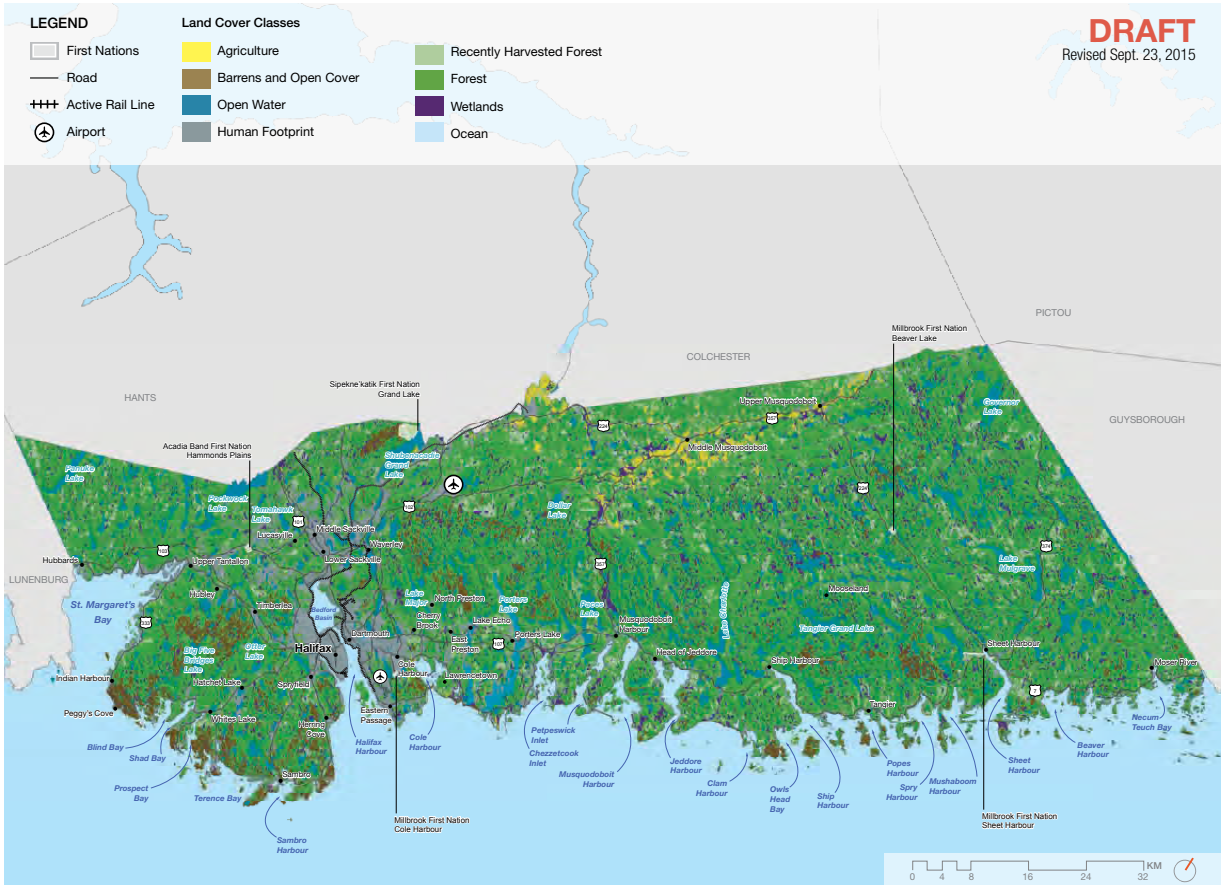


Figure 1. Land cover in the Halifax Regional Municipality.

of farms in the region. The low productivity of HRM soils also restricts the productive forest land base and limits the amount of commercial logging and small-scale private woodlots found throughout the region.

GOVERNANCE

HRM is a single tier municipal level government (i.e., no sub levels of local government) that contains a mosaic of public and private lands. The federal and provincial governments and HRM are all involved to varying degrees in managing lands and water, harvesting and extracting natural resources, economic development, and reviewing environmental impacts.

Federal Government

In the HRM, federal lands and properties are mostly connected to responsibilities and jurisdiction in defence, marine fisheries (wharves and harbours), marine transportation and navigation (lighthouses and beacons), national transportation infrastructure (Stanfield Airport, Port of Halifax) national historic sites and heritage properties (the Citadel, Halifax Harbour forts and Point Pleasant Park), coastal waters up to the high water mark (with the exception of a few water lots), Aboriginal Affairs (lands occupied by First Nations), and some harbour islands (e.g., McNabs, Georges, Devil's Island). With the exception of national historic sites, there are no other national parks or wildlife areas in HRM and most federal properties have a defence, administrative, or navigational function.

Provincial Government

The provincial government is responsible for managing many aspects of the landscapes found in HRM, including:

- management of forest resources on Crown lands and the regulations that apply to private wood lots;
- mining and aggregate extraction;
- protection of drinking water and the requirement for municipal water utilities to prepare source water protection plans;
- water bodies and wetland protection;
- provincial parks and protected areas;
- regional transportation networks;
- aquaculture; and
- wildlife and biodiversity.

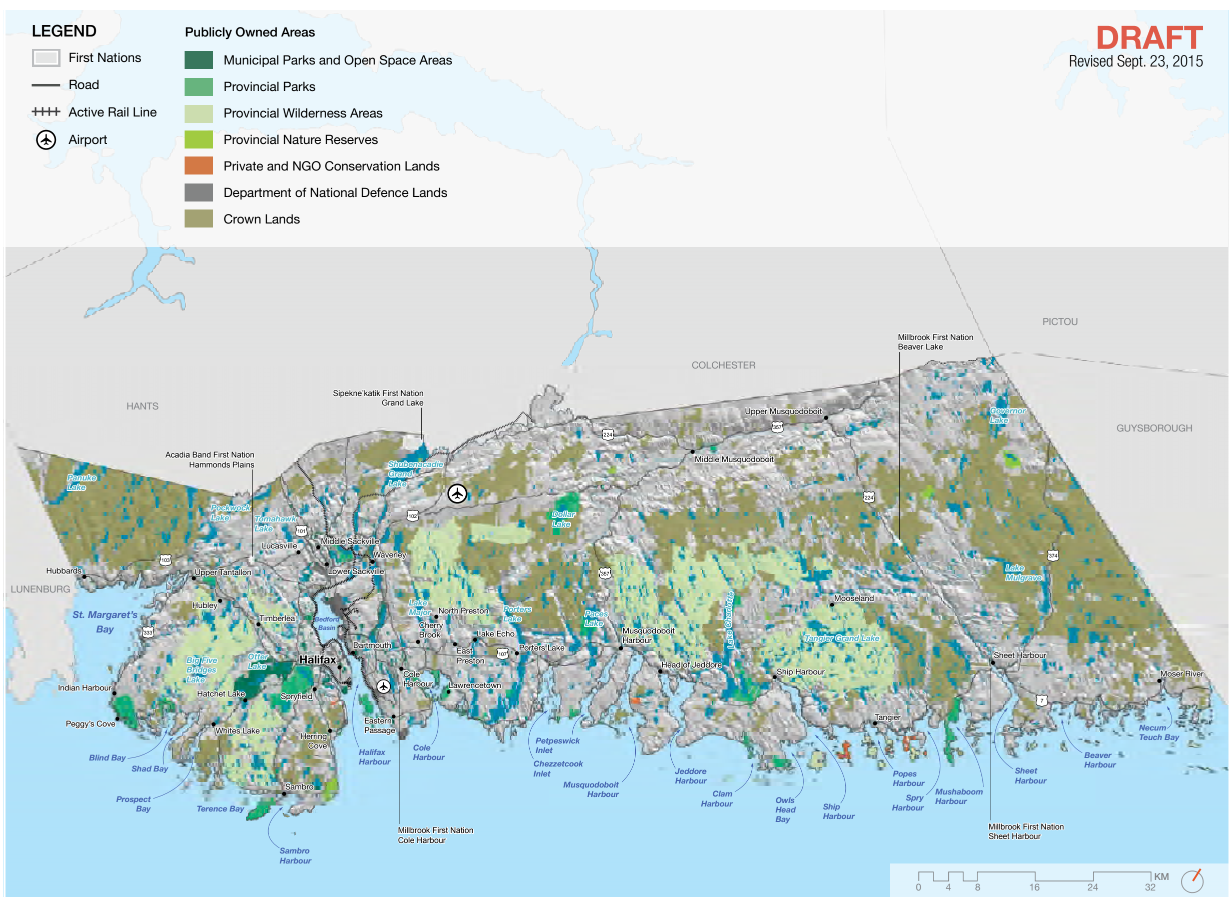


Figure 2. Public lands in the Halifax Regional Municipality.

Halifax Regional Municipality (HRM)

The following highlights the key legislation and municipal plans related to the HGNP.

The Halifax Regional Municipality Charter

The Halifax Regional Municipality Charter is a provincial statute that grants the municipality broad authority and tools to enact municipal policies and regulations. Important provisions that enable integrated open space planning and management include the power to control land subdivision, use, and development. The charter also enables the municipality to acquire open spaces through the subdivision process or purchase.

Regional Plan (2014)

The Regional Plan is a municipal planning strategy that provides policies that direct how the HRM will develop and grow between 2014 and 2031 (Regional Municipal Planning Strategy, 2014). It identifies open space planning and land management as a regional priority and provided overarching guidance for the development of the HGNP. The HGNP aligns with the Regional Plan and advances multiple guiding principles, including:

- Support development patterns that promote a vigorous regional economy;
- Preserve and promote the sustainability of cultural, historical and natural assets;
- Manage development to make the most effective use of land, energy, infrastructure, public service and facilities, and foster healthy lifestyles; and,
- Ensure opportunities for the protection of open spaces, wilderness areas, natural beauty, and sensitive environmental areas.

Municipal Planning Strategies and Land Use By-laws

Municipal planning strategies and land use by-laws provide comprehensive planning policy and regulations for each of the 22 Community Plan Areas in the HRM, including specific direction and procedures to guide land use and open space development. The HGNP informs future updates to these plans and by-laws by delineating valued landscapes to protect from development and providing guidance for the creation of open spaces throughout the HRM.

Priorities Plans

Priorities Plans are inter-department strategic plans that provide direction to implement the policies of the Regional Plan. Several existing Priorities Plans related to HGNP include the Active Transportation Priorities Plan (2014), the Urban Forest Master Plan (2012), the Community Facilities Master Plan 2 (2016), and the Integrated Mobility Plan (2017).

HGNP Planning Process

The HGNP was developed in the following three phases.

Phase 1: Foundations (started in Spring 2015 completed in Winter 2016)

Objective: To understand what we have, what we value, and where we want to go.

Outcomes:

- State of the Landscape Report (2015), which reviewed the Region's current open space assets, strengths and challenges, and included an ecological connectivity analysis;
- Phase 1 "What We Heard" Engagement Report (2015), which summarized all public feedback received during Phase 1; and,
- Cultural Landscapes Framework Report (2016), which conducted a preliminary assessment of the Region's cultural landscapes.

Phase 2: Planning Directions (started in Winter 2016, completed in Winter 2017)

Objective: To understand landscape impacts and detailed ecological assessment, refine open space network scenarios and options, and develop planning and implementation directions.

Outcomes:

- Phase 2 "What We Heard" Engagement Report (2016), which summarized all public feedback received during Phase 2; and
- Halifax Green Network Plan Primer (2017), which provides preliminary policy direction for the final plan for public and stakeholder discussion and feedback.

Phase 3: Final Plan (started in Winter 2017, completed in Summer 2018)

Objective: To adopt a final priorities plan that guides Municipal decisions and actions related to land use planning, park network management, project work and partnerships, among other initiatives.

Outcomes:

- Final Halifax Green Network Plan, which contains detailed objectives and actions; and
- Phase 3 "What We Heard" Engagement Report (2018), which summarizes the feedback received on the primer report.

PUBLIC AND STAKEHOLDER ENGAGEMENT

The three phases of region-wide community and stakeholder engagement were conducted between May 2015 and June 2017. Engagement efforts included 26 open houses, 11 stakeholder workshops, surveys, and the use of an interactive mapping tool. In total, participants provided over 10,000 comments, as well as 1,051 'push pins' on the interactive map, indicating places of natural or cultural value.

While preparing the final HGNP, staff also consulted key stakeholders on items related to their area of expertise including consultations with Halifax Water, Our HRM Alliance, Fisheries and Oceans Canada, Nova Scotia Environment, the Nova Scotia Department of Natural Resource, and the Nova Scotia Department of Transportation and Infrastructure Renewal. The input received from residents, community and industry groups, and provincial government departments through all phases of the project meaningfully contributed to the development of the HGNP. The following summarizes key messages related to the HGNP theme areas.

Ecology

Participants emphasized that diverse and healthy ecosystems provide a series of important services and benefits, such as provision (e.g., water, food, fiber), regulation (e.g., climate, water), and support for natural and built environments (e.g., habitats, water quality).

Working Landscapes

Participants acknowledged that working landscapes provide important economic development opportunities, while also emphasizing the importance of protecting viable ecosystems in the long term. They also advocated for the preservation of traditional land uses, food security, and the ongoing viability of rural communities, which all depend on thriving working landscapes.

Community Shaping

Participants indicated that parks and open spaces contribute to a unique sense of place and help shape community identity and form.

Outdoor Recreation

Participants emphasized the importance of connected parks, wilderness areas, and trails to provide a range of recreational and active transportation opportunities close to communities. This will help promote active lifestyles, contribute positively to quality of life, and stimulate economic investment.

Figure 3. Halifax Green Network Plan engagement.

Cultural Landscapes

Participants emphasized that cultural landscapes, including their historical context and land uses, provide the foundation for a community's sense of place and identity.

HGNP KEY HIGHLIGHTS

Overall, the HGNP shows that the HRM has a remarkably diverse range of ecosystems and intact system of green spaces compared to other city regions. While the HGNP identifies areas for improvement, fortunately, the direction contained in the HGNP is able to build on HRM's existing assets and policy context. The following highlights key objectives and actions contained in the final HGNP according to the plan's five theme areas: 1) Ecology; 2) Working Landscapes; 3) Community Shaping; 4) Outdoor Recreation; and, 5) Cultural Landscapes.

Ecology

The landscape of the HRM contains a diverse range of ecosystems including Acadian forests, rock barrens, wetlands, and coastal areas. Remnants of old growth forest are found in isolated stands and an extensive network of rivers, streams and lakes means that most areas are within a short distance of riparian vegetation. (State of the Landscape Report, 2015) These ecosystems provide important wildlife habitats for deer, migrating shorebirds, a variety of Species at Risk. As well, they create and deliver critical ecosystem services, such as providing a reliable supply of fresh drinking water and managing stormwater runoff. Managing these areas requires balancing ecological integrity with human activity to ensure that key areas are protected and the benefits of natural ecosystems are maintained.

Goal: To support a healthy and sustainable natural ecosystem.

Key Highlights:

- adopt the HGNP Ecology Map in the Regional Plan;
- consolidate and apply environmental protection zones to large wetland complexes and vulnerable land forms;
- refine and strengthen existing variable watercourse buffering requirements;
- support naturalized approaches to storm water management; and,
- request an amendment to the *HRM Charter* to enable the Municipality to acquire environmental reserves through the subdivision and development process, in addition to parkland dedication requirements.

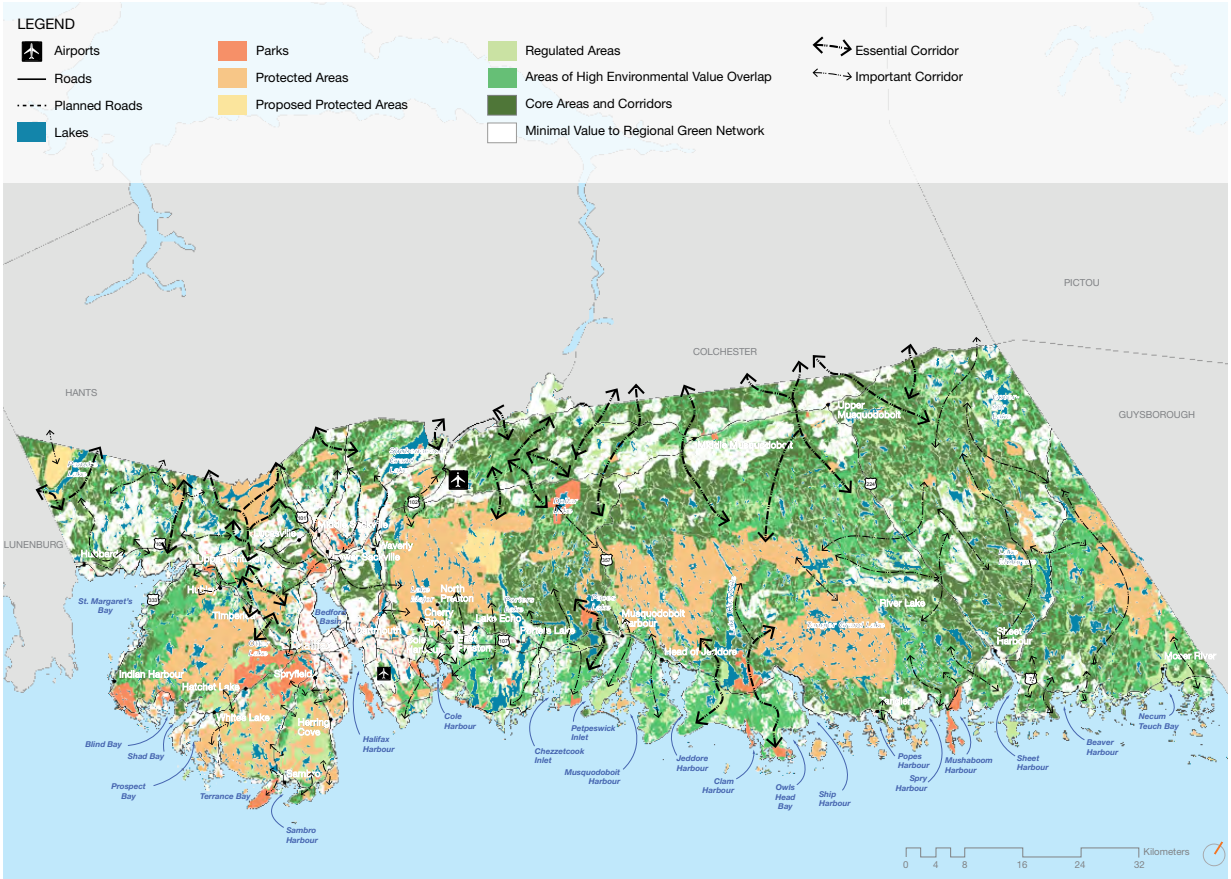


Figure 4. Halifax Green Network ecology map.

Working Landscapes

Working landscapes are open spaces that support economic activity, such as resource extraction (e.g., mining, forestry), agriculture, and tourism. These industries are important components of the HRM's economy, especially in rural areas, and provide local resources for the Region's food, construction and manufacturing sectors. Well-managed working landscapes enable private landowners to benefit from their land holdings while contributing to ecological connectivity and/or wildlife habitat at the broader landscape scale.

Goal: To support the sustainable use and management of the Region's natural resources.

Key Highlights:

- provide greater as-of-right opportunities for primary resource industries;
- limit or prohibit conservation design developments in the Regional Plan's Agricultural Designation; and
- relax restrictions on tourism related home-based businesses in rural areas and consider large scale rural-based tourism proposals by rezoning or development agreement, where not already permitted.

Community Shaping

Open spaces shape communities and contribute to a sense of place. By considering the Green Network, valued open spaces can help establish clear community edges, natural connections, and focal points, while contributing to the health and sustainability of neighbourhoods.

Goal: Use the Green Network to guide the growth and development of communities.

Key Highlights:

- consider the Green Network when reviewing and considering changes to the Urban Service Area, the Urban Settlement Designation, and Urban Reserve Designation;
- prioritize the development of brownfield and infill sites over greenfield development areas;
- prioritize the preservation and creation of natural connections to the Chebucto Peninsula; and,
- streamline development approval processes within clearly defined rural centres, while carefully controlling the scale and design of conservation design development proposals in areas located between these rural centres.

Outdoor Recreation

Most outdoor recreation in the HRM takes place in the diverse network of public parks. These parks can be described as important parcels of land, defined by natural and human influences, that welcome people of all ages and abilities into its public realm to play, reflect, and share their experiences.

Goal: Manage a municipal park network that meets the outdoor recreation needs of residents and visitors, supports ecological and cultural conservation, and shapes community form and identity.

Key Highlights:

- promote the importance of parks for community health and well-being through improved communications and engagement and by accommodating all ages and abilities;
- establish a Park Spectrum that captures the range of user experiences and supports both recreation and natural systems and includes national and provincial parks and school grounds;
- evaluate service delivery gaps and overlap;
- use the land capability tool, included in the HGNP, to evaluate existing and proposed parks;
- establish an Open Space Network in cooperation with provincial and federal governments and conservation groups;
- continue to place emphasis on establishing the regional parks identified in the Regional Plan, while recognize new nature parks and open space areas; and,
- request an amendment to the *HRM Charter* to enable the municipality to establish parkland dedication requirements based on residential density.

Figure 5. Halifax's Park Spectrum.

Cultural Landscapes

The landscape of the HRM is characterized by a complex history of human habitation dating back over 10,000 years (Cultural Landscape Framework Study, 2016). Cultural Landscapes reflect the interaction between people and nature over time and include landscapes that have been created, used, modified, or protected – from historic gardens to heritage conservation districts, from streetscapes to scenic views.

Goal: Identify, preserve and celebrate cultural landscapes and their value in connecting people to the land and telling their stories.

Key Highlights:

- develop a cultural landscape program through the Culture and Heritage Priorities Plan (CHPP);
- clarify the scope and role of cultural landscapes studies as part of master planning exercises; and,
- proactively engage underrepresented groups to identify valued cultural landscapes.

Implementation

The HGNP includes direction to carry out 79 actions needed to effectively support the Plan's vision, goals, and objectives. Out of these 79 actions, 52 actions are associated with short (1-2 year), medium (2-4 year), and/or long (4-7 year) timelines; the remaining 27 actions provide immediate and on-going direction to municipal operations and decisions. The following describes the HGNP implementation tools together with progress updates dated to September 2019.

Land Use Planning

The Municipality has adopted a number of land use policy and regulatory documents, including the Regional Plan, the Regional Subdivision By-law, secondary plans and land use by-laws, that control development on privately-owned land. Together, these documents, among many other matters, regulate the location, shape and form of development including if and where new public roads can be constructed, the design and density of new development, parkland dedication requirements and watercourse setbacks. The HGNP recommends 27 actions that provide guidance and specific instructions on how to amend these planning documents through future project work.

As set out in the HGNP, the majority of recommended planning policy/regulatory changes will be implemented through the next Regional Plan review and Plan and By-law Simplification Program over the next 2-7 years. The following highlights the progress being made on updating various land use planning documents:

- As part of the 2019/20 budget process, Council approved a new Planner III position in Planning and Development to coordinate the implementation of the HGNP. This staff resource will be key to ensuring that the HGNP land use planning direction is carried forward into the upcoming Regional Plan Review and on-going Plan and By-law Simplification Program.
- As directed by Council in August 2018, HRM staff prepared a near-term amendment to the Regional Plan, prior to the next Regional Plan Review, by referencing the HGNP within the conservation design development agreement policy criteria concerning the connectivity of open space.
- The Centre Plan Package A (Secondary Planning Strategy), approved by Regional Council on September 17, 2019, includes new landscaping and open space policies that support the HGNP direction (Regional Centre Secondary Municipal Planning Strategy and Land Use By-law, 2019).

Park Network Management

As the Municipality moves forward, there are a number of action items specific to the management of municipal parkland that support the goals and objectives set out in the HGNP. Initiatives range from changing policies regarding parkland dedication and how recreation service is delivered to promoting parks and open space for health and wellness, and having a formalized public engagement program. The HGNP contains 22 actions related to park network management. The following highlights the progress being made on aligning HRM's park network management activities with the HGNP:

- Federal 'Quickstart' funding was acquired to help with municipal land acquisitions for the establishment of the Blue Mountain Birch Cove Wilderness Park. A federal funding application to help with additional land acquisitions has been submitted.
- In partnership with the Nature Conservancy of Canada, the Municipality acquired 379 acres of lands to establish the Shaw Wilderness Park in the Williams Lake area.
- In 2019, the Municipality acquired a property that connected existing municipal parcels within Sir Sanford Fleming Park and was required to maintain parkland service including uses for nature walks, interpretation, and appreciation.
- The promotion of being active in outdoor green spaces for improved health has been bolstered through the expansion of programming and training offered through the Adventure Earth Centre, a pilot playbox at Aberdeen Court Park, and the development of factsheets about the health benefits of being in nature and physical literacy.
- In January 2019, Regional Council approved the direction contained in a staff report on park naturalization. A multi-business unit working group has since been established that is in the process of choosing a pilot site and HRM's website now hosts a

landing page for the initiative: https://www.halifax.ca/recreation/parks-trails-gardens/park-naturalization

- There are four significant park plans underway (Halifax Common, Gorsebrook Park, Eastern Passage Common, Lake Echo District Park), which incorporate numerous HGNP actions including having versatile flexible space for all ages and abilities, year-round infrastructure, naturalized areas and green infrastructure, and the celebration of public art and cultural landscapes.

Figure 6. Park Naturalization.

Current and Future Project Work

The Municipality is continually carrying out project work on a wide variety of items, from considering the development of new municipal business parks to reviewing corporate policies and by-laws. A number of the actions contained in the HGNP guide current and future project work. Some projects may lead to strategic investments, programs, policies or regulations. The HGNP recommends 16 actions that guide current and future project work. The following highlights how the HGNP direction is being incorporated into project work:

- The HGNP data was published for public use through HRM's Open Data portal in fall 2019.
- Several active transportation initiatives linking outdoor recreation amenities have been completed or are underway, such as the completion of the Sackville Greenway between Glendale and Sackville Drive; construction of the Bissett Greenway connection to the Rehab parkland; and, planning around a missing link in the Trans Canada Trail between Sullivan's Pond and the Dartmouth Waterfront.
- A staff report concerning a potential private tree by-law to manage the removal of trees on private property within serviced (urban) areas is being drafted and is targeted to be presented to Regional Council in 2021.
- The HGNP direction concerning cultural landscapes is being advanced through the on-going development of the Culture and Heritage Priorities Plan: https://www.halifax.ca/about-halifax/regional-community-planning/regional-plan/sharing-our-stories

PARTNERSHIPS

While the Municipality is a key government body in the Region, responsibility for managing the environment is shared between multiple levels of government, including Nova Scotia Environment and the Provincial Department of Natural Resources. Universities, non-profits, and community groups also bring valuable expertise, information, and resources to conservation efforts. Private landowners play an integral role in stewarding natural resources and investing in sustainable development approaches. The cultivation of partnerships, therefore, is important to carrying out many of the objectives identified in this Plan. The HGNP identifies 14 partnership opportunities. The following highlights the progress being made in fostering partnerships:

- In late 2018, Regional Council, through a letter from HRM's Mayor Savage, formally requested that the Province amend the *Halifax Regional Municipality Charter* to: 1) enable the Municipality to acquire sensitive environmental lands (e.g., riparian areas, wetlands, steep slopes) as an environmental reserve through the land development and subdivision process; and 2) enable the ability to enact parkland dedication requirements based on population density to address development that does not include the subdivision of land. A letter from Minister of Municipal Affairs Chuck Porter confirming receipt and future follow up by provincial staff was received in February 2019.
- As outlined under the land use planning section, Council recently approved a new Planner III position in Planning and Development to coordinate the implementation of the HGNP. This staff resource will be key to proactively fostering research and HGNP-related partnerships.
- A new by-law concerning storm water management that promotes the use of low-impact design approaches was developed in close consultation with Halifax Water and Nova Scotia Environment and approved by Regional Council in September, 2020.
- In April 2019, Municipal staff attended and presented the HGNP at the Canadian Maritimes Ecological Connectivity conference held at Dalhousie University.
- Staff are participating in the Habitat Conservation Strategy for Nova Scotia (St. Margaret's Bay to Cape Breton).

LESSONS LEARNED

The HGNP was approved by Halifax Regional Council in August 2018 and there are many actions still to be implemented in the coming years. Nevertheless, the plans development and early implementation highlight several lessons learned.

Engagement with First Nations and other Underrepresented Groups

The HGNP planning process included three phases of public and stakeholder engagement across HRM's diverse urban and urban rural communities. Unfortunately, however, this engagement did not meaningfully engage with the Region's Mi'kmaq communities or specifically with HRM's historically underrepresented groups (African Nova Scotian, Acadian and immigrant communities). While this lack of targeted engagement is regrettable, several new initiatives are attempting to build positive working relationship that can support the HGNP implementation, including:

- the creation of an HRM Mi'kmaq advisor position to assist in establishing working relationships and engagement protocols with the Region's various Mi'kmaq communities; and,
- targeted engagement efforts with historical underrepresented groups that are currently being carried out through the Culture and Heritage Priorities Plan.

Chebucto Peninsula

While the HGNP shows that the HRM has a remarkably diverse and intact system of green spaces, the project found that the Chebucto Peninsula is largely disconnected from the mainland by Highway 103 and the associated expansion of both urban and rural settlements. This development has created a barrier to wildlife movement (HGNP, 2018). The planned development of Highway 113, together with the multiple areas planned for future urban development, may eliminate the few remaining natural corridors between the peninsula and the mainland. If concerted efforts are not undertaken to mitigate and avoid impacts to landscape connectivity, the functioning of the Chebucto Peninsula for wildlife and overall ecological health will be severely compromised.

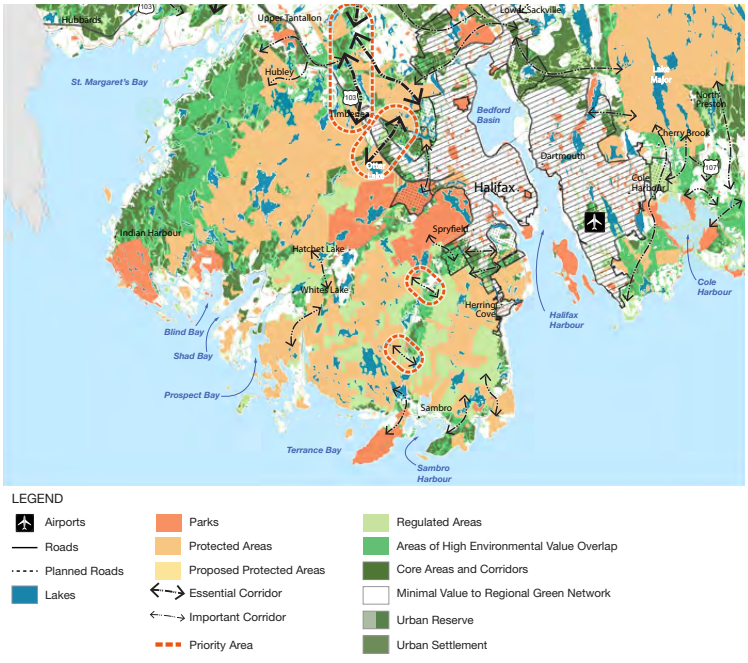


Figure 7. The Chebucto Peninsula part of the Halifax Green Network.

Dedicated Resources for Implementation

Preparing the HGNP required significant resources. However, once the Plan was complete, there was limited staff resources available to implement the HGNP directions. To address resourcing concerns, Council recently approved a new Planner III position in Planning and Development to coordinate the implementation of the HGNP. This staff resource will be key to ensuring the HGNP is incorporated into planning project work and to proactively fostering research and HGNP-related partnerships with the province, conservation groups, and local universities.

Importance of Partnerships

While the Municipality is a key government body in the Region, responsibility for managing the environment is shared between multiple levels of government. The cultivation of partnerships, therefore, is important to carrying out many of the objectives identified in the HGNP.

In addition, while the HGNP project compiled a wide variety of information, the municipality does not currently have the capacity or expertise to identify key indicators or collect and interpret ecological information on a regular basis. Thankfully, the HRM contains several universities and non-profit organizations that specialize in wildlife and ecosystem science. The province also monitors information on the health of the environment and support the protection and sustainable use of Crown lands. Consequently, partnerships will be essential to monitoring the heath of the HRM's environment and the impact of the municipality's focus on land use planning and park network management.

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Sahtú, Northwest Territories (Photo by Jean Polfus)

CHAPTER 3j

The Sahtú Land Use Plan

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THE SAHTU LAND USE PLAN (SLUP) FOR THE SAHTU SETTLEMENT AREA (SSA)

HEIDI WIEBE, HEIDI R. WIEBE CONSULTING LTD., YELLOWKNIFE, NT

Example of Lesson Learned

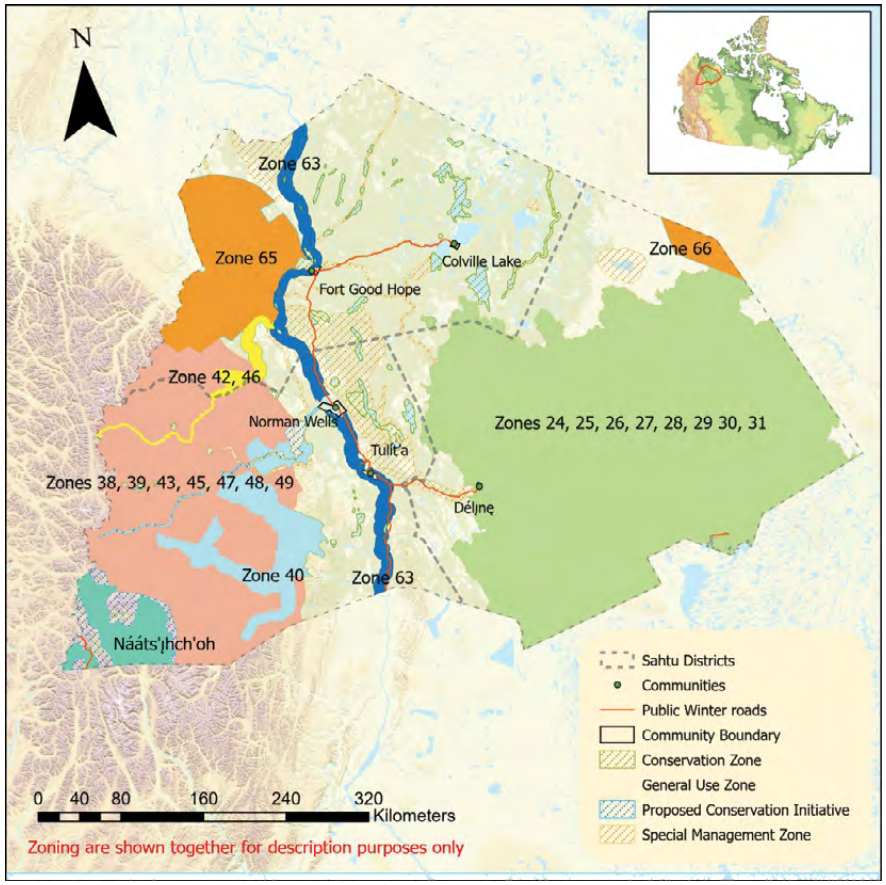
- Land use planning is a community-driven process, with the key direction for planning decisions and content coming from deep engagement with the Sahtu communities.

Example of Recommendation

- Develop methods to better monitor implementation of the plan.

SUMMARY

- Water is a key value in the SSA.
- Protected and conserved areas are connected by dominant rivers, lakes, and wetlands.
- Land use plans are legally binding documents, established under land claim agreements, with the authority to restrict development as specified in the plan.
- Land use plans are generally comprehensive and tackle a range of land uses and issues.



Connected Zones map
prepared by the Government of the NT, 2020)

The Mackenzie River (Zone 63): A Special Management Zone (SMZ) protecting the river and its values throughout the region.

Mackenzie Mountains (Zone 38): An SMZ providing a buffer and additional protective measures for species and values unique to the mountains for several Conservation Zones (CZs) embedded in this area.

Great Bear Lake and Watershed (Zones 23, 24, 25, 26, 27, 30 and 31): A mix of CZs and a surrounding SMZ that provide strict protection to ensure the maintenance of the ecological and cultural integrity throughout those portions of the watershed lying within the SSA.

Shúhtaot'ıjęnę Néné (Zone 40): A CZ buffering and enhancing protection around the Canol Trail and Dodo Canyon, and a second area connecting portions of the Keel, Redstone and Ravens Throat Rivers with Drum Lake, June Lake and Caribou Flats.

Nááts'ıch'oh National Park Reserve of Canada (No zone number): As an established National Park Reserve it is exempt from application of the Plan but protects the headwaters of the Nahanni River and important wildlife habitat within the SSA.

Ts'udé Nıljné Tuyeta (Ramparts River and Wetlands – Zone 65): A Proposed Conservation Initiative (PCI) that connects a whole series of wetlands with the Ramparts River and Mackenzie River.

Connectivity between the Ramparts and the Mountain River (Zones 65, 42 and 46): A mix of PCI, CZ and SMZs to connect and protect the flow of water between these two important water systems (Sahtu Land Use Planning Board 2013).

OVERVIEW

This case study is intended to Illustrate the contribution of regional land use planning in the Northwest Territories (NWT) to connectivity, using the Sahtú Land Use Plan (SLUP) as an example. It was written by the author, with permission from the Sahtú Land Use Planning Board (SLUPB). Any errors or omissions are the responsibility of the authors.

DESCRIPTION OF THE SAHTÚ SETTLEMENT AREA

Location and History

The Sahtú Settlement Area (SSA) is located in the central Mackenzie Valley of the NWT (Figure 1). The area is 282,773 km^2 in size (28,277,300 ha) (Figure 1). The SSA was created as a result of the *Sahtú Dene and Métis Comprehensive Land Claim Agreement (SDMCLCA)*, which was signed in 1993 between the Sahtú Tribal Council, Government of Canada, and the Government of the Northwest Territories (GNWT). The SSA is the homeland of the Sahtú Dene and Métis. The Sahtú Dene have occupied the area for thousands of years. The Sahtú Métis descended from intermarriage between Sahtú Dene and Euro-Canadians who began to move into the region with the fur trade in the early nineteenth century.

There are five communities within the SSA with a combined population of 2,645 people (NWT Bureau of Statistics, 2019):

- K'abami Tué - Colville Lake (149 people)
- Radilih Koe - Fort Good Hope (582)
- Le Gohlini - Norman Wells (768)
- Tulita (521)
- Déļınę (625)

Norman Wells is the regional centre; approximately 40% of its population is Indigenous. The populations of the other four communities are 80-90% Indigenous (NWT Bureau of Statistics, 2019). The Sahtú Dene and Métis are active land users with nearly 50% of the population engaging in traditional activities of hunting, fishing, trapping, producing crafts, or gathering berries (NWT Bureau of Statistics, 2019). They maintain a close, spiritual connection to the land.

Under the *SDMCLCA*, the Sahtú Dene and Métis have surface title to 41,437 km^2 of land and subsurface rights to 1,813 km^2 (Indian and Northern Affairs Canada, 1993). Together these are known as Sahtú lands. The rest of the SSA is considered public land.

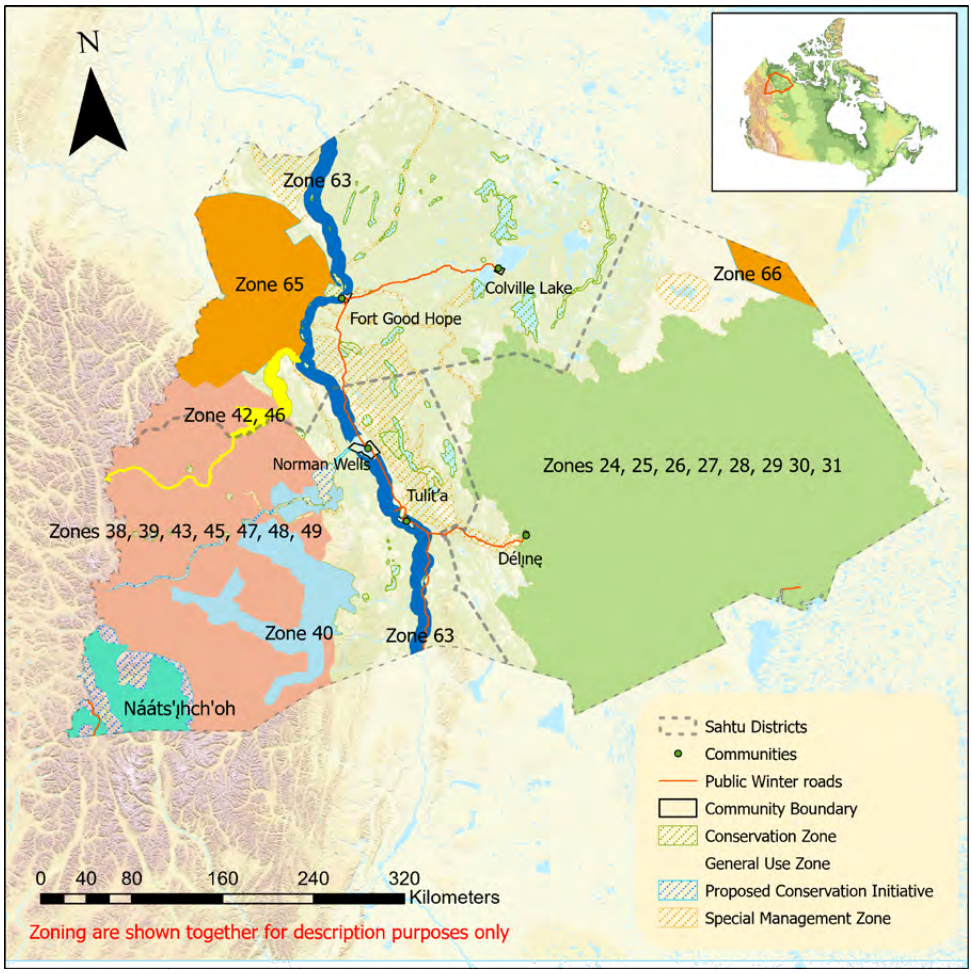


Figure 1. The Sahtú Settlement Area

The Sahtú Dene and Métis established a corporate body to administer their rights under the SDMCLCA known as the Sahtú Secretariat Incorporated (SSI). The SSA is divided into three Districts, with each district being represented by a district land corporation which administers its Sahtú Lands:

- K'asho Got'ine District
- Déļınę District
- Tulita District

In 2015, Déļınę, the Government of Canada, and the GNWT signed the Déļınę Self-Government Agreement, which began the process to dissolve the Déļınę First Nation, Déļınę Land Corporation, and Déļınę Charter Community into one Déļınę Got'ıne Government (DGG). On September 1, 2016, the DGG came into existence (Déļınę Got'ıne Government, 2020). It is the first Sahtú community to complete this process, though self-government negotiations are underway in other Sahtú communities as well.

Natural Features

This section is summarized from SLUPB, 2010. The dominant natural features in the SSA are Great Bear Lake (Sahtú) and the Mackenzie River (Dehcho). Great Bear Lake is the largest freshwater lake entirely in Canada and the ninth largest freshwater lake in the world, both in terms of surface area (31,326 km^2) and volume (2,292 km3. Great Bear Lake supplies Great Bear River, which flows into the Mackenzie River. The majority of streams that flow through the Sahtú lie within the Mackenzie River Basin, the largest river basin in Canada, flowing from the Rocky Mountains in British Columbia and Alberta to the Mackenzie River in the NWT, which empties into the Beaufort Sea.

Much of the Sahtú is located in the boreal forest biome, and taiga ecoregion. The taiga is one of the major peatland areas in Canada. The long cold winters and short summers limit tree and plant growth, making this the "land of little sticks". The taiga is covered in hundreds of thousands of lakes and ponds gradually draining to the Arctic Ocean via Great Bear Lake and the Mackenzie River in a generally low relief.

The southwestern portion of the SSA lies in the cordillera ecoregion – a complex landscape of rugged peaks and ridges, rolling hills, eroded plateaus, deep V- and U-shaped valleys, fast-flowing braided rivers and streams, and slow-flowing meandering rivers. In the south and east there are glaciers and icefields. Glacial deposits are broadly distributed and mostly found on the floors and lower slopes of valleys. Lakes and ponds are small and thinly distributed. Wetlands are locally common only on the floodplains and lower slopes of large rivers and on a few broad plateaus.

The treeline cuts across the far northeast corner of the SSA. About 60% of the region has continuous permafrost (north and western portions), while the area just west and south of Great Bear Lake has extensive discontinuous permafrost.

Black spruce (*Picea mariana*), jackpine (*Pinus banksiana*), tamarack (*Larix laricina*), white spruce (*Picea glauca*), paper birch (*Betula papyrifera*), and aspen (*Populus tremuloides*) are the most common trees, with common shrubs and ground cover consisting of dwarf birch (*Betula nana*), willow (*Salix sp.*), cottongrass (*Eriophorum sp.*), lichen, mosses (*Bryophyta*), sedges(*Carex sp.*), Labrador tea (*Rhododendron groenlandicum, Rhododendron tomentosum*), and ericaceous shrubs.

The Sahtú is home to barren-ground caribou (*Rangifer tarandus groenlandicus*), woodland caribou (*Rangifer tarandus caribou*), moose (*Alces alces*), waterfowl, migratory birds, and plenty of furbearers. For the purposes of planning, the landscape, in all its dimensions, helped to define zones and areas of protection, depending on the feature of interest – rivers and lakes, mountains (using contour lines), ecoregion boundaries, wildlife habitat features, or culturally significant sites and landscapes as defined by the communities and their traditional knowledge.

LAND USES

Mining

Mining has been a long-term historical land use in the Sahtú. Mineralization hotspots include:

- The eastern shore of Great Bear Lake (known as the Great Bear Magmatic Zone), which has deposits of silver, uranium, low-grade copper, gold, cobalt, bismuth, zinc, nickel, lead, radium, and rare earth elements;
- The Mackenzie and Selwyn Mountains have sediment-hosted copper-silver, lead-zinc, tungsten, as well as some interest in emeralds;
- Coal in the interior platform (central Mackenzie Valley); and,
- General interest in exploring for diamonds both in the north central part of the SSA and interior platform (SLUPB, 2010).

Historically, there were several mines on the east shore of Great Bear Lake, which have been closed for decades and undergoing remediation. More recently there was tungsten mining on the NWT/Yukon border (Cantung and Mactung mines), but the company went bankrupt and the properties were acquired by the federal and territorial governments to provide care and maintenance until further opportunities could be assessed (GNWT, 2019). The only other active project is the Selwyn-Chihong proposed lead-zinc mine at Howard's Pass, also straddling the NWT/Yukon border, which is at the advanced exploration stage (Selwyn-Chihong, 2020).

While the mineral potential is still there, the dominant mining-related industry right now is cleanup and remediation of historic mine sites.

Oil and Gas

Oil was discovered in Norman Wells in 1911. Imperial Oil opened a refinery there in 1939 that continues to produce oil today, guided by the Norman Wells Proven Area Agreement between Imperial Oil and Canada. An oil pipeline was constructed between Norman Wells and Zama City, AB in 1985, which allowed for increased production (Canada Energy Regulator, (2020a).

There is high to general high potential for oil and gas through the central and northwest portions of the SSA. Previous exploration focused around Tulita and Colville Lake (SLUPB, 2010).

The defining oil and gas projects for the region were the two proposals to build a gas pipeline up the Mackenzie Valley to get the much larger reserves in the Beaufort Delta to southern Canada.

The initial proposal in the 1970s, and the backlash it caused from Indigenous communities, led to Justice Thomas Berger recommending a moratorium on development for a decade to allow the completion of land claims agreements and land use planning in the Mackenzie Valley (Berger, 1978). The second proposal to build a pipeline (the Mackenzie Gas Project) started in 2004, and wasn't officially abandoned until 2017 (Strong, 2017).

Shale gas exploration became the dominant land use activity in the central Mackenzie Valley near Tulita between 2011 and 2013. Three successive calls for bids resulted in the issuance of 14 exploration licences to six companies (NRCAN, 2020). Although there was a flurry of drilling activity in the years immediately following rights issuance, activity ground to a halt due to the high costs of drilling and dropping gas prices that made further work uneconomical. There has been no additional oil and gas activity since 2015 (Canada Energy Regulator, 2020).

Roads and Infrastructure

There is no all-weather road in the Sahtú, only winter roads, and the passable season is getting shorter and more unpredictable every year as a result of climate change. For years, the GNWT has sought funding and support to extend the all-weather Mackenzie Valley Highway north of Wrigley through the Sahtú to Inuvik. It is currently conducting planning and environmental studies, and construction of specific infrastructure sites, such as the Great Bear River Bridge and an access road from Norman Wells to Canyon Creek (GNWT Infrastructure (a), 2020). In 2015, the GNWT also installed a Mackenzie Valley Fibre Optic line up the Mackenzie Valley to provide high-speed telecommunications for communities in the Mackenzie Valley and Beaufort Delta regions (GNWT Infrastructure (b), 2020).

Outfitting and Tourism

The lack of roads and infrastructure in the Sahtú makes travel expensive. Conversely, it also attracts wilderness, adventure, and outfitting tourism. There are a number of big game outfitters and wilderness lodges in the Mackenzie Mountains (mostly targeting Dall's sheep (*Ovis dalli*) Ik), and a fishing lodge on Great Bear Lake (mostly targeting lake trout (*Salvelinus namaycush*) and arctic grayling (*Thymallus arcticus*)) ("Mackenzie Mountains", 2020;"Great Bear Lake", 2020).. The Canol Trail is a long-distance hiking trail (355 km) in the Mackenzie Mountains (SLUPB, 2010).

Hydro-Electric Potential

Studies by the GNWT indicate a few sites with good potential for hydro-electricity generation along the Great Bear River, Keel River, Mountain River, and Carcajou River. However, not only would the remoteness of most of these locations would make them economically unfeasible without heavy government subsidy, but they are also unnecessary since there is no nearby market for the energy unnecessary (SLUPB, 2010).

OVERVIEW OF CONNECTIVITY

Protected and conserved areas in the SSA focus on, and are connected by, water – lakes, rivers, and wetlands are among the dominant features protected through the Sahtu Land Use Plan (SLUP). Water provides travel routes, drinking water, and habitat for fish, moose, caribou, waterfowl, and other wildlife. Historic trails are another feature protected through the SLUP and also contribute to landscape connectivity. While connectivity was not a defined objective for land use planning, it is an outcome of planning because trails and water are landscape connectors, and these were the focus of many of the SLUP's zones.

Types of Protected Areas in the SSA

The SSA includes or acknowledges a variety of sites and designations conserved under various mechanisms, all tied together within the context of the Sahtú Land Use Plan (SLUP) under the authority of the *SDMCLCA*. These include:

- Two sites protected or recommended for protection under the *SDMCLCA* (Kelly Lake Protected Area and Doi Et'Q - Doi T'oh Territorial Park and Canol Heritage Trail Reserve);
- One National Park Reserve (Nááts'įhch'oh) and one National Historic Site (Saoyú -ehdacho) cooperatively managed by Parks Canada and the local community;
- One site that is in the process of being established under the GNWT's *Protected Areas Act* (Ts'udé Nįlįné Tuyeta - Ramparts River and Wetlands);
- One UNESCO Biosphere Reserve (Tsá Túé Biosphere Reserve);
- Conservation Zones and Proposed Conservation Initiatives in the SLUP; and,

- Special Management Zones and General Use Zones and conditions in the SLUP, which provide guidance and conditions for land use between protected and conserved areas.

Of note, the Tsá Túé Biosphere Reserve is an honourary designation applied to the portions of the Great Bear Lake and Watershed within the SSA that recognizes important areas where people are living sustainably and whose approaches to sustainable development are instructive for others and does not protect land itself. The designation is acknowledged in the SLUP five-year amendments, but not integrated into its zoning.

THE SAHTÚ LAND USE PLAN (SLUP)

Introduction to Land Use Planning

Land use planning is the process of making informed decisions about the best use of land, waters and resources to achieve a defined vision and goals for the future. Land use planning addresses the conservation, use and development of land, waters and resources, and looks at all past, present and reasonably foreseeable land uses. In the NWT, land use plans are legally binding documents. Established under land claim agreements and given legal force through federal legislation, approved land use plans have the authority to restrict development as specified in the plan. Land use plans are generally comprehensive and tackle of range of land uses and issues.

Legal Authority for the SLUP

The Sahtú Land Use Plan (SLUP or "the Plan") is a legal requirement of the *SDMCLCA*. The *Mackenzie Valley Resources Management Act (MVRMA)*, enacted in 1998, is the federal legislation that implements the *SDMCLCA's* land use planning provisions. The *MVRMA* nests land use planning within an integrated system of land and resource management that involves land access, land and water regulation, environmental impact review, renewable resource management, and environmental monitoring and audit. Within this system, land use plans act as a gatekeeper: all proposed activities must conform to the plan before an application can proceed into the regulatory system.

As per section 46(1) of the *MVRMA*, once approved, the "Sahtu First Nations, departments and agencies of the federal and territorial governments, and every body having authority relating to the use of land or waters or the deposit of waste, shall carry out their powers in accordance with the land use plan applicable in a settlement area." References to "Sahtu First Nations" in the *MVRMA* generally refer to the SSI and/or the district land corporations. Each authority of the Sahtu First Nations under the *MVRMA* and *SDMCLCA* was delegated to the corporate bodies through a register of designated Sahtu organizations.

Governance

The Sahtú Land Use Planning Board (SLUPB or "the Board") was established as an institution of public government under the *MVRMA* and the *SDMCLCA*. It is a co-management board with equal participation of the Sahtú Dene and Métis, and Government. SSI nominates two members, the GNWT nominates one member, and Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) nominates one member on behalf of the Government of Canada; those four jointly nominate one person to as a Chair. All five members are formally appointed by the Minister of Northern Affairs Canada based on the nominations from each party. Once appointed, all Board members must act in the public interest rather than representing the parties that nominated them.

The SLUPB's mandate is to develop the SLUP. Once completed and adopted by the Board, the Board submits the Plan to SSI, the GNWT, and CIRNAC for approval, so the Board must involve the approving parties (as well as many others) in plan development. Once approved, the SLUPB's roles are to:

- Monitor implementation of the SLUP;
- Determine conformity of applications/activities with the SLUP, where they are referred to the Board (regulators are mainly responsible for this but anyone affected may refer an application to the Board to make the determination);
- Consider exceptions to the SLUP;
- Carry out periodic reviews of the SLUP every five years;
- Amend the SLUP as required; and
- Maintain a public registry of applications and decisions made by the SLUPB.

Funding

Land use planning is a requirement of the *SDMCLCA*, so all costs associated with the SLUPB, as well as development and implementation of the SLUP, are funded by the federal government.

Guiding Principles

The *SDMCLCA* and the *MVRMA* set out the following guiding principles for planning:

- "The purpose of planning is to protect and promote the social, cultural, and economic well-being of residents and communities of the SSA, having regard to the interests of all Canadians;
- Special attention shall be devoted to the rights of the Sahtú First Nations under their land claim agreement, to protecting and promoting their social, cultural, and economic well-being and to the lands used by them for wildlife harvesting and other resource uses; and

- Land use planning must involve the participation of the First Nation and of residents and communities in the settlement area" (Government of Canada, 1998, s. 35).

Land use planning is a community-driven process, with the key direction for planning decisions and content coming from deep engagement with the Sahtú communities. While the Board must engage everyone affected by the process, the "purpose of planning" principle above clearly gives priority to protecting and promoting the interests and well-being of residents and communities in the SSA above other stakeholders.

Status of the SLUP

The initial plan was approved and came into force on August 8, 2013. Since then, two amendment processes have been initiated – one to rezone areas left out of the Nááts'įhch'oh National Park Reserve when it was established in December 2014, and one for the comprehensive five-year review of the SLUP. The Nááts'įhch'oh Amendment is currently awaiting final approval (SLUPB, 2015). The five-year amendment is nearing completion and will be submitted for approval in the spring of 2020. The Draft Amendment package was broadly distributed for public comment in December 2019 and represents the most up-to-date picture of the Sahtú Land Use Plan (SLUPB, 2019). **The information presented in this case study about the SLUP comes from the December 2019 Amendment Package, as the most current publicly available information about the plan and its revisions. However, the August 8, 2013 version of the Plan is the approved version that is currently in effect, and will remain so until the amendments are completed and approved** (SLUPB, 2013). Both sets of amendments may be subject to further revision as they move through the approval process.

Vision and Goals

The SLUP includes a holistic vision and supporting goals that touch on social, cultural, ecological, and economic aspirations for the region. The vision and goals provide the overarching guidance to the individual decisions that make up the plan, e.g., what land use choices must be made in this location of for this issue to achieve the vision and goals we've identified? How does this land use factor into the regional vision and goals? The concepts of ecological and cultural integrity are key elements of the vision, that carry through other parts of the plan. The vision is four paragraphs long. The paragraph relevant to ecological integrity and protection of land is:

"The ecological integrity of the region is maintained. The land, water and natural resources on which people depend are clean, healthy and abundant. There is a balance of industrial development and vast wilderness areas, a model of development hand in hand with environmental protection. Conservation Zones and legislated protected areas protect the most important places and values for future generations, while careful management allows sustainable development to proceed in all other areas." (SLUPB, 2019)

Similarly, the plan includes a broad goal and supporting goals related to ecological integrity:

> *1. Maintain the ecological integrity of the SSA. The following supporting goals will contribute to this broader goal:*
>
> *1.1 Protect environmentally significant areas and ecologically representative areas.*
>
> *1.2 Water quality, quantity and ecological productivity will not be degraded and will be restored and enhanced where degradation has occurred.*
>
> *1.3 Consider and mitigate long-term cumulative impacts to land and water from land use activities.*
>
> *1.4 Remediate current contaminated and waste sites.*
>
> *1.5 Maintain or increase the populations of wildlife on which people depend, including but not limited to woodland and barren ground caribou, moose, Dall's Sheep, furbearers, waterfowl and fish.*
>
> *1.6 Consider impacts of, and adaptations to, climate change in decisions affecting land, water and other resources.*
>
> *1.7 Build on the Cumulative Impact Monitoring Program (CIMP) to develop a research and monitoring program necessary to understand and monitor the ecological and cultural integrity of the SSA.*
>
> *1.8 Manage transboundary issues in cooperation with organizations from adjacent regions. (SLUPB, 2019)*

Some of the cultural integrity goals are also relevant to protection of land and contribute to increasing landscape connectivity:

> *2. Maintain or enhance the cultural integrity of the SSA. The following supporting goals will contribute to this broader goal:*
>
> *2.1 Protect places of significant cultural or spiritual value.*
>
> *2.2 Enhance protection of heritage sites, and important subsistence use and harvesting areas. (SLUPB, 2019)*

While the vision and goals clearly guide decisions towards protection of land and connectivity, they are not readily quantifiable or measurable, making it difficult to identify if they've been achieved. The SLUPB has identified this as a potential area for future revision.

KNOWLEDGE

Data Collection

The SLUPB relies on traditional, local, and scientific knowledge equally to inform planning decisions – they often complement each other. Traditional and local information is gathered from communities, while the federal and territorial governments, industry, and non-governmental organizations all contribute the best available scientific data to the process. Information is collected pertaining to social, cultural,

economic, and ecological aspects of land use, the residents and communities, and the environment. This includes information on:

- Regional and community population size, education levels, employment, and ethnicity;
- Language, culture, history, and traditional use and occupancy;
- Biophysical environment: geology, climate, watersheds and water quality/quantity monitoring, landcover and ecoregions, wildlife and habitat, as well as the many reports and strategies for protection of these values (e.g., Species at Risk recovery plans, conservation network planning, water stewardship planning, etc.); and,
- Land use and tenure: past, present and foreseeable land uses occurring in the region, including where existing rights are held that would be grandfathered in, projects currently being planned or anticipated (and government strategies such as Transportation Strategy, Mineral Development Strategy, etc.), and where potential lies for future development. Key land uses addressed in the SLUP are mining, oil and gas, forestry, power development, transportation and infrastructure, quarrying/granular resources, and tourism.

Information Exchange

All information gathered in the SLUP process is public unless specifically identified as confidential. For example, the traditional use maps of individual land users are generally considered confidential. However, compilation maps that illustrate which areas are most important to a community for traditional use (overall, or for specific mapped features like trails, or ungulate harvesting) are considered public information. The SLUPB documented its information gathering in a Background Report (SLUPB, 2010). This served as a record of the information relied on by the Board in making its decisions. All maps, reports and planning documents produced by the Board are on its website. Source materials are all documented through referencing and proper metadata standards within reports, plans and maps.

Regional planners in the NWT maintain open communications, especially those in adjacent planning regions, to share information, insights, lessons, and practices, and collaborate on shared issues. In addition, the GNWT has been hosting an annual Land Use Planning Forum since 2015 to exchange information and build relationships between land use planning regions and Indigenous governments and organizations in the NWT (GNWT, 2019).

PROTECTION AND CONNECTIVITY THROUGH THE SLUP

The heart of the SLUP is the zoning system, which identifies which land uses can take place, where, and under what conditions. The SLUP uses five zone designations (Figure 2):

- **General Use Zones (GUZ)** allow all land uses except bulk water removal, subject to the general Conformity Requirements (CRs – rules or conditions for land use) outlined in the Plan.
- **Special Management Zones (SMZ)** allow all types of land use other than bulk water removal, subject to the general CRs and applicable special management CRs outlined in this Plan.
- **Conservation Zones (CZ)** are significant traditional, cultural, heritage and ecological areas in which specified land uses (bulk water removal, mining, oil and gas, power development, commercial forestry, and quarrying) are prohibited. The zoning allows for access across CZs under stringent conditions.
- **Proposed Conservation Initiatives (PCI)** are areas for which formal legislated protection is being sought through federal or territorial legislation, or pursuant to commitments under the *SDMCLCA*. The establishment of a protected area is the intended use of PCIs and is permitted. PCIs have the same status as CZs in the SLUP until they are protected under other legislation.

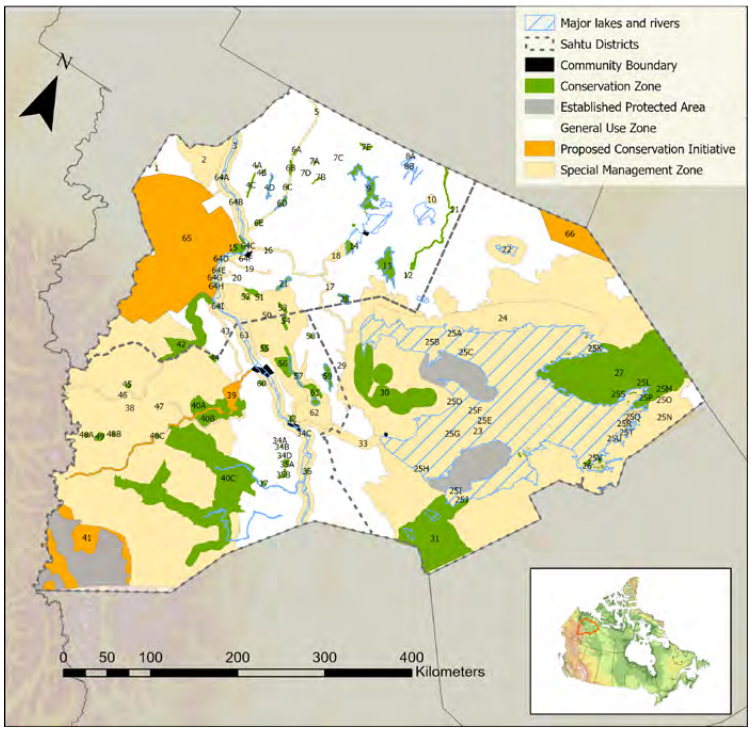


Figure 2. SLUP Land Use Zones (Proposed 5-Year Amendment, December 2019).

- **Established Protected Areas (EPA)** is the designation given to all legislated protected areas once they are fully established. Once an area is designated as an Established Protected Area, the SLUP no longer provides direction to these areas. Instead, they are managed according to their legislation and management plans. (SLUPB, 2019)

While increasing connectivity was not a defined objective or goal of the SLUP, it is definitely a key outcome of the plan. The Sahtú communities are mostly Indigenous, with many residents actively engaging in traditional land use and their culture. They maintain strong ties to the land. Areas of traditional use are concentrated around water (lakes and rivers), wildlife habitat, and traditional trails and travel routes. These became key areas for protection in the plan, through various measures.

- The zoning map illustrates some great examples of landscape connectivity, including:
- The Mackenzie River (Zone 63): An SMZ protecting the river and its values throughout the region).
- Mackenzie Mountains (Zone 38): An SMZ providing a buffer and additional protective measures for species and values unique to the mountains for several CZs embedded in this area.
- Great Bear Lake and Watershed (Zones 23, 24, 25, 26, 27, 30 and 31): A mix of CZs and a surrounding SMZ that provide strict protection to ensure the maintenance of the ecological and cultural integrity throughout those portions of the watershed lying within the SSA.
- Shúhtaot'ıné Néné (Zone 40): A CZ buffering and enhancing protection around the Canol Trail and Dodo Canyon, and a second area connecting portions of the Keel, Redstone, and Ravens Throat Rivers with Drum Lake, June Lake, and Caribou Flats.
- Nááts'ıh̨ch'oh National Park Reserve of Canada (no zone number): As an established National Park Reserve it is no longer subject to the plan and is instead managed under federal legislation; it protects the headwaters of the Nahanni River and important wildlife habitat within the SSA.
- Ts'udé Nı̨ı́n̨é Tuyeta (Ramparts River and Wetlands – Zone 65): A PCI that connects a whole series of wetlands with the Ramparts River and Mackenzie River and is in the process of being established under the territorial *Protected Areas Act*.
- Connectivity between the Ramparts and the Mountain River (Zones 65, 42 and 46): A mix of PCI, CZ and SMZ to connect and protect the flow of water between these two important water systems.

Table 1. Summary of protected areas and designations within the SSA.

Name	Area (ha)	IUCN Category	SLUP Zone Designation	Notes / Comments
Nááts'ıh̨ch'oh National Park Reserve	489,200	II	EPA	Provides for a range of wilderness experiences. Public and motorized access is controlled or prohibited in some areas. Other land uses can only occur by permit and must not have a significant adverse environmental impact on the park, its natural resources or the cultural, historical or archaeological resources.
Saoyú ʔehdacho National Historic Site	554,200	VI	EPA	Has both surface and subsurface protection. Access and other activities are managed by permit.
Tuktut Nogait National Park Reserve	182,500	II	PCI	Portion in SSA not yet designated under the *Canada National Parks Act;* key land uses are prohibited as per SLUP zoning for PCIs.
Kelly Lake Protected Area	27,100	Ib	CZ	Prohibits key land uses as per SLUP zoning for CZs.
Ts'udé Nı̨ı́n̨é Tuyeta (Ramparts River and Wetlands)	1,463,000	Ib	PCI	Not yet designated under the *Protected Areas Act*; key land uses are prohibited as per SLUP zoning for larger PCIs. Smaller area will be managed under future regulations and management plan.
Doi Et'Q (Doi T'oh Territorial Park and Canol Heritage Trail Reserve)	95,200	n/a	PCI	Not yet designated; key land uses are prohibited as per SLUP zoning for PCIs.
Nááts'ıh̨ch'oh (areas omitted)	270,200	n/a	PCI	Amendment in process to rezone these as SMZ; key land uses are prohibited as per SLUP zoning for PCIs.
Conservation Zones (CZ)	3,120,400	n/a	CZ	41 CZs, including Kelly Lake mentioned above; key land uses are prohibited as per SLUP zoning for CZs.
Special Management Zones (SMZ)	13,508,300	n/a	SMZ	21 SMZs, most land uses allowed except bulk water withdrawal, subject to protection of values for which zone was established, general conformity requirements (CRs) in the SLUP & regulatory processes.
General Use Zone (GUZ)	8,841,100	n/a	GUZ	Not numbered, most land uses allowed except bulk water withdrawal, subject to general CRs in the SLUP and regulatory processes.

The zoning integrates a variety of types of protection, described below, to provide a comprehensive, regional picture of conservation, use and development in the SSA. As stated above, the PCI designation provides interim protection to areas (under the plan's own authority) until the legislated processes to protect them are complete. Once legislated processes are complete, the plan identifies them as Established Protected Areas and ceases to provide direction, to avoid conflict or duplication. Any areas left out of final legislated protected areas stay under the authority of the plan as a PCI until such time as a plan amendment to rezone them is completed and approved. The other legislated designations integrated into the SLUP are summarized in Table 1 and described below.

Federal Sites

There are two sites protected under federal legislation – Nááts'ı̨hch'oh National Park Reserve (completed) under the *Canada National Parks Act*, and Saoyú -ʔehdacho National Historic Site, established under the *Historic Sites and Monument Act*. Both sites have a high level of protection, which restricts activities that would impact them. Other activities may be allowed under permit. In accordance the *MVRMA*, the SLUP ceased to apply to these two sites upon establishment. In addition, a portion of Tuktut Nogait National Park that extends into the Sahtú Settlement Area was put forward as a National Park Reserve but never formally completed. The SLUP provides interim protection to Tuktut Nogait as a PCI until such time as its designation as a national park reserve is complete.

Sites Protected Under the SDMCLCA

Section 17.3 of the *SDMCLCA* allows for, but does not require, the establishment of a Territorial Park around the Canol Trail and Dodo Canyon (Do Et'Q - Doi T'oh Territorial Park and Canol Heritage Trail Reserve) (Indian and Northern Affairs Canada, 1993). This area is part of a 355 km road and pipeline built during World War II to connect an oil field in Norman Wells to Whitehorse, Yukon. It is the main path through the mountains and follows a trail taken by the Mountain Dene for centuries to hunt, fish, and trap. Today Dodo Canyon and the Canol Trail are cultural and recreational use areas with historic and heritage value. The project has been in progress for years because the federal government must remediate contamination left from its prior industrial use, which is preventing the transfer of land to the GNWT and establishment of the site. The SLUP provides interim protection to this site until such time as this process is complete (see PCIs below).

Section 17.4 of the *SDMCLCA* sets aside and protects Kelly Lake to preserve the natural environment of the area in its natural state for the benefit and enjoyment of the public. The surface is withdrawn from development through the *SDMCLCA*. The SLUP provides additional protection to the subsurface and restriction of activities as a CZ in the SLUP (see CZs below).

GNWT Sites

The GNWT has recently completed its new *Protected Areas Act*. This piece of legislation requires the GNWT to negotiate an establishment agreement with at least one Indigenous Government partner to establish a protected area. The establishment agreement sets out the provisions for establishing a protected area, including guiding principles for its management, governance of the management body, roles and responsibilities of the parties, funding, infrastructure, and management planning. An establishment agreement was signed for Ts'udé Nı̨ı́ı̨né Tuyeta (Ramparts River and Wetlands) and regulations to establish the areas under the Act are underway. In the meantime, the SLUP provides interim protection for this area as a PCI (see PCIs below). It is an important wetland and key migratory bird terrestrial habitat site. It includes a few culturally significant sites, and has been an important hunting, trapping, and fishing area for Fort Good Hope for generations. The SLUPB will begin work in the Spring of 2020 on a plan amendment to recognize the change.

In addition to the zoning, the plan includes other CRs which set rules or conditions for land use, that provide additional protection. Some CRs prohibit specific activities or impacts in specific areas:

- CR #16 prohibits fish farming and aquaculture within Great Bear Lake;
- CR #17 prohibits the use of any activity that would disturb the lakebed of Great Bear Lake, other than environmental monitoring equipment, wharves and docks, and work on the community of Dél̨ı̨nę's water intake pipeline;
- CR #18 prohibits commercial renewable or non-renewable resource development and the establishment of permanent structures other than monitoring equipment within the Sentinel Islands Conservation Zone (Zone 26); and
- CR #19 prohibits the withdrawal of water for industrial purposes from Stewart and Tate Lakes, except from the outflow.

Many other CRs provide a range of environmental protection within the GUZ and SMZs, to minimize environmental impacts and ensure communities are involved in, and benefit from, resource development within the SSA, including:

- Managing overall impacts within watersheds, and protection for drinking water source watersheds;
- Protection for important fish and wildlife habitat (includes setbacks and minimum flight altitudes for land use in sensitive habitat during sensitive periods);
- Protection for sensitive species and features such as karst, mineral licks, hot springs, rare plants, and glacial refugia;

- Protection against invasive species and impacts to permafrost;
- Requirements for project-specific monitoring programs; and
- Protection of special values in SMZs for which the zones are defined.

Through the zoning and additional CRs listed above, the Plan provides a combination of buffers to protected areas (many are nested within surrounding SMZs) and a surrounding matrix of conditions for careful sustainable development in the areas that are open for development.

Finally, the plan also includes some non-binding actions and recommendations, such as one encouraging applicants and regulators to integrate an analysis of climate change impacts into proposed land use activities.

MANAGEMENT PLANNING

Land Use Planning does not include management planning directly. It is one part of an integrated system of land and resource management in the Mackenzie Valley. Other partners within the system have direct management responsibilities for the protection of biodiversity, maintenance of landscape connectivity, fire management, wildlife management, water management, etc. including:

- The Sahtú Renewable Resources Board – a co-management board that acts as the main instrument for wildlife management within the Sahtú Settlement Area, established through the *SDMCLCA*.
- GNWT:
    - Department of Environment and Natural Resources – works to promote and support the sustainable use and development of natural resources and to protect, conserve and enhance the NWT environment for the social and economic benefit of all residents. This includes the management of wildlife, forests, water, conservation planning/protected areas planning, and wildfire management. Key policies that contribute to connectivity are Healthy Land, Health People: GNWT Priorities for Advancement of Conservation Network Planning 2016-2021, Northern Voices, Northern Waters: NWT Water Stewardship Strategy, and the 2030 NWT Climate Change Strategic Framework.
    - Department of Lands – manages, administers, and plans for the sustainable use of public land in the NWT in a fair and transparent manner that reflects the interests of the people of the NWT. A key policy that contributes to connectivity is the GNWT Land Use and Sustainability Framework.
- Government of Canada:
    - Environment and Climate Change Canada – federal department responsible for wildlife, migratory birds, and species at risk on federal lands (few left).
    - Parks Canada – federal agency responsible for management of National Parks and Historic Sites in the Sahtú Settlement Area.
    - Fisheries and Oceans Canada – federal department responsible for fish habitat and fisheries within the SSA.
- Communities - Déļınę, Norman Wells and Tulita, and Colville Lake have all developed their own Caribou Management/Conservation Plans (Déļınę ʔekwę́ Working Group, 2016; Advisory Committee for Cooperation on Wildlife Management, 2014; Colville Lake Renewable Resources Council, 2019).

The SLUPB works with all these partners in developing/amending the SLUP, and discusses how those regional, territorial and federal policies and plans should be implemented and integrated within the regional context. In some cases, the Plan may provide the legal vehicle to implement management recommendations from these plans/strategies, by protecting key habitat, or connecting existing protected areas through a new conservation zone. In other cases, the plan may seek to concentrate and contain development in one area to avoid a proliferation of access in relatively undisturbed areas (e.g., providing for a transportation and infrastructure corridor up the Mackenzie Valley).

The Plan may also point to a gap in knowledge and recommend further management action be taken to resolve an issue. So, while the SLUPB does not do management planning itself, it plays a strong coordination function to reconcile and integrate all the sector and issue-specific management plans, written at different scales (community, regional, territorial, or national) to achieve different departmental and government mandates pertaining to land, water, and resource use in the region, in a way that makes sense for the region.

ENGAGEMENT, PARTNERSHIP, COLLABORATION, AND TRUST

Plan development is a highly collaborative process. A good plan requires meaningful and active engagement from all those affected at each step of the process (e.g., scoping and vision, data collection, options/zone development, draft, revised draft). Key planning partners are:

- Communities and residents (the most affected and the most engaged);
- Other community or regional Indigenous organizations (District Land Corporations, SSI);

- The Sahtú Renewable Resource Board and community renewable resource councils;
- Project proponents and business/industry organizations;
- Regulators;
- Federal and territorial government departments and agencies;
- Environmental and social non-government organizations; and,
- The general public.

Each of these planning partners have interests and priorities that must be considered, and accommodated to varying degrees; many have data, information, and helpful perspectives to contribute to the process. A successful process requires broad, inclusive, collaborative, regular, and transparent engagement. It is well understood and accepted that community input must drive the process. However, other partners hold information and perspectives that, if brought to communities for discussion, allow for more informed and targeted results. The more interactive and collaborative the process (where parties can work through issues and jointly craft solutions), the better the plan.

Planning is all about building relationships and trust, between the Board and those it engages, but just as important, between all the parties involved. The relationships and trust are what allow land use issues to get resolved. The SLUPB does this by running a fair and transparent process for all involved and being clear about each parties' role in the process.

The SLUPB followed a rigorous engagement plan. Initially, the Board solicited independent input from all affected partners in the early stages of plan development, to enable them to develop their thinking without external influences. In the final two years of the planning process, it brought planning partners together through a public hearing, a series of multi-party technical workshops, and a final workshop between the Board and approving parties only, to gradually resolve outstanding issues and build consensus on the final plan. The SLUPB focused especially on engaging the approving parties and building their commitment and understanding in the final stages of the process, to avoid some of the surprises and challenges faced during plan approval by previous regional planning bodies in the NWT.

The SLUPB also formed a number of strategic partnerships over the course of plan development and implementation:

- The Sahtú GIS project was an early partnership between the SLUPB, ENR and SSI to co-fund a Geographic Information Systems position to collect data and provide mapping support;
- The SLUPB partnered with Ducks Unlimited Canada to fund research on a Cumulative Effects Management Framework for the region;
- The SLUPB regularly collaborated and shared information with other public bodies in the region – the Sahtú Renewable Resources Board and Sahtú Land and Water Board; and,
- Currently, the SLUPB and the Sahtú Land and Water Board share office space and some administrative staff to reduce costs.

IMPLEMENTATION, MONITORING AND AMENDMENT

The SLUP, like other NWT regional plans, is a living document. It is intended to be implemented, monitored, and updated periodically to keep it current, accurate, and reflective of evolving regional interests and priorities.

Implementation

The SLUP came into force on August 8, 2013. Since then, as per S. 46(1) of the *MVRMA*, the "Sahtú First Nations, department and agencies of the federal and territorial governments, and every body with the authority under any federal and territorial law to issue licenses, permits, or other authorizations relating to the use of land or waters or the deposit of waste, shall carry out their powers in accordance with the land use plan."

The primary responsibility for implementation therefore rests with other parties (regulators and governments) through the authorizations and dispositions they grant. However, anyone affected by an application for land use, including the regulator, may refer it to the SLUPB to determine if it conforms. Where a referral is made, the Board's decision is final and binding. The Board may also consider applications for exceptions to the Plan.

Since the plan was approved, the NWT economy has been in a downturn and there have been few regulatory applications, but the plan is in effect and guiding those activities that have advanced. It also restricts the Sahtú, federal, and territorial governments from granting rights and interests in land, water, and resources (e.g., mineral tenure) in zones where such uses are prohibited. Where those rights existed before the plan was approved, they are allowed to proceed.

Monitoring

The SLUPB is responsible for monitoring plan implementation. In 2016, the SLUPB commissioned a review of the SLUP development and its initial three years of plan implementation to evaluate the awareness that planning partners had of the Plan, the effectiveness of the SLUP, and to identify challenges and opportunities for further work. This work was intended to assist the Board in fulfilling its monitoring function and prepare for the upcoming five-year review. The consultants interviewed and surveyed a number of planning partners on the effectiveness of the plan, what was working well, and what was proving challenging in implementation. The key findings included:

1. The majority of planning partners are positive about how the SLUP has been implemented to date.
2. Regulatory agencies that are responsible to implement portions of the SLUP have successfully issued numerous authorizations under the new regulatory framework.
3. The SLUPB is well respected and believed to be functioning effectively, though with limited financial and human resources.
4. The SLUP is seen as an effective tool for managing land use at a regional scale (particularly through its different zones).
5. Representatives of Sahtú organizations were confident that zoning is protecting some of the most sensitive cultural and natural areas in the region.
6. The SLUPB website is seen as an easy-to-use tool for getting information about the SLUP and current conformity determination or amendment processes.
7. Overall, the Plan seems to be working as expected. However, with only three years of implementation following over a decade of planning, there is a broad consensus that the SLUP has not yet been fully tested (HTFC Planning and Design, 2017).

The three-year review also recommended a number of areas for the SLUPB to focus on during the first five-year review, one of which was to develop methods to better monitor implementation of the plan. The SLUPB commissioned further work by the same contractor to develop a Monitoring and Evaluation Framework for the SLUP, that the Board recently released for discussion and comment (HTFC Planning and Design, 2019). The Framework identifies two streams for monitoring:

STREAM 1 monitors implementation activities under the plan. This is a process of tracking applications and authorizations (specifically gathering information on how determinations are made). Information is collected on an ongoing basis and reviewed periodically to refine the plan and process. It is intended to address the following questions:

- Is the SLUP being implemented fully and appropriately (by the many bodies responsible for implementation)?
- Would further clarification assist in accurately interpreting and implementing the SLUP?
- How is the SLUP affecting the regulatory system (is it having the desired result)?

STREAM 2 focuses on monitoring progress towards the SLUP vision and goals. Monitoring tracks indicators to assess the status of key values captured in the vision and goal statement. Where possible, it reflects on how implementation of the plan has affected these values. This addresses the question: Is the SLUP achieving its goals and advancing the vision (for the Sahtú region)?

Review and Amendment

The *MVRMA* requires that the SLUP is reviewed every five years. This is an opportunity to review and consider a number of factors, including:

- Do the vision and goals still reflect the values of the region?
- Is the SLUP achieving the vision and goals of the region and of the individual zones?
- Is the SLUP achieving the purposes established for it under the *SDMCLCA* and the *MVRMA*?
- Have there been any exception or amendment requests that signal a need for a change?
- Is there new information available that needs to be considered in land use decisions?
- Have there been changes in Proposed Conservation Initiatives that need to be updated in the SLUP?
- Are there new land uses, issues, or major projects on the horizon that need to be addressed?
- Have there been any challenges related to the implementation of Conformity Requirements that need to be addressed?

Although a review may not necessarily result in a plan amendment, it is generally the expectation. Outside the five-year review, the plan can be amended at any time. The SLUPB may adopt any amendments to a land use plan that the planning board considers necessary. An amendment may be initiated by the SLUPB itself, or one may be requested by anyone at any time following approval of the original SLUP by submitting an amendment application.

SLUP amendments may be considered for a variety of reasons, including the need to address a new land use, consider new information, update the status and application of the SLUP to a newly established protected area, or clarify SLUP requirements. However, plan amendments take time and resources. Just because an amendment is requested, doesn't mean it will be carried out immediately. If the reason for the amendment can be handled another way, that may be an option, or waiting and rolling the change into the next five-year review. All amendments must be approved by the three parties again (i.e., SSI, GNWT, and CIRNAC).

The SLUPB began working on its give-year review in 2016 through the assessment work referenced above. On January 23, 2018, the SLUPB released an opinion paper on its five-year review, concluding that amendments were needed, and seeking input on the document (SLUPB, 2018). The Board then began work to build the amendment application.

The SLUPB has two active amendment processes right now: one to amend zoning of the areas left out of Nááts'įhch'oh National Park Reserve when it was established, and one associated with the five-year review. The Nááts'įhch'oh amendment package is in the approval process, and the Board will submit its five-year review amendment package for approval in spring 2020. Once submitted, the SLUPB will be initiating a new plan amendment to address the changes resulting from the establishment of Ts'udé Nįłįné Tuyeta and rezoning the areas left out of that protected area.

Challenges

Completing five-year reviews of plans has proved challenging in the NWT. While the SLUP did complete its review within five years (i.e., by January 2018), the amendments relating to that are ongoing. Other NWT planning processes have taken longer. From a theoretical perspective, amendments appear easy, but that doesn't consider the amount of time it can take to research, consult on and develop the amendments, and then build consensus between the approving parties on the revisions.

From a conservation perspective, there is also a possibility of having areas rezoned through amendment and losing their protective designation. There are a few examples of that in the current active SLUP amendments:

1. The areas left out of Nááts'įhch'oh National Park Reserve are on the cusp of being rezoned from PCI to SMZ to reflect the reasons for which these areas were omitted from the national park reserve in the first place.
2. Colville Lake requested that parts of two former CZs in their area (Zones 10 and 14) change to SMZ or GUZ, which is reflected in the current amendment package. The reasons for this were… (The community also increased the area included in other CZs so these were part of a series of refinements to better reflect community interests). These are community-driven processes so if the community changes its mind, that will drive amendments.

CONCLUSION

The SLUP is the result of a comprehensive, regional planning process, constitutionally enshrined in the *SDMCLCA*. The purpose of the plan is to protect and promote the social, cultural and economic well-being of the residents and communities of the SSA.

The SLUP integrates and reconciles regional, territorial, and federal policies and initiatives on a variety of resource sectors and environmental values into one comprehensive regional vision, driven by the Sahtú community and regional interests, that provide direction on the conservation, use and development of land, waters, and resources within the SSA.

The plan is legally binding – all applications for the use of land, waters and resources must conform to the land use plan or they cannot proceed further in the regulatory process.

While landscape connectivity was not a specified goal or objective of planning, it is a key outcome of the plan nonetheless. The Sahtú Dene and Métis maintain strong connections to the land, water, and resources as active land users. The protection of ecological and cultural integrity are key themes woven throughout the plan. Water, trails, and wildlife habitat are key landscape features valued by the Sahtú Dene and Métis, which are protected in various ways through the plan. These are all features that create landscape connectivity.

The plan achieves protection through a combination of zoning and other CRs (conditions for land use). Almost 22% of the SSA is protected through a combination of CZs and legislated protected areas (under federal or territorial legislation). A further 47% of the SSA receives additional protection through special management zoning, which requires that land uses occurring in those areas be designed and carried out in a manner that protects the values for which the zones were established. The plan also includes a number of CRs that either prohibit specific activities in specific zones, or that provide general direction for activities in GUZs and SMZs to minimize impacts from land use on a variety of values, such as fish and wildlife and their habitat, watersheds, drinking water sources, sensitive ecological features (e.g., karst, ice patches, glacial refugia, hot and warm springs), permafrost, and archaeological sites and burial sites.

Further information on the Sahtú Land Use Plan and the Sahtú Land Use Planning Board may be found on the Board's website at: https://Sahtulanduseplan.org.

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Grand River, Waterloo, Ontario (Photo by SF photo)

CHAPTER 4

Connectivity Conservation in Canada Organizational Capacity and Needs Assessment

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INTRODUCTION

While a rich knowledge of the social, scientific, and engineering aspects of connectivity conservation in the airscapes, landscapes, and waterscapes continues to grow (Chapter 2), translating this knowledge into preferred outcomes in-situ remains a significant challenge (Keeley et al., 2018). Importantly, some examples at the science-practice interface of connectivity conservation are beginning to emerge (Bormpoudakis & Tzanopoulos, 2019; Keeley et al., 2018, 2019; Wyborn, 2011, 2015; Wyborn & Bixler, 2013), most of these examples are focused outside of Canada (e.g., Australia, England, and the U.S.) (Keeley et al., 2018).

Overall, however, few studies have explored the challenges, enablers, and needs of practitioners working to operationalise connectivity in landscapes and waterscapes. Furthermore, given the recent focus of international biodiversity conservation goals and targets that call on Parties to enhance connectivity measures, such as those highlighted in the United Nations (UN) *Convention on Biological Diversity Post-2020 Global Biodiversity Framework* (see Chapter 1) (Convention on Biological Diversity (CBD), 2020), there is a clear need to empirically examine how connectivity is being operationalised by the agencies responsible for protected and other conserved areas in Canada.

To improve understanding of factors that enable or inhibit the implementation of ecological networks for conservation, we developed and implemented a pan-Canadian capacity and needs assessment survey. Specifically, we examine the current capacity, obstacles, and needs of Canada's conservation community to effectively include ecological networks in the conservation toolbox by exploring key themes of institutional capacity, as illustrated in Figure 1. It is important to note that the themes are not mutually exclusive and should be considered interrelatedly in order to develop a sense of the challenges of employing ecological networks and ecological corridors for conservation within the boundaries of any type of planning frameworks.

METHODS

In response to the obvious science-implementation gap with respect to connectivity conservation that exists within Canadian protected areas jurisdictions, we developed and administered a collaborative survey to assess the current capacity of organizations to implement connectivity conservation initiatives. For the purposes of this survey, capacity denotes a suite of characteristics that describe (and measure) an organization's ability or readiness to implement connectivity conservation. Characteristics include, but are not limited to, an organization's readiness to

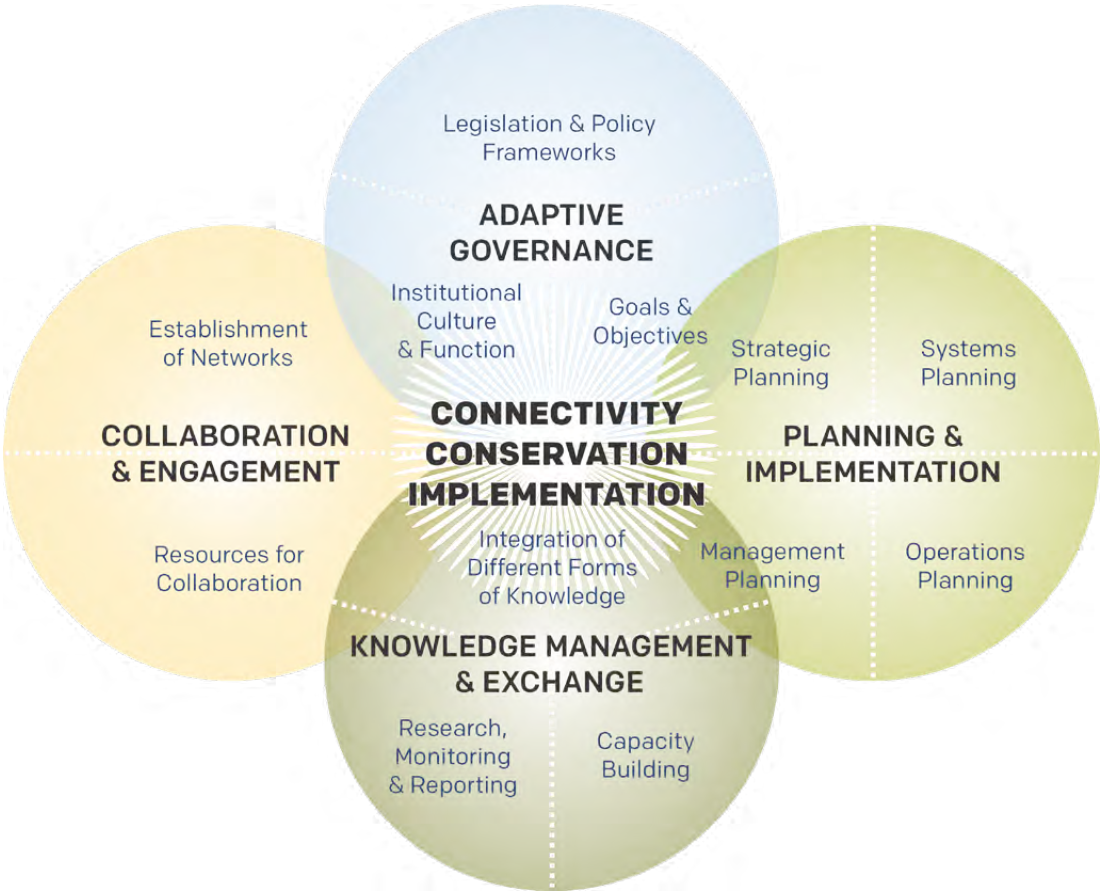

Figure 1. The four themes used in this chapter to assess organizational capacity and needs with respect to the implementation of connectivity conservation in Canada.

influence human behaviour, to make important policy and management decisions in response to social and ecological data and information (such as wildlife movements), marshal the necessary human and financial resources, communicate with the public, and establish and maintain the necessary partnerships to deliver on the commitment to establish well-connected systems of protected areas, Indigenous and Protected Conserved Areas (IPCAs), private protected areas (PPAs), and other effective area-based conservation measures (OECMs).

Questions were grouped according to the four themes noted in Figure 1 to ensure the flow and sequence of the survey was appropriate to the respondents' understanding of the research purpose. In total, respondents were provided with 55 questions; 26 questions were focused on capacity assessment and 29 questions on organizational needs to enhance connectivity conservation. Response options to each capacity-focused question were displayed along a five-point continuum that assesses the extent and capacity associated with the implementation of various connectivity conservation themes (ranging from 'Not at all' or 'No Capacity' to 'Completely' or 'Full Capacity'). The survey was administered through Wilfrid Laurier University, and received ethics approval for research involving human participants (by the Office of Research Services, File no. 6421).

SUMMARY OF RESULTS

The survey sample represented the spectrum of organizations operating at varying geographical and jurisdictional scales across Canada and included core protected area organizations from the federal government, provincial and territorial governments, non-governmental organizations, and local governments (Table 1). In total, 24 participants representing 17 organizations across Canada completed the survey: 3/3 federal core protected area departments, 9/13 core provincial/territorial departments, and 4/16 local government departments, representing a total response rate of 75% for core protected area agencies and 25% for local government.

For reporting of survey results, we first provide a broad assessment of capacity strengths and limitations identified by survey participants at the aggregate level, followed by a more detailed assessment organized by the major themes of the themes noted in Figure 1. Also included are recommendations provided by respondents, which have been used to help develop the priority recommendations presented in the Executive Summary of this report.

Selected Examples of Organizational Strengths in the Effective Implementation of Connectivity Conservation:

- Overall capacity for implementing connectivity conservation among all core protected areas agencies was perceived as somewhat low to moderate. While local governments represent a small part of the sample, it appears that they are somewhat more effective at integrating connectivity conservation initiatives through regional and urban planning initiatives.

Table 1. Summary of survey participants.

Federal Governments	• Parks Canada • Environment and Climate Change Canada • National Capital Commission
Provincial/ Territorial Governments	• Alberta Parks • Department of Fisheries and Land Resources, Government of Newfoundland and Labrador • Government of New Brunswick • Government of Northwest Territories (GNWT), Department of Environment and Natural Resources • Manitoba Conservation and Climate • Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC) Québec • Nova Scotia Environment/Nova Scotia Department of Lands and Forestry • Ontario Parks • Saskatchewan Ministry of the Environment
Non-governmental Organizations	• Nature Conservancy of Canada (NCC)
Local Governments	• City of Calgary, Parks (Alberta) • City of Edmonton (Alberta) • City of Vaughan, Policy Planning and Environmental Sustainability (Ontario) • Regional District of Central Okanagan (Parks Services) (B.C.)

- The extent to which Scientific Knowledge has been integrated into connectivity conservation planning was perceived as high, and represented the highest ranked question included in the questionnaire.

- The focus of many core protected areas agencies has been on completing protected areas systems to meet representation targets, where substantial progress has been made.

- Generally, some level of the importance of connectivity conservation is recognized by all agencies and organizations. In some instances, goals and objectives have been established. In a few cases, these goals have been engrained in legislation and policy and/or as commitments in strategic plans, which have contributed to notable progress in connectivity conservation implementation in protected areas and on the intervening landscapes and waterscapes.

- A mandate for the protection, acquisition, and restoration of ecological integrity is perceived to provide the stimulus to manage for connectivity within protected and other conserved areas. These three activities provide the foundation for connectivity conservation in Canada.

- Some jurisdictions sponsor legislated requirements for "state of" reporting on ecological integrity (i.e., Ontario/Nunavut/Parks Canada), which requires inventory, monitoring, and reporting programs that also contribute to the ongoing assessment of management effectiveness. These programs denote the presence of 'learning organizations' in Canada, which is a fundamental requirement for adaptive governance.
- Work on facilitating and financially supporting a process to identify Key Biodiversity Areas (KBAs) as a science-based foundation upon which connectivity conservation can be implemented is currently underway.
- Productive collaborations and partnerships that focus on connectivity conservation implementation exist or are emerging, especially at local levels of planning.
- Relationships between some provincial conservation agencies and private land organizations such as the Nature Conservancy of Canada (NCC) has helped facilitate the implementation of connectivity conservation initiatives.
- Relationships with universities has helped offset science capacity issues through research including inventorying, monitoring, and evaluation.

Selected Examples of Obstacles to the Effective Implementation of Connectivity Conservation:

- Protected areas strategies tend to be outdated, focused on completing protected areas systems, and more often than not exclude goals and targets for connectivity conservation.
- Few policy frameworks for mainstreaming connectivity conservation have been created and are generally treated as a secondary priority behind economic development.
- Human and financial resources are perceived by most as inadequate for understanding social and scientific issues, fostering and maintaining collaborative partnerships, and implementing connectivity conservation.
- Environmental/impact assessment (EA/IA) is perceived as a major obstacle to the effective implementation and protection of connectivity conservation. Often mitigation of impacts to connectivity conservation is not required in EA/IA. Many permitted activities in provinces that affect connectivity are not subject to EA/IA and some respondents noted that thresholds used to trigger an EA/IA process are too high. Some respondents noted a lack of comprehensive and integrated inventories of important ecosystems, such as wetlands, forests, and grasslands, as well as reliable information on disturbance features, all of which are important to practitioners working to generate science-based knowledge that inform connectivity conservation initiatives.
- In some instances where key connectivity areas have been identified, this knowledge has not been used to acquire and/or restore areas suitable for inclusion in natural heritage systems networks. This is a significant gap in connectivity conservation implementation.
- Some jurisdictions sponsor financial incentive programs for private landowners who elect to participate in connectivity conservation and others do not. Failure to mitigate the effects of human activities on connectivity conservation between protected areas on the intervening landscapes and waterscapes (e.g., buffer zones) is perceived as a threat and a significant barrier to reconnecting Canada.
- The politics of natural asset allocation on the intervening landscapes and waterscapes are perceived as a significant obstacle. For example, one respondent noted that the current institutional culture tends to discourage engagement (i.e., "it's none of your business") of park managers in contributing to decisions designed to mitigate ecological threats and issues outside the park boundaries even if such threats may impact ecosystem services inside the park.
- While a number of respondents noted a willingness to integrate Indigenous Knowledge into connectivity planning initiatives, capacity to achieve such integration is low at the present time.
- Some respondents expressed concern that agency staff, including leaders, and the general public do not know about and/or misunderstand the concept and utility of connectivity conservation.

OVERALL CAPACITY TO IMPLEMENT CONNECTIVITY CONSERVATION

Figure 2 illustrates the current organizational capacity for the implementation of connectivity conservation initiatives in Canada. To assess capacity, 26 questions were administered across four major themes: 1) Adaptive Governance; 2) Planning and Implementation; 3) Knowledge Management and Exchange; and, 4) Collaboration and Engagement. Survey participants assessed the strength of organizational capacity with a Likert-scale ranging from 1 (no capacity, no implementation) to 5 (high capacity, full implementation). Please refer to Appendix 1 for the complete list of survey questions.

At a very broad level, overall capacity for connectivity conservation by participants from core protected areas agencies was perceived as low to moderate. Across its suite of nine questions, the Governance theme was ranked highest by participants. However, this theme also included the second lowest ranked question included in the survey, which pertained to the adequacy of financial resources to support connectivity conservation initiatives (mean = 2.3). Notably,

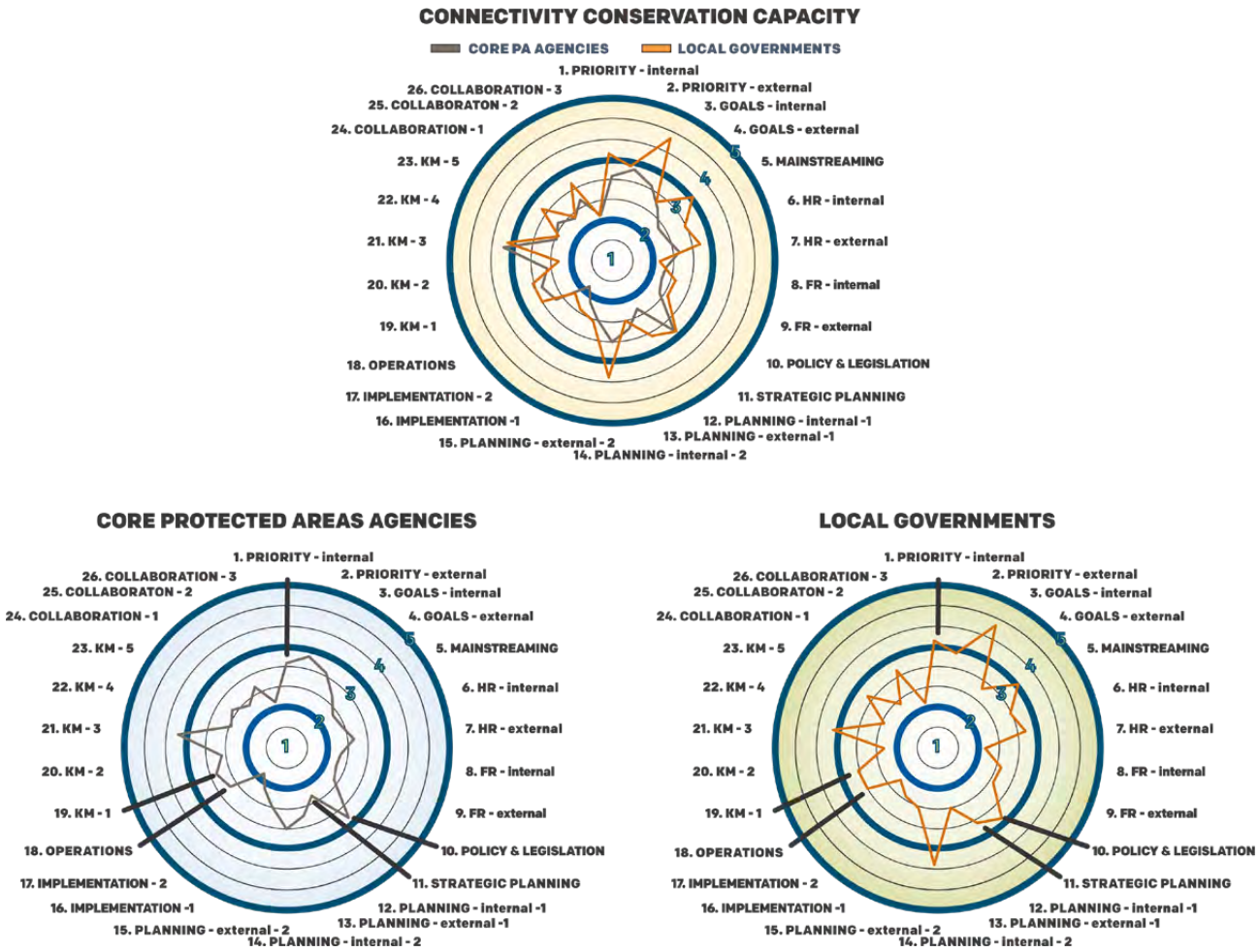

Figure 2. Current organizational capacity for the implementation of connectivity conservation initiatives in Canada.

the extent to which the priorities of other agencies within participants' own jurisdiction, other levels of government, and other land-use planning stakeholders present barriers to achieving connectivity conservation objectives within their agency (e.g., resource development, transportation, urban sprawl, etc.) was ranked the highest amongst all questions included in the survey (mean = 3.31).

Again, generally speaking, participants from local governments indicated a greater capacity for connectivity conservation implementation across the majority of questions included in the survey. While these results should be interpreted with caution given the small sample size, local government experience with more integrated, regional planning initiatives appears to have its benefits with respect to being able to implement connectivity conservation initiatives. Notably, local governments have made significant progress identifying areas important for connectivity conservation (e.g., through gap analyses, connectivity (wildlife) mapping, transportation mitigation / corridor mapping, or climate change modelling) (mean = 4.0) and have developed goals and objectives for connectivity within their respective agencies (mean = 4.3, the highest ranked question among all included in the survey).

A lack of financial resources for collaboration appear to be equally affecting both core protected area agencies and local government in their ability to effectively collaborate on connectivity. Both core protected area agencies and local governments also assessed the extent to which the planning activities of other agencies within their jurisdictions are impacting the ability of their agency to achieve connectivity conservation goals (e.g., transportation planning, climate change adaptation planning, etc.)? More detailed results organized by theme are presented below.

THEME 1: ADAPTIVE GOVERNANCE

Current Capacity:

- Across the 10 questions included in the Adaptive Governance domain, capacity to implement a range of governance mechanisms, including enabling policy and legislation, priorities for connectivity conservation, and human and financial resources, were consistently ranked by respondents as somewhat low to moderate.
- With the highest scored mean of 3.4/5, the adoption of goals and objectives for connectivity and integration were perceived to be relatively high, although there was considerable variation amongst respondents (Question 2). The extent to which

goals and objectives have been adopted was notably higher in local government agencies than core protected area agencies.

- Over 40% (7) of agencies identified the priorities of other agencies as either somewhat or mostly a barrier to the implementation of connectivity conservation initiatives (Question 3).
- With the lowest overall mean score (2.3/5) amongst all survey questions, dedicated financial resources for connectivity conservation was ranked lowest amongst all questions included in the survey by respondents (Question 8).
- Maintenance of ecological integrity within protected areas was noted as (implicitly) important to implementing connectivity conservation initiatives, irrespective of explicit connectivity goals.
- Respondents working at the municipal level provided many examples of where connectivity conservation has been mainstreamed into land use planning, including through EA/IAs (e.g., Vaughn in southern Ontario, where natural heritage systems must be considered) and Indigenous engagement protocols for EA/IAs.

Obstacles:

- Many organizations lack policy, legislation, and direction specifically for connectivity or integration. This gap was also noted in a number of case studies (see Three Borders, Algonquin to Adirondack (A2A), Rock Creek, and Yellowstone to Yukon (Y2Y) case studies).
- There is a lack of incentives or political pressure to develop and implement connectivity policy.
- Major obstacles identified by respondents included political priorities that tend to focus on ensuring resource development, fragmented land management systems and associated strategic planning (including private land ownership and forestry), lack of human and financial resources (for both protection and restoration), and lack of education and awareness. Many of these obstacles were identified by case study authors as well. A key obstacle identified in the case studies is the lack of government leadership and associated absence of policy tools. For example, in the Yellowstone-to-Yukon region there is little coordination by government at the landscape level of planning, there is need for a unified approach to legislation to simplify and enhance land use planning, few legal and policy tools are available to assess and mange cumulative effects, and lands and waters on the intervening landscapes are not provided a high degree of protection, which has a number of implications for connectivity conservation implementation.
- Growth focused on economic objectives was identified as a primary challenge to achieving connectivity conservation. Urban development, agriculture, forestry, and transportation issues typically take higher priority over functional connectivity planning.
- Restoring connectivity is sometimes perceived as a threat to the interests of many established land-use stakeholders even more than protected areas themselves because a much larger proportion of landscape may be implicated. This issue is also described in the A2A case study.
- Other noted obstacles included the focus on completing representative systems of protected areas, but no high-level direction or commitment to ensure connectivity.
- Many respondents noted the need for greater inter-agency and multi-level coordination, particularly with respect to the alignment of provincial and municipal government priorities.
- Provincial growth strategies tend to promote sprawl to accommodate population and economic growth without consideration of connectivity.
- Dense transportation networks and infrastructure planning were perceived as a major obstacle by many respondents.
- No legislative or policy requirements currently exist for connectivity planning. Staff often work to incorporate it knowing it is best practice for landscape decision-making.
- Not a single participant identified human resource capacity as completely adequate.
- There are no programs to financially incentivize small private landowners to manage their lands in a coordinated way to maintain connectivity, and in agriculture, no on-the-ground effort whatsoever is evident.

Needs and Recommendations:

- Environment and Climate Change Canada has not provided effective leadership and did not effectively coordinate the actions required to achieve Canada's 2020 biodiversity targets (Office of the Auditor General of Canada, 2018).
- A transformative recommendation included the establishment of a new agency to coordinate, facilitate and implement a connectivity conservation vision for Canada.
- Senior leadership, the public, the Council, and other administrators need to be educated on the importance of connectivity.
- It was recommended that legally established goals and indicators for connectivity could raise 'whole government' attention and, in particular, the ability and willingness to influence land use decision-making

outside protected area boundaries to maintain and restore connectivity. This gap is identified in the A2A case study and a description of how this issue was mitigated in Ontario is included in the Oak Ridges Moraine and the Long Point case studies, as well as the Niagara Region vignette in Chapter 3.

- It was noted by several respondents that policy should be developed in conjunction with transportation departments and other departments to ensure wildlife crossings are implemented for all major highways with adjacent protected wildlife corridor buffers. The Three Borders and the Rock Creek Corridor case studies illustrate the important role of transportation agencies in creating and/or protecting connectivity conservation areas. Moreover, the Ontario Ministry of Transportation has been actively engaged in connectivity conservation in northcentral Ontario along Highway 69 (Eco-Kare International, 2017) and in southwestern Ontario along the Rt. Honourable Herb Gray Parkway (Ministry of Transportation (MTO), 2016).
- Respondents identified the need for protection and connectivity to be integrated outside traditional protected area boundaries, through key planning processes like EA/IA. The Y2Y case study addresses EA/IA as well.
- Where mainstreaming has been successful at the provincial and territorial levels, integration with EIAs has been key. However, guidelines and requirements have often been 'soft'. Natural science and social science-based guidelines need to be developed and integrated into EA/IA programs and protocols.
- Major obstacles identified by agencies included competing land uses, lack of enforcement of provisions in key provincial wildlife zoning plans at municipal levels, poor multi-level government consultation, lack of process for designating OECMs in municipal settings, and lack of provision of tools for biodiversity conservation.
- Early lessons from case studies and research suggest that the conventional approach to protected area governance – state-owned or state-controlled areas – is not significant in the connectivity conservation context. Non-government organizations (NGOs) and others could be a conciliator in designing efficient and effective corridors between national and provincial parks and other conserved areas. The Three Borders, A2A, Rock Creek, and Y2Y case studies address this role for NGOs.
- A major identified barrier was the lack of legislative support to protect corridors, and a lack of integration of connectivity into regional plans. Lack of legislation and policy that addresses connectivity conservation is identified as gap in the Three Borders, Rock Creek Corridor and Y2Y case studies as well.
- Provincial growth strategies tend to promote sprawl to accommodate population and economic growth without consideration of connectivity.
- Dense transportation networks and infrastructure planning were perceived as a major obstacle by many respondents.
- All major land use sectors should have staff dedicated to conservation connectivity. This would include mines, petroleum, forestry, protected areas, biodiversity/wildlife, Crown land, agriculture and any other relevant agencies.
- Many respondents were not aware of available financial and human resources and planning initiatives by agencies other than their own.

THEME 2: PLANNING & IMPLEMENTATION

Current Capacity:

- With a mean of 3.4/5, recognition of the need for well-connected systems of protected areas and ACCs (e.g., OECMs) in strategic plans was assessed relatively as moderate to high (Question 11). Over 50% of respondents noted that their organization's strategic plan recognized connectivity conservation.
- The majority of organizations (56%) noted that connectivity conservation has either not at all or slightly been integrated into protected areas systems plans (mean = 2.6/5) (Question 12). A number of the case studies outline the strengths of current systems plans and planning tools (e.g., Halifax Regional Municipality, Three Borders, Oak Ridges Moraine, Long Point, Woodland Caribou Corridor, Rock Creek Corridor, and Y2Y). 64% (9) of organizations reported that the planning activities of external organizations either somewhat or mostly affect the ability to achieve connectivity conservation goals (Question 13).
- With a mean of 3.2/5, the capacity to identify areas for connectivity conservation was perceived as relatively high (Question 14). 13 agencies (76%) noted 'somewhat', 'mostly,' or 'complete' progress on this question. Many agencies at the local, provincial and territorial levels have completed inventory and mapping projects to support connectivity conservation. Municipal government evaluations were notably higher than core protected area agencies. Case study authors report their experiences with a variety of modelling and mapping tools (e.g., A2A, Oak Ridges Moraine, Long Point, Y2Y, Rock Creek Corridor, and Climate Change in B.C.).
- Partnerships with research institutions, including universities and private organizations (such as the NCC), have been key to the advancement of connectivity conservation through various activities such as gap analysis, wildlife mapping, corridor mapping, and climate change. Partnership was

noted as important in all case studies. Examples of partnerships between Indigenous communities and governments include the Woodland Caribou Corridor in Ontario and Manitoba, and the Tallurutiup Imanga in Nunavut case studies in this report.

- Strong relationships exist between some provincial conservation organizations and the NCC, which has helped facilitate the implementation of connectivity conservation initiatives. For example, NCC has been instrumental in the 2C1F, A2A, Long Point, and Rock Creek Corridor projects.
- Wildlife crossing considerations and road signage are increasingly integrated into road construction design in national parks. The case studies provide examples of engineered connectivity conservation infrastructure in Three Borders, Long Point, Rock Creek Corridor and Y2Y.
- With a mean score of 1.9/5, the extent to which connectivity mitigation has been designed and built into infrastructure outside of protected areas was assessed relatively as low (Question 16). The case studies suggest that this trend may be changing. Perhaps a Canada-wide survey of connectivity conservation programs could be added to the connectivity toolbox. For example, in the Y2Y region there are more than 100 designated wildlife crossing structures and associated fencing across busy roads that help keep wildlife connected and increase road safety; these can be within protected areas, or outside parks and if outside parks, lands on either side are generally secured from development, Effectiveness monitoring has been completed for some of these installations, which would be useful for operations engineering, planning and management. For example, highway mitigation in Banff National Park has reduced collisions by at least 80% and more than 96% for elk and deer alone (Y2Y case study).
- Citizen science is providing useful data for identifying the need for connectivity corridors (e.g., wildlife distribution and abundance and human-wildlife conflicts such as road mortality). Key examples of citizen science are described for Three Borders, Oak Ridges Moraine, Rock Creek Corridor, and Y2Y.

Obstacles:

- In many instances, key connectivity areas have been identified, but have not been acquired and/or restored.
- Connectivity conservation is not addressed in some jurisdictional strategic plans.
- Some jurisdictions do not sponsor incentive programs for the maintenance and/or restoration of connected areas outside of protected areas on the intervening landscapes and waterscapes. boundaries.
- Within provinces and territories, the majority of activities that affect connectivity are approved and undertaken without any regard for connectivity (e.g., roads and other activities associated with forestry, agriculture, urban development).
- Provincial and territorial conservation agencies encounter significant challenges working with other departments within their own government. One respondent noted that inter-agency partnerships are 'forced' through the EA/IA process.
- Many partnerships tend to be ad-hoc and sporadic, lacking long-term momentum.
- Other issues include bullying and outright refusal by some organizations to work with others(see the Y2Y case study).

Needs and Recommendations:

- Significant revisions to land-use rules and regulations are required to affect change, including revision to the criteria that define the conditions under which proposed development activities become subject to an EA/IA.
- Some plans recognize the value of connectivity but do not identify strategic actions to achieve it other than the protection of certain select areas of high connectivity importance.
- Development plans, urban growth plans, and regional land use plans should be updated to include connectivity conservation.
- NGOs could be an increasingly effective conciliator in designing efficient and effective corridors between national and provincial parks and other conserved areas. NGOs have been instrumental in the management and delivery of connectivity conservation programs through property acquisition, restoration and protection across Canada. The Three Borders, A2A, Oak Ridges Moraine, Long Point, Rock Creek Corridor and Y2Y case studies describe the key roles that NGOs have played in international and sub-national connectivity conservation programs.
- The awarding of access to publicly owned natural resources (e.g., forests and minerals) should include conditions that require developers to integrate provisions for connectivity conservation in their development plans.
- There is a need to better understand and recognize ecosystem services provided by protected areas, which could lead to a real and concrete integration of connectivity conservation objectives. The Halifax Regional Municipality, Oak Ridges Moraine, Long Point, Climate Change in B.C., and Y2Y case studies address the importance of ecosystem services valuation. The Long Point case study explores the value of ecosystem services and the important role that ALUS Canada plays in involving the farming community in the protection of ecological services.

The program provides payments to landowners to create and restore habitats that provide ecological services such as water purification and pollinator habitat. This is an excellent example of the integration of ecosystem services with the market economy. ALUS Norfolk is the longest continually running ALUS program in Canada and has engaged over 160 farm families (approximately 10% of the total for the county) and enrolled over 525 ha. As in many other protected areas, the ecosystem services provided by the Oak Ridges Moraine serve to mitigate the escalating effects of climate change (e.g., carbon sequestration and flood attenuation) and awareness of these services and their value (including a monetary equivalent) is an important part of planning and implementation.

- Initiatives such as Nature Legacy have and will continue to provide opportunities to better orient protected areas initiatives in ways that explicitly focus on connectivity as an outcome.

- Climate change modelling is perceived as an important need to advance the identification of areas important to connectivity conservation. The case study by Mann and Wright on climate change in B.C. (Chapter 4) illustrates the application of their climate-conscious and connectivity-focused systematic conservation planning methods in northern British Columbia's 'Wild Harts' of the Peace River Break. They integrated climate metrics and connectivity analysis to model the differences between scenario planning that explicitly incorporated climate targets and those that did not. This work should be included in the conservation connectivity toolbox.

- Connectivity metrics for monitoring and evaluation are needed. Quantitative tools for assessing connectivity conservation are relatively new to some organizations and being explored. Practitioners require access to and training in the use of connectivity tools (e.g., Circuitscape), which require significant data preparation and processing time, as well as interpretation before they can be used to identify systems or network planning options. The Three Borders, A2A and Y2Y case studies illustrate the application of Circuitscape and other tools and techniques available to practitioners. Noseworthy (2020) describes a number of other spatial planning tools available to practitioners.

- There is an opportunity to enhance partnership between government agencies by requiring industries responsible for land use change to address (e.g., maintain) connectivity conservation (e.g., road mortality surveys, options for 'work arounds', wildlife crossing structures, and fencing).

- Partnerships with universities was noted as important to identifying areas important for connectivity, including road mitigation projects within protected areas. The Climate Change in B.C., 2C1F, A2A, Rock Creek Corridor, and Y2Y case studies detailed in Chapter 4 exemplify projects with university partnerships, particularly with respect to research and modelling.

THEME 3: COLLABORATION & ENGAGEMENT

Current Capacity:

- 53% of respondents (9) noted the extent to which collaborative networks were established was either not at all or slightly implemented (Question 24).

- With a mean of 2.8/5, the extent to which agencies collaborate with partners to implement connectivity conservation initiatives was evaluated as moderate (Question 25). A number of case studies show the importance of partnership to the success of government-led and NGO-led conservation connectivity programs. While the 2C1F Collaborative led the Route 85 conservation connectivity project, the Québec government funded research and provided expertise, funded research, and committed to the development of connectivity infrastructure. As noted above, the Ontario government-led Oak Ridges Moraine initiative, 1) assumed responsibility for the care and management of the moraine's ecosystem services, 2) created the Oak Ridges Moraine Foundation, Oak Ridges Moraine Land Trust, and Oak Ridges Trail Association, and 3) funded a number of initiatives delivered by these partners. The NGO-led Rock Creek Corridor project was financially supported by the Alberta government.

- With a mean of 2.1/5, the extent to which there are dedicated resources to coordinate connectivity conservation was perceived as low.

- 11 (65%) of agencies noted that human and financial resources to support collaboration was either not at all or slightly adequate.

- No agency noted full integration of collaborative networks.

- Partnerships with universities were again noted as providing capacity for research beneficial to monitoring and reporting. As mentioned above, the Three Borders, A2A, Rock Creek Corridor, Climate Change in B.C., and Y2Y initiatives exemplify projects with university partnerships, particularly with respect to research and modelling.

Obstacles:

- Existing collaborative efforts have been largely ad-hoc and informal.

- For many, collaboration involving partners with significantly different mandates than those of the usual partners responsible for protected areas, wildlife agencies, land trusts and academics is in the early stages, including transportation agencies and municipalities.

Needs and Recommendations:

- Existing collaborative efforts have been largely ad-hoc and informal. Some respondents identified need for formal collaboration between municipalities, universities, and provincial/federal agencies to share knowledge and lessons learned.
- Going forward, partnerships involving scientists and practitioners responsible for applying scientific and engineering solutions are important to the success of conservation connectivity projects and programs. Collaboration between agencies working at various levels of government are critical to in-situ conservation connectivity programs at the municipal and regional levels of land use planning.
- The establishment of a pan-ecozone conservation network, similar to the U.S. Landscape Conservation Cooperatives (LCCs), comprising of public-private partnerships including provinces or territories, Indigenous Peoples, federal agencies, science-based non-governmental organizations (e.g., Canadian Council on Ecological Areas, Canadian Parks and Wilderness Society, Canadian Parks Council), universities, international organizations (e.g., CC-IUCN, WCPA), and others working together to address landscape, waterscape, and airscape conservation issues including connectivity should be considered. The purpose of the network would be to support natural and social science research on connectivity, harness the capacities and abilities of all partners in support of common conservation outcomes, and to serve as a strategic forum for collegial collaboration, coordination and integration.
- Existing partnerships should be leveraged where possible and appropriate. For example, the Canadian Council on Ecological Areas is particularly well positioned to help deliver on the recommendations calling for enhanced collaboration on connectivity. For nearly 40 years, the Canadian Council on Ecological Areas (CCEA) has fostered networking, partnering and excellence in the management of Canada's protected and conserved areas. The CCEA is well structured to foster involvement and collaboration among different protected areas jurisdictions and its various partners – individuals, professionals, students, and academics representing a wide variety of agencies, organizations and other institutions.

THEME 4: KNOWLEDGE MANAGEMENT & EXCHANGE

Current Capacity:

- With a mean of 2.9/5, support for staff training opportunities was perceived as low to moderate (Question 19).
- Many agencies noted the integration of Indigenous Knowledge into connectivity planning but noted that this has not been done or is in early stages of implementation due to capacity constraints (Question 20). There are some excellent examples of the combined application of traditional knowledge, community knowledge, and science-based knowledge in organizations throughout Canada. For example, the Sahtu case study describes the development of the Sahtu management plan, which defines traditional knowledge to mean *"... knowledge and values, which have been acquired through experience, observation, from the land or from spiritual teachings, and handed down from one generation to another"* and requires *"... equal consideration to relevant community traditional knowledge and modern science and expects applicants to do the same"* (Sahtu Land Use Planning Board, 2013).
- With a mean of 3.7/5, the incorporation of Scientific Knowledge into connectivity conservation planning was high (Question 21). It was the highest ranked theme amongst all questions included in the survey.
- Generally, connectivity conservation was perceived to be well-founded on scientific knowledge, when and where available.
- The use of Scientific Knowledge is expanding in some departments with new staff being hired or transitioned to research roles in the past year to expand research capacity.
- Some agencies noted legislative requirements for "state of" reporting (Ontario/Nunavut/Parks Canada), which has or will prompt inventory and monitoring.
- Obstacles:
- Training opportunities are limited due to the current economic climate. Training is not seen as effective or worthwhile if there is no ability to implement it.
- It was noted that decision-makers encounter conflicts of interest, which are primarily political in nature, so a massive investment in science does not necessarily translate into science-guided decisions.
- Many agencies lack formal funding programs to support research. Funding research projects can a complicated and tedious process due to bureaucratic hurdles and inconsistent funding.
- A lack of specific goals for connectivity conservation has meant little integration of inventory and monitoring.

Needs and Recommendations:

- Support for staff to attend conferences on transportations and wildlife, landscape ecology, and other areas relevant to connectivity conservation is required. Additional training on Circuitscape and other connectivity models/tools, for example,

would be useful, as well as methods/indices for assessing connectivity and identifying priorities for conservation and/or restoration/mitigation.

- Lack of resources for consultation was noted as a barrier to effective incorporation to Indigenous Knowledge. Dedicated and experienced personnel are needed to gain the trust of communities and ensure that knowledge is translated into planning outcomes.
- The number of bureaucratic hurdles should be reduced if better collaboration with researchers is to be achieved.
- Better science and tools are needed to help identify connectivity corridors.
- Agencies are increasingly relying on data relating to species occurrences from citizen science programs. However, there tends to be a lack of awareness and integration with conservation planning. Citizen science was effectively used to monitor road mortality in the Rock Creek Corridor project.
- More funding for citizen-science research projects and more staff resources to spawn and guide such projects is needed.
- Connectivity metrics are required to identify, protect, and manage ecological cores and corridors (linkage areas). The Three Borders, A2A, Rock Creek Corridor and Y2Y case studies report on their use of connectivity metrics and the conservation toolbox developed by Noseworthy (2020) provides some useful references.

CONCLUSIONS

The results of the survey reveal an over-riding need for more resources to build capacity for connectivity conservation implementation within both core protected areas organizations and local governments. These results are of concern because they are consistent with other protected area/conservation organizational capacity assessments on a variety of issues (Barr, Larson, Beechey, & Scott, 2020; Lemieux, Groulx, Bocking, & Beechey, 2018; Office of the Auditor General of Canada, 2013, 2018; Office of the Auditor General of Ontario, 2020) which have revealed long-term, persistence challenges implementing strategies to establish and manage protected areas and adequately safeguard biodiversity. While constraints such as limited financial resources, limited capacity, and lack of understanding of real or anticipated connectivity conservation needs will need to be eliminated, an immediate need will be to bring the diverse and growing Canadian conservation community together to begin the process of developing a national connectivity strategy. These and other recommendations are detailed in the Executive Summary and Conclusions of this report.

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Pacific Rim National Park Reserve, British Columbia (Photo by Chris Lemieux)

CHAPTER 5

(Re)Connecting Canada: Setting the Table for Transformation

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INTRODUCTION

The establishment of networks of protected areas and ecological corridors is an economically feasible and ecologically necessary component of effectively conserving biodiversity. However, the sheer cumulative extent and magnitude of the impacts from habitat loss and fragmentation, harvesting (legal or otherwise), pollution, climate change, invasive species, and other direct and indirect causes of mortality will more than offset any gains if we fail to address these threats to growing biodiversity loss.

Canada's current system of protected and conserved areas is woefully inadequate to ensure the long-term persistence of biodiversity. Ecosystems remain unprotected, especially in southern regions. Between 1970 and 2016, the populations of Canadian species assessed as at-risk nationally have declined by 59 per cent, on average (World Wildlife Fund (WWF)-Canada, 2020). Between one-half to two-thirds of the areas that supply and provide key ecosystem services in Canada overlap with current and planned natural resource extraction (Mitchell et al., 2021). Demands for the goods and services produced by agriculture and forestry are projected to increase over the coming decades as a result of population growth, increasing average wealth, and other demographic changes. Similarly, the increasing spatial demands of transportation infrastructure and predicted continued growth in traffic flows will further exacerbate conflicts between infrastructure development and biodiversity conservation. Such impacts will be magnified with infrastructural adaptions in response to climate changes such as sea-level rise, more frequent and severe wildfires and floods, and melting sea ice and permafrost.

Precipitous declines in biodiversity threaten the planet's living systems (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2019; Steffen et al., 2015; World Wildlife Fund (WWF)-Canada, 2019). Biosphere integrity, which regulates the stability of the Earth system, is at 'high risk', currently exceeding the 'safe operating space for humanity': it is 'beyond the zone of uncertainty' that human perturbations will destabilize the system at a planetary scale (Steffen et al., 2015).

A key message in the recent *Global Assessment Report on Biodiversity and Ecosystem Services* of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2019) is that stemming the precipitous declines in biodiversity will only be achieved through transformative changes. These will entail system-wide re-organization of our sense of reality and associated paradigms, goals and values across economic, social, political and technological sectors (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2019).

Foundationally, we will need to embrace transformative changes in how we organize and run our institutions so that we can value ecosystems and allocate the ecosystem services that hold the key to a quality life. It seems that we must complete this search together, and in reality, it's about leadership, not just by who but how. As Nancy Chahwan, Chief Human Resources Officer at the Treasury Board of Canada Secretariat recently commented at the Global Government Forum, "*"The future isn't what it used to be," and rapid technological and social changes are making it increasingly difficult to predict how the challenges facing governments will evolve. There is, she added, an "ambiguity about the future state of things"*, and "it is in these times of ambiguity and unpredictability that leadership becomes a key element of success for organizations'" (Ross, 2019).

Existing protected and conserved areas are not sufficiently large, located or connected to stem the decline of biodiversity on their own. Key recommendations to enhance biodiversity conservation through the implementation of connectivity conservation in Canada may be drawn from this report (Table 1; see also Executive Summary). In order to mitigate habitat loss and fragmentation beyond the boundaries of protected and conserved area, they will need to be expanded into ecological networks that are connected by ecological corridors and integrated into truly sustainable use of landscapes and seascapes (Hilty et al., 2020).

Integration will entail transformational efforts to mainstream biodiversity considerations into forestry, agriculture, energy/mining, urban and rural planning, transportation and infrastructural developments, and environmental assessment and other legislative and policy tools. Transformations in these sectors and agency mandates will be essential in ensuring not only the conservation and sustainable use of biodiversity, but in many instances the continued legitimacy of the sectors and governing agencies themselves. Furthermore, development proposals affecting the ecological structure and composition of landscapes and waterscapes will require rigorous review through more effective environmental/impact assessment (EA/IA) at federal, provincial, and territorial levels (F/P/T). Such assessment should emphasize the need to implement appropriate measures and options for avoiding and reducing both direct and indirect threats to biodiversity and ecosystem functions, including for individual proposed projects as well as strategic and regional assessments (i.e., evaluating the existing or proposed policies, plans, or programs relevant to impact assessment; to evaluate the costs, benefits, and impacts of past, present, and future physical activities carried out in a region). All of these efforts will require dramatically enhanced collaborative mechanisms across sectors and governance systems, including with Indigenous Peoples.

A large part of the reason why Canada has ultimately failed to meet the majority of the Aichi Targets by 2020 is due to a lack of measurable targets and milestones (Green et al., 2019), attention to qualitative aspects of the targets, and a clear implementation plan on how Canada's diverse conservation community can work together to achieve desired ecological and social outcomes, including those related to connectivity. Moving forward, achieving the goals and targets in the United Nations (UN) *Convention on Biological Diversity* (CBD) *Post-2020 Global Biodiversity Framework* will require concerted commitment to shared governance (power) arrangements established by Indigenous Peoples, federal, provincial/territorial, and local governments,

Table 1. Summary of recommendations to enhance implementation of connectivity conservation in Canada.

Adaptive Governance (Legislation, Policy, Goals, etc.) – 'Mainstreaming'	**Primary Strategic Recommendation:** Mainstream ecological connectivity across sectors by adapting F/P/T legislation, regulations, and policies to mandate the prevention and mitigation of impacts on connectivity and to require that the costs of doing so be built in	
	Immediate term	**Short term**
	Require provisions for connectivity retention, restoration and mitigation in F/P/T infrastructure funding Invest in staffing and provide resources required to actively enforce legislation and regulations and adhere to policies governing activities that influence connectivity	Include requirements for connectivity protection, mitigation and restoration in F/P/T EA/IA legislation and associated regulations Update F/P/T legislation, regulations and/or policies to include responsibilities to restore and conserve ecological connectivity in the mandates of agencies whose activities impact it (e.g., transportation, forestry, agriculture, energy and mining) Assert connectivity interests in P/T legislation governing municipal governments and require municipal planning to protect and restore connectivity and compensate for impacts on connectivity Mainstream protected and other conserved areas and other measures that support connectivity conservation (including restoration of ecological integrity) in national and sub-national climate change mitigation and adaptation plans as 'natural climate solutions' (NCSs) Identify synergies with other multi-lateral environmental agreements and goals, such as the UN Sustainable Development Goals (SDGs), to streamline reporting requirements
On-the-Ground Planning & Implementation	**Primary Strategic Recommendation:** Prioritize the funding of on-the-ground connectivity conservation retention and restoration	
	Immediate term	**Short term**
	Identify focal areas for the retention and restoration of ecological networks and corridors of national, sub-national, and cross-border importance Adopt specific connectivity targets for protected and conserved areas	Establish F/P/T legislation, regulations or policies to conserve ecological networks and corridors of national, sub-national and cross-border importance FPT governments establish or update financial programs for Crown lands and financial incentives for non-Crown lands to conserve areas important for ecological connectivity Plans are implemented to ensure the Trans-Canada Highway and other major highways do not impede ecological connectivity
Collaboration & Engagement	**Primary Strategic Recommendation:** Foster collaboration among connectivity conservation promoters and influencers	
	Immediate term	**Short term**
	Establish a national connectivity partnership	Develop a national ecological connectivity conservation strategy in collaboration with and endorsed by partners Establish 'regional transboundary conservation cooperatives' (RTCCs) to support coordinated cross-boundary and inter-agency conservation efforts F/P/T governments adopt specific connectivity targets for protected and conserved areas as well as for natural ecosystems

	Primary Strategic Recommendation: Invest in social and natural science research to build the evidence-base and support effective implementation of connectivity conservation	
	Immediate term	**Short term**
Knowledge Management & Exchange	Invest in social and natural science research and knowledge mobilization activities to support effective planning and implementation of connectivity conservation including design, monitoring and reporting	Develop and monitor connectivity conservation metrics, inclusive of both the natural and social science dimensions of connectivity conservation Train staff to support connectivity conservation efforts Collaborate with the broader conservation community, including research organizations (e.g., universities), science-based non-governmental organizations (NGOs), Indigenous Peoples and organizations, and others to help inform the evidence-based management of ecosystems and connectivity conservation areas that support biodiversity outcomes

and private landowners who are actively engaged in biodiversity conservation.

Raising awareness of the socio-ecological costs of ignoring connectivity in our decision-making, and the benefits of retaining and restoring connectivity, will be necessary endeavors. Sustained funding for the implementation of Canada's post-2020 conservation agenda, including transformative adjustments to the legal, regulatory, and policy environments, and to the landscape of deliberate and inadvertent financial incentives that currently result in decisions that degrade connectivity, are urgently required. As Maxwell et al. (2020) emphasize, governments must future-proof area-based conservation by mainstreaming biodiversity across environmental and socio-economic policies.

Protected and other conserved areas will not solve the global biodiversity crisis on their own. While they are crucial and may carry much of the weight, their ultimate effectiveness largely depends on the capacity and management of surrounding landscapes and planetary systems to support ecological connectivity and other transboundary processes. The engagement of private sectors, the public, and decision-makers will also be key to achieving the transformations required to reduce threats and stem ongoing biodiversity loss. Development of evidence-based guidance using natural, social, and Indigenous forms of knowledge, collaborative and multi-scalar ecological network design and actions plans, the establishment of comprehensive monitoring networks, and review mechanisms to assess the effectiveness of both social and ecological conservation outcomes will all be necessary to achieve a more ecologically and socially connected Canada (Lemieux et al., 2018). Given that social connectivity and natural connectivity are integral elements of cultural life and individual health and well-being, leadership and participation by Canada's Indigenous Peoples will be key to both retaining connective and reconnecting Canada (Indigenous Circle of Experts (ICE), 2018). Indeed, the continued push for biodiversity conservation in the absence of consent and direct involvement of Indigenous groups would only serve to further entrench contemporary and unethical colonization practices and miss important opportunities (Artelle et al., 2019; Loring & Moola, 2020; Zurba et al., 2019).

The protection and restoration of connectivity is key to a healthy environment, intact ecosystems, and viable and abundant populations of wildlife. Environments in which these characteristics are healthy are more stable, adaptable, and hospitable to the lives of people and the other species that inhabit Earth. Humanity, even with all its distractions, can be reminded of our connections to and dependence on healthy environments through effective social marketing. Marketing will be key to increasing public and decision-making support for changes that tip cost-benefit analyses toward retaining and restoring connectivity. Greater efforts are needed to reach the public and influence their behaviour in a context of overwhelming information and constant availability of entertainment (Wright et al., 2015). As Wright et al. (2015: 1) emphasize, *"Without the ability to influence human behaviour, a conservationist's role will likely be limited to that of describing the loss of biodiversity and the decline of the environment."*

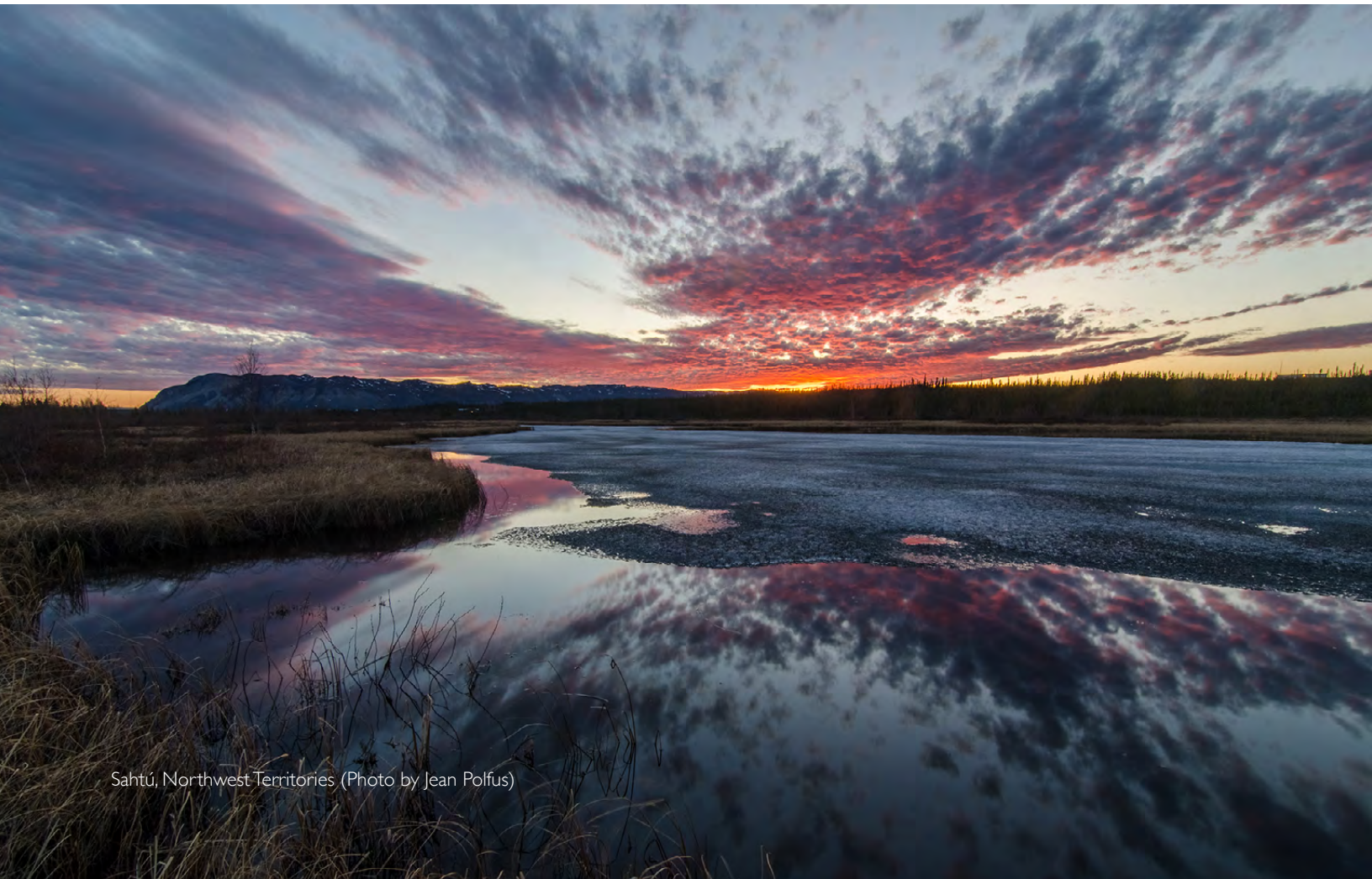
Recently, the COVID-19 pandemic, which continues to affect the lives of all Canadians, has shown us that much more of Canada's terrestrial, freshwater, and marine area needs effective protection to sustain the healthy ecosystems that Canadians rely on. Indeed, ecological integrity is lost when industrial activities expand into previously remote areas with limited human access (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2019), and further incursions risk exposures that may place all species at risk. Governments in Canada at all levels will need to put nature conservation at the heart of the country's recovery from the COVID-19 pandemic (Canadian Parks and Wildnerness Society (CPAWS), 2020). This recommendation was recently supported by The Task Force for a Resilient Recovery, who detailed '5 Bold Moves' to ensure a resilient recovery for Canada from the COVID-19 pandemic. At the forefront of the report's recommendations was to *"Invest in the Nature that Protects and Sustains Us"* (The Task Force for a Resilient Recovery, 2020). The report went on to aptly state that *"…our nature economy is Canada's secret weapon for spurring a resilient recovery from COVID-19."* (The Task Force for a Resilient Recovery, 2020: 19)

The UN *2015 Paris Agreement on Climate Change* reinforces the need for meaningful commitment to the UN *Post-2020 Global Biodiversity Framework* and its 2050 Vision of 'Living in Harmony with Nature'. The *Paris Climate Agreement* declared a commitment to hold "the increase in the global average temperature to well below 2°C above preindustrial levels" and to pursue efforts to limit the temperature increase even further to 1.5°C (United Nations Framework Convention on Climate Change (UNFCCC), 2015). Without the agreement, projected average global temperatures could increase by 4°C, resulting in a variety of catastrophic and irreversible climate change impacts on biodiversity (Intergovernmental Panel on Climate Change (IPCC), 2018). In Canada, the rate of warming has already increased at nearly double the global average contributing to the re-distribution of flora and fauna, increases diseases and extreme weather events, and other impacts (Bush & Lemmen, 2019).

Canada's commitment to curbing climate change presents another opportunity to enhance complementary efforts on biodiversity conservation and integrate protected areas and connectivity as natural climate solutions (NCS) (Griscom et al., 2017; Smith, 2020) to help to meet the interrelated goals of both the *Paris Agreement* and the CBD. NCSs can help mitigate climate change by increasing carbon sequestration and reducing emissions of carbon and other greenhouse gases through conservation, restoration, and improved management practices in forests, wetlands, and grasslands. Ecological networks of protected and conserved areas connected by ecological corridors will help to mitigate the impact of global warming, assisting species' migration, helping to maintain critical environmental functions such as hydrological cycles, and enhancing the resilience and integrity of regional ecosystems, among other social and economic functions and ecosystem services (Dudley et al., 2010; Hilty et al., 2020).

While both the imperative for change and an effective way of doing so through connectivity conservation are clear, both the opportunities and challenges are critical, and they differ across the country and from north to south. Taken collectively, it is clear that Canada has a unique and critical conservation challenge in the coming decades, and we must ask the important question: *Can we protect some of the world's last intact wild areas in northern Canada and can we conserve and restore the fragments of nature that remain in southern Canada where most Canadians live?*

In the north, Canada's boreal, taiga and arctic regions contain some of the planet's last intact natural areas (Watson et al., 2018). Canada is one of the few nations that has an opportunity to protect vast, largely intact areas with free-flowing rivers, undeveloped valleys and long-distance animal migrations – with this comes a global responsibility. And yet, these wild places are not without human relationships: Indigenous people in Canada have practiced land management for generations. Inuit, First Nations, and Métis peoples have constitutionally protected rights to the land, fish, and widllife. Indigenous-led protected and



Sahtú, Northwest Territories (Photo by Jean Polfus)

conserved areas represent a crucial opportunity to honour and acknowledge the important contributions Indigenous peoples have made and continue to make to biodiversity conservation through their effective stewardship and governance of the lands and waters (Indigenous Circle of Experts (ICE), 2018). To explore and support opportunities for IPCAs and other Indigenous governance systems for conservation and reconciliation is potentially one of Canada's most important contributions to global biodiversity conservation and social justice. As human developments and the impacts of climate change continue to affect northern regions, a co-developed comprehensive vision of how Indigenous and non-Indigenous Canadians may work together is needed to conserve huge areas of the country.

In southern Canada, the challenge is very different, but similar to many other countries where nature has been reduced to isolated fragments. Here, the task is not solely to stop the continued loss and degradation of ecosystems but also to repair, restore and reconnect the remnants that remain. Many existing protected areas will continue to pay an 'extinction debt' (Tilman et al., 1994), with the continued loss of wildlife until they are connected within ecological networks and embedded in ecologically sustainable landscapes and waterscapes. For these and other fragmented landscapes, the UN Decade of Ecosystem Restoration (2021-2030) provides an enhanced focus: *"promoting a global movement focusing on restoration; developing legislative and policy frameworks to incentivize restoration; developing innovative financing mechanisms to fund operations on the ground; detailing a values-based imperative to conserve, restore and care for nature; undertaking social and natural science research on restoration in terrestrial, freshwater, estuarine as well as marine environments; monitoring global progress on restoration; and building the technical capacity of restoration practitioners globally"* (United Nations (UN), 2020) (see https://www.decadeonrestoration.org/).

Finally, a growing recognition of the need to support the supply and provision of ecosystem services and NCSs in our cities and rural landscapes will also create new opportunities for policies and projects to improve connectivity across southern Canada. While attention to ecosystem services is crucial, providing many side-benefits and overlapping values in support of biodiversity, it is also important to acknowledge the conflicts and spatial mismatches between some categories of these services and biodiversity conservation, as well as the locations of service capacity and provision (Mitchell et al. 2021) and thus the need for a continued strong policy focus on biodiversity objectives (Buchmann-Duck & Beazley, 2020; Cimon-Morin et al., 2013).

Canada's new target of protecting 30% of lands and oceans by 2030 provides an historic opportunity to enhance connectivity within a network of protected and conserved areas. Based on area alone, the amount of protected and conserved lands in Canada will need to increase by approximately 1.8 million square kilometers to meet this target (Environment and Climate Change Canada (ECCC), 2020). But as we learned from past Aichi targets, the greatest challenge may not be protecting 30%, but protecting the most critical 30% that best protects nature. Many elements of biodiversity need to be included in these efforts, ranging from habitats for endangered, wide-ranging, or endemic species to Key Biodiversity Areas (KBAs). But for all protected areas and OECMs, maintaining and restoring their ecological connections that reach through the landscape and maintain the flow and exchange of wildlife populations, water and nutrients is essential.

Building resiliency in nature is critical for the protection of biodiversity and also strengthens the ecological foundation that supports economies and societies. In a world that is rapidly changing, and the consequences of biodiversity loss are no longer theoretical, building a healthy network of connected protected areas is one of the most critical infrastructure projects of our generation. Meeting this challenge is essential for the future of nature in Canada and the well-being of Canadians.

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APPENDIX 1

Connectivity Conservation Capacity & Needs Assessment Survey

THEME 1: ADAPTIVE GOVERNANCE	
1-PRIORITY-internal	The UN Convention on Biological Diversity (CBD) Aichi Target 11 states that: "By 2020, at least 17 per cent of terrestrial and inland water areas and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascape." *In light of the above, to what extent is connectivity conservation a priority within your agency?*
2-PRIORITY-external	To what extent do the priorities of other agencies within your jurisdiction, other levels of government, and other land-use planning stakeholders present barriers to achieving connectivity conservation objectives within your agency (e.g., resource development, transportation, urban sprawl, etc.)?
3-GOALS-internal	To what extent has your agency adopted goals and objectives for ensuring that protected areas and OECMs) are connected and integrated into the wider landscape?
4-GOALS-external	*To what extent do the goals and objectives of other agencies within your jurisdiction, other levels of government, and other land-use planning stakeholders inhibit the effective implementation of connectivity conservation goals within your agency?*
5-MAINSTREAMING	Mainstreaming is the integration of connectivity conservation into policies, strategies, plans, and guidelines used by an organization to successfully meet its core business goals and objectives (such as protecting or maintaining ecological integrity). *Considering the above, to what extent has your jurisdiction attempted to mainstream connectivity conservation into land-use planning?*
6-HR-Internal	To what extent does your agency dedicate the necessary human resources to implement effective connectivity conservation?
7-HR-external	To what extent do other agencies within your jurisdiction, other levels of government, and other land-use planning stakeholders dedicate the necessary human resources to implement effective connectivity conservation (e.g., other land-use planning agencies, transportation, etc.)?
8-FR-internal	To what extent does your agency dedicate the necessary financial resources to implement effective connectivity conservation?
9-FR-external	To what extent do other agencies within your jurisdiction, other levels of government, and other land-use planning stakeholders dedicate the necessary financial resources to implement effective connectivity conservation (e.g., other land-use planning agencies, transportation, etc.)?
10-POLICY & LEGISLATION	Given that decisions about the allocation of land resources and assets are complex and are likely to become more so as demand for access to resources increases, it is important to keep policy and legislation current and responsive as conditions evolve and new knowledge is acquired. Policy frameworks include, but are not limited to, legislation, standards, procedures, regulatory frameworks, and guidelines. *To what extent do the policy frameworks employed in your jurisdiction enable the mainstreaming of connectivity conservation?*
THEME 2: PLANNING AND IMPLEMENTATION	
11-STRATEGIC PLANNING	Strategic planning is used both as a catalyst for change and as a tool to manage for change that serves to identify, establish, and modify short- to long-term direction in support of an organization's vision for the future (e.g., biodiversity representation targets, and ecosystem structure and function targets such as connectivity). *To what extent does your jurisdiction subscribe to a strategic plan that recognizes the importance of establishing a well-connected system of protected areas and OECMs?*

12-PLANNING-internal-1	Given that a commitment to biodiversity conservation requires decision-making about the allocation of natural assets inside and outside of protected areas at the landscape and waterscape levels of planning, systems approaches are being integrated into national, subnational, and regional planning programs. The need for systematic approaches designed to keep ecosystems protected, managed, and connected are critical as demand for access to natural resources and/or assets grows. To what extent does your agency's protected areas systems plan (if applicable) include plans for connecting protected areas and OECMs and integrating them into the wider landscape?
13-PLANNING-external-1	To what extent do the planning activities of other agencies within your jurisdiction affect the ability of your agency to achieve connectivity conservation goals (e.g., transportation planning, climate change adaptation planning, etc.)? For this question, you may want to reflect on agencies and organizations that may have a large impact on the implementation and effectiveness of connectivity conservation outcomes. For example, are there planning provisions to provide for connectivity in new construction or retrofitting / rebuilding existing infrastructure? Are transportation barrier-mitigation planning initiatives integrated with land-use and protected areas planning?
14-PLANNING-internal-2	To what extent has your agency identified areas important for connectivity conservation (e.g., through gap analyses, connectivity (wildlife) mapping, transportation mitigation / corridor mapping, or climate change modelling)?
15-PLANNING-external-2	To what extent has your agency collaborated with other agencies within your jurisdiction, other levels of government, and other parties interested in land-use planning stakeholders to identify areas important for connectivity conservation, including connectivity mitigation? Connectivity mitigation refers to measures which offset negative impacts of development (e.g., wildlife crossing structures, fencing, road signage).
16-IMPLEMENTATION-1	To what extent has connectivity mitigation (e.g., wildlife crossing structures, fencing, road signage) been designed and built into infrastructure within your agency's protected areas network (i.e., within the boundaries of protected areas)?
17-IMPLEMENTATION-2	To what extent has connectivity mitigation been designed and built into infrastructure (e.g., wildlife crossing structures, fencing, road signage) in the vicinity of your agency's protected areas (e.g., surrounding landscapes / greater protected area ecosystems)?
18-OPERATIONS	An operations plan provides detailed guidance on how to achieve measurable outcomes. An operations plan tends to focus on the location and timing of in-situ conservation practices guided by best management practices, guidelines, and other tools and techniques. *To what extent does your agency have access to the connectivity tools, techniques, and data needed to achieve connectivity conservation outcomes?* For this question, you may want to reflect on the full range of data that could support connectivity conservation including, but not limited to, wildlife collision data, land-cover and habitat suitability data, existing infrastructure barriers, connectivity analyses, cost-benefit analysis tools, climate and water-flow modelling, citizen science data, etc.
THEME 3: KNOWLEDGE MANAGEMENT & EXCHANGE	
19-KM-1	*To what extent does your agency support staff training opportunities related to connectivity conservation?*
20-KM-2	*To what extent is Indigenous Knowledge incorporated into planning and decision-making for connectivity conservation within your agency?*
21-KM-3	*To what extent is Scientific Knowledge incorporated into planning and decision-making for connectivity conservation within your agency?*
22-KM-4	*To what extent is Community/Local Knowledge (including citizen science) incorporated into planning and decision-making for connectivity conservation within your agency?*
23-KM-5	*To what extent do agency (or broader jurisdictional) inventory, monitoring, and assessment programs enable the evaluation of "connectivity conservation-related outcomes" and associated "state-of" reporting?*

THEME 4: COLLABORATION & ENGAGEMENT	
24-COLLABORATION-1	*To what extent are collaborative networks in place to facilitate connectivity conservation planning initiatives?*
25-COLLABORATION-2	The implementation of connectivity conservation initiatives benefits from the active engagement of people with diverse goals, values, interests, knowledge and perspectives. A culture of partnership is key to successful implementation of connectivity conservation initiatives, and collaboration is a fundamental requirement for most, if not all, proactive and adaptive decision-making and program management strategies. *To what extent does your agency collaborate with partners to implement connectivity conservation initiatives at a scale that will enable achievement of a well-connected network of protected areas and OECMs? Examples of partners may include transportation agencies, resource agencies, municipal planners, land trusts, etc.*
26-COLLABORATION-3	To what extent are there dedicated resources (human and financial) to coordinate collaboration with partners in support of connectivity conservation?

APPENDIX 2

Author Biographies

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A Professor at Dalhousie University's School for Resource and Environmental Studies, Karen's applied scholarship focuses on biodiversity conservation system design, co-production of knowledge, and conservation through reconciliation. Her research interests include protected areas planning, wildlife conservation in a climate change context, international conservation goals and targets, re-Indigenization and decolonizing people and nature, ecological corridors and networks in terrestrial and aquatic (freshwater and marine) realms, and Indigenous research ethics. She is a Director of the Canadian Council on Ecological Areas, Member of the IUCN World Commission on Protected Areas, and Special Member of the Canada Pathway Connectivity Working Group. https://www.dal.ca/faculty/management/sres/faculty-staff/our-faculty/karen-beazley.html

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Between 1970-2001, Tom Beechey worked with the Ontario Principal Parks program where his efforts were focused on representing and conserving Ontario's ecological diversity in the parks system. Since retiring as the Senior Conservation Biologist with Ontario Parks in 2001, he has been very active in consulting and volunteer efforts on nature conservation, notably extending his longstanding association with the Nature Conservancy of Canada. His keen interest in collaborative approaches and capacity building for nature conservation include helping with establishing Carolinian Canada, the Parks Research Forum of Ontario, the Ontario Natural Heritage Information Centre, and other initiatives. He is a founding member of the Canadian Council on Ecological Areas (CCEA), now serving on the CCEA Board. He has authored, co-authored, and collaborated on many publications and technical reports on nature conservation

Gary Bell

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Gary Bell retired from the Nature Conservancy of Canada (NCC) in 2019, after 14 years as Program Director for Eastern Ontario. Dr. Bell holds degrees from Queen's University and Carleton University and held postdoctoral fellowships at UCLA and Boston University. He previously worked for The Nature Conservancy (TNC), first in Southern California where his work with conservation partners received a citation from President George H. W. Bush. As Director of Conservation Science in New Mexico, he was responsible for conservation planning across a large portion of the Southwest and led a team in TNC's Global Habitat Assessment. In 2006, he joined NCC where he was involved in conservation planning and land securement and negotiated the purchase of approximately 10,000 acres of priority conservation lands in the Frontenac Arch and the Ottawa Valley.

Victor Doyle

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A professional planner, Victor worked for the Ministry of Municipal Affairs from 1988-2017 where he was intimately involved in the design, development, implementation, defense of, and educational outreach on the Oak Ridges Moraine Conservation Plan while also leading the development of Ontario's Greenbelt Plan. A staunch advocate and practitioner of multi-disciplinary, landscape level, watershed-based planning approaches, terrestrial and hydrological connectivity and stakeholder engagement underpin his work.

Danah Duke

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Danah Duke is the Executive Director of the Miistakis Institute, a not-for-profit, charitable applied research institute affiliated with Mount Royal University. Miistakis's vision is a world where communities have access to the science and research they need to make choices that promote healthy landscapes. Danah works at the interface between academia, policy and decision-making, and community conservation focused on human wildlife coexistence, transportation ecology, citizen science, and conservation planning. Her experience also includes non-profit management and governance, facilitation, collaboration, and community engagement.

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Jessica Elliott is a Park Planner for the Government of Yukon and former Chair of the Canadian Council on Ecological Areas. She has a Master's degree in Environmental Design from the University of Calgary with over 12 years of experience in protected areas design, establishment, and management for both the governments of Manitoba and Yukon. Prior to working in the protected areas field she worked in wildlife management and environmental education.

Louise Gratton

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Louise Gratton is a consultant in ecology and conservation. She has a Master's degree in Biology from UQAM (1981) and over 40 years of experience in these fields, including 12 years as Science Director of Nature Conservancy Canada, Quebec region. As a consultant, she has worked with federal and provincial agencies, non-governmental organizations, and landowners across Quebec. Louise is a founding member and acting secretary of the Appalachian Corridor and was involved with Two Countries, One Forest from its

inception. She is also acting chair of Nature Québec. Over the years, Louise has received several awards recognizing her commitment to biodiversity conservation, including the 2011 Pierre-Dansereau Award from the Quebec Biologists Association and the 2019 Gold Leaf Award from the Canadian Council on Ecological Areas.

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Paul holds a Ph.D. in Biology, is a certified wildlife biologist, and is comfortable working on assignments that range from broad strategic planning and policy initiatives to applied research and management projects. During his 40+ year career, Paul has worked on a variety of natural asset management projects in Canada (Ontario, Alberta, and the Northwest Territories) and Zimbabwe, where he has served as a wildlife biologist, environmental impact assessment biologist, habitat management supervisor, science policy analyst, strategic planner, natural heritage area specialist, and a climate change program advisor and project coordinator. Paul currently works as a consultant with a focus on climate change and protected area issues.

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Claudia is a Protected Areas Biologist for the Government of the Northwest Territories for the past 12 years and provides broad ecological expertise to protected areas, ecological representation, biodiversity conservation, and connectivity planning. Prior to working for the Government of the Northwest Territories, she worked for the North Slave Métis Alliance, an indigenous organization, for two years. She is Chair of the Canadian Council on Ecological Areas.

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Chris is a biologist for Ontario Parks, Ministry of Environment, Conservation, and Parks, in Red Lake, Ontario. She has focused on landscape ecology, fire ecology, species at risk habitat management, and long-term monitoring. A highlight of her work is teaching youth ecological concepts and backcountry skills.

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Craig Harding is the Director of Conservation Science and Planning for the Nature Conservancy of Canada (NCC), a non-profit that works across Canada. He has experience developing conservation planning strategies at a variety of scales, to better position the organization to collaborate with other groups. Craig has worked with NCC for over five years, and has been actively involved in connectivity-related projects over that time. In addition to conservation planning, Craig's work connects the organization with academics, researchers, and project specialists that can help integrate new and exciting science, research, and ideas into NCC's planning, securement, and stewardship work.

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Jodi Hilty is president and chief scientist of the Yellowstone to Yukon (Y2Y) Conservation Initiative, a joint US-Canada non-profit organization. Y2Y's vision is an interconnected system of wild lands and waters stretching from Yellowstone to Yukon, harmonizing the needs of people with those of nature. She is a conservation biologist specializing in ecological corridor and large landscape research and has over 20 years of experience managing large landscape conservation efforts. She works to apply science-based solutions to complex challenges and to advance conservation by leading science-informed community-based and collaborative conservation efforts.

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Rachel Hodgson is a Master of Environmental Studies student at Wilfrid Laurier University. She holds a BES in Environment, Resources, and Sustainability from the University of Waterloo, and an advanced diploma in Ecosystem Management Technology from Fleming College. Rachel's Masters research examines the implementation of effective connectivity conservation measures from protected areas agencies and partners' perspectives.

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Aerin Jacob is a conservation scientist at the Yellowstone to Yukon (Y2Y) Conservation Initiative, a joint U.S.-Canada non-profit organization focused on landscape connectivity across western North America. Trained as an ecologist, she has worked in research, conservation, teaching, and consulting in North and Central America and East and Central Africa. Her research and conservation interests include species at risk, animal behaviour, ecosystem services, conservation and land-use planning, and the science-policy interface. She serves on the boards or policy/conservation committees for philanthropic and scientific societies and is active in science communication. www.aerinjacob.ca

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Dan is the Senior Conservation Biologist with the Nature Conservancy of Canada's national office. He is an expert on Canadian biodiversity and has authored reports on topics ranging from endemic species to Key Biodiversity Areas to species at risk legislation. Dan often shares his passion about nature conservation and his editorials have appeared in media across Canada. He is a councillor for the Canadian Society for Ecology and Evolution and Deputy Chair of the Committee on the Status of Species at Risk in Ontario. Dan also teaches about wildlife extinction and recovery at the University of Waterloo.

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Tracy is a senior project manager at the Miistakis Institute, a research institute affiliated with Mount Royal University. Miistakis's vision is a world where communities have access to the science and research they need to make choices that promote healthy landscapes. Over the last 15 years Tracy has developed expertise in the fields of citizen science, transportation ecology, conservation planning, and human and wildlife co-existence.

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Chris Lemieux is an Associate Professor and John McMurry Research Chair in Environmental Geography at Wilfrid Laurier University, Ontario. His research interests broadly focus on protected areas policy, planning, and management, with special attention paid to evidence-based decision-making, international conservation goals and targets, climate change, and the human health and well-being benefits associated with contact with nature. He is a Director of the Canadian Council on Ecological Areas (CCEA) and a Member of several task forces associated with the IUCN World Commission on Protected Areas (WCPA). https://bit.ly/2SczG7p

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David MacKinnon is the System Planning Coordinator in the Protected Areas and Ecosystems Branch of Nova Scotia Environment. He is currently Vice-Chair of the Canadian Council on Ecological Areas, Co-Chair of the Pathway to Canada Target 1 Connectivity Working Group, and a member of the IUCN WCPA Other Effective Area-based Conservation Measures Specialist Group.

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Kathy Macpherson is Vice President, Research and Policy with the Greenbelt Foundation, leading projects to protect and enhance natural and agriculture systems and support sustainable rural economies in and around Ontario's Greenbelt. She has worked with international development agencies, providing advice to the Indonesian government in the development of evidence-based policy in different sectors during its tumultuous "reformasi" period. This followed more than a decade of policy and program development with the Ontario government.

Jerrica Mann

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Jerrica Mann is a Geographic Information Systems (GIS) Technician for British Columbia's Ministry of Forests, Lands, Natural Resource Operations and Rural Development. She graduated with a Master's degree from the University of Northern British Columbia in Natural Resources and Environmental Studies where she applied her background and previous education in GIS and conservation to incorporate climate-change resiliency into the Systematic Conservation Planning Framework. The goal of her research is to help conservation planners understand how they can effectively incorporate climate change data into conservation planning with the goal of planning for future climate conditions and climate change impacts.

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Mhairi McFarlane is the Director of Science and Stewardship for Ontario Region of the Nature Conservancy of Canada (NCC). She oversees stewardship of NCC properties throughout Ontario and supports the development of science-based landscape-scale Natural Area Conservation Plans.

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David Miller is Executive Director of the Algonquin to Adirondacks Collaborative (A2A). David has a B.E.S. in Urban and Regional Planning from the University of Waterloo and an M.Sc. in Resource Management from the University of British Columbia. His career in conservation and environmental planning has spanned 30 years and included work with Ontario Conservation Authorities, Provincial Ministries, and Municipalities including the City of Ottawa where he was the manager of Natural Systems Planning and Environmental Land Acquisition.

Brett Norman

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Brett is the Invasive Species Program Coordinator for Ontario Region of the Nature Conservancy of Canada. Brett has eight years of experience working for NCC in the Norfolk Forests and Long Point Wetlands focal area and has been involved in over 600 hecatars of restoration projects, including 22.6 ha of wetland restoration in the Lower Big Creek Block. Brett has managed several large-scale invasive species removal efforts and now leads NCC's Phragmites Control Program on private lands in the Big Creek Watershed. Brett has an B.Sc. (Hons.). in Ecological Restoration from Trent University and a Diploma Ecological Restoration from Fleming College.

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Jesse graduated from the University of Waterloo's novel Master of Climate Change program in 2016, where he applied his background and previous education in ecology and conservation. Since then, Jesse has worked in various roles for Environment and Climate Change Canada, focused on the protection and conservation of the Great Lakes, and co-authored the 2018 report Approaches for Conducting Vulnerability Assessments in the Great Lakes Basin: A Review of the Literature. Jesse currently works with the Meteorological Service of Canada to analyze and comprehend climate data.

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Trevor Reid is Manager of Conservation Planning and Spatial Analysis for the Alberta Region of the Nature Conservancy of Canada (NCC). As a GIS professional, Trevor is dedicated to incorporating innovative methods for using spatial information technology to enhance conservation decision making. He has extensive experience developing spatial analyses for conservation plans at a variety of scales. Trevor has worked with NCC for over 10 years.

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Ben Sivak is the Community Policy Program Manager with the Halifax Regional Municipality's Planning and Development Department. Ben has been a municipal planner for over 15 years after receiving an undergraduate degree in biology from the University of Toronto and Masters of Urban and Rural Planning from Dalhousie University. Ben has led a wide variety of planning initiatives ranging in scale from individual building sites to region wide plans resulting in the adoption of policies and regulations that shape our urban and rural communities.

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Justin is the Executive Director of the Southern Alberta Land Trust Society, a rancher-based land trust focused on the protection of ecologically important private lands in southern Alberta. Justin has an educational background in biology and public policy and has worked for or in partnership with several conservation organizations including the Miistakis Institute, Nature Conservancy of Canada, Canadian Parks and Wilderness Society, and Yellowstone to Yukon Conservation Initiative. He has been involved in a number of conservation planning initiatives throughout his career as well as the delivery of conservation projects on the ground.

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Heidi Wiebe is an independent consultant based in Yellowknife, Northwest Territories (NWT), specializing in regional land use planning. She was the senior planner for both the approved Sahtu Land Use Plan (2013) and the 2006 Draft Dehcho Land Use Plan. She has also been involved with regional planning in the Akaitcho and Wek'eezhii regions of the NWT, as well as in Nunavut. Her education is in Ecology (B.Sc. Hon Ecology) and Environmental Design (M.E.Des.) Heidi also supports a variety of Indigenous and government clients with workshop facilitation.

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Pamela Wright is a conservation scientist and an Associate Professor of Ecosystem Science and Management at the University of Northern British Columbia. Her research focuses on conservation-based approaches to protected areas design, planning, and management; systematic-conservation planning and climate change; managing and monitoring the ecological integrity of protected areas; and connecting people to nature.

Arrowhead Provincial Park, Ontario (Photo by Chris Lemieux)

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Pinery Provincial Park, Ontario (Photo by C. Lemieux)

The extent and diversity of Canadian ecosystems, coupled with complex land use patterns and climate change across settled regions and northern landscapes, poses many challenges for those engaged in efforts on biodiversity conservation. Combining case studies on a variety of connectivity conservation areas with a review of governance provisions and established practices on connectivity, this report aims to inspire and guide wider application of connectivity work in efforts to complete a comprehensive viable network of protected and conserved areas representative of Canada's ecological diversity.

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