



INTEGRATED BIODIVERSITY PATHWAYS FOR SUSTAINABILITY IN CANADA

Living within the Earth's Carrying Capacity Knowledge Synthesis Report

A reflection on progress and challenges over the past decade for biodiversity conservation and action-oriented recommendations to chart pathways forward for nature-centered development in Canada

Future Earth Canada Hub, Sustainability in the Digital Age,
and Concordia University



Integrated Biodiversity Pathways for Sustainability in Canada

Acknowledgements

This Knowledge Synthesis Report draws on research supported by the Social Sciences and Humanities Research Council (SSHRC).

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Glossary

Biocapacity: Also called biological capacity. It refers to the capacity of ecosystems to regenerate what people demand from those surfaces. Life, including human life, competes for space. The biocapacity of a particular surface represents its ability to regenerate what people demand. Biocapacity is therefore the ecosystems' capacity to produce biological materials used by people and to absorb waste material generated by humans, under current management schemes and extraction technologies. Biocapacity can change from year to year due to climate, management, and also what portions are considered useful inputs to the human economy. Biocapacity is usually expressed in global hectares (Global Footprint Network, 2021).

Biocultural diversity: This term comprises the diversity of life in all of its manifestations – biological, cultural, and linguistic. It provides a more complex and integrated perspective on the diversity in both nature and culture. The concept implicates that cultural diversity, including diversity of societies, cultures and languages that have developed throughout human history, is another fundamental expression of life's evolutionary potential and is profoundly interrelated and interdependent with biodiversity, through the co-evolutionary processes. (Maffi & Dilts, 2018).

Canada: In this report, Canada refers to the internationally recognized boundaries of the Canadian State. **Indigenous Peoples Lands and Territories** including the lands, territories, and resources in what is now known as Canada, have been traditionally owned, occupied or otherwise used or acquired by First Nations, Métis and Inuit Peoples (United Nations [UN], 2007, Article 26) and subject to treaties, agreements and other constructive arrangements with Indigenous Peoples.

Conservation: Conservation of biological diversity is a common concern of humankind. It fundamentally requires the in-situ conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings (UN, 1992a). In this report, conservation is not limited to the measures which isolate the lands for natural growth, but also include the conservation of components of biodiversity beyond their natural habitats (i.e., ex-situ conservation) which in some cases offers the only chance of survival for some species-at-risk, and has an essential role in conserving genetic resources, socio-cultural values and other important ecosystem services of biodiversity (Minister of Supply and Services Canada, 1995; Li & Pritchard, 2009). It implies the formulation of harmonious relationships built between humans, wildlife, and ecosystems through well-managed human activities and wise and careful use of natural assets. Conservation in Canada has historically been used as part of colonization and to extend state authority into Indigenous territories (Littlechild, 2020). The Canadian government has committed to elevating Indigenous-led conservation in the spirit and practice of reconciliation.

Decolonization: Decolonization at its heart is about the “repatriation of Indigenous land and life” (Tuck and Yang, 2012, p. 3). It is a direct challenge to colonial foundations of Canada, including a categorical repudiation of the Doctrine of Discovery and the concept of terra nullius. It aims to unpack and permanently disrupt structures of systemic oppression. Decolonizing involves de-centering dominant paradigms and pluralizing voices of those who have been traditionally marginalized. It is a tireless commitment which goes beyond cultural awareness and tokenistic inclusion.

Functional diversity: A component of biodiversity that generally concerns the range of things that organisms do in communities and ecosystems. Critical points in developing predictive measures of functional diversity are the choice of functional traits with which organisms are distinguished, how the diversity of that trait information is summarized into a measure of functional diversity, and that the

measures of functional diversity are validated through quantitative analyses and experimental tests (Petchey & Gaston, 2006).

Genetic diversity: The variation in the amount of genetic information within and among individuals of a population, a species, an assemblage, or a community (United Nations, 1992b).

Global hectare (gha): Global hectares are the accounting unit for the Ecological Footprint and Biocapacity accounts. These productivity-weighted biologically productive hectares allow researchers to report both the biocapacity of the earth or a region and the demand on biocapacity (the Ecological Footprint). A global hectare is a biologically productive hectare with world average biological productivity for a given year. Global hectares are needed because different land types have different levels of productivity. A global hectare of, for example, cropland, would occupy a smaller physical area than the much less biologically productive pastureland, as more pasture would be needed to provide the same biocapacity as one hectare of cropland. Because world productivity varies slightly from year to year, the value of a global hectare may change slightly from year to year (Global Footprint Network, 2021).

Other effective conservation measures (OECMs): It is a conservation designation for areas that are achieving the effective in-situ conservation of biodiversity outside of protected areas. OECM are diverse in terms of purpose, design, governance, stakeholders and management, especially as they may consider associated cultural, spiritual, socio-economic, and other locally relevant values. The examples of OECMs include but are not limited to Indigenous conserved areas, sections of military reserves with access restrictions and conservation goals, and productive landscapes managed for conservation. (Secretariat of the Convention on Biological Diversity [SCBD], 2018; MacKinnon, 2019).

Reserve: A reserve is land set aside by Canadian federal government for the use and occupancy of a First Nation group (Aboriginal Awareness Canada, 2021). On reserve includes six types of census subdivisions (CSDs) legally affiliated with First Nations or Indian bands, i.e., Indian reserve (IRI), Indian settlement (S-É) (except for the five Yukon settlements of Champagne Landing 10, Klukshu, Two and One-Half Mile Village, Two Mile Village and Kloo Lake), Indian government district (IGD), terres réservées aux Cris (TC), terres réservées aux Naskapis (TK) and Nisga'a land (NL), as well as the northern village of Sandy Bay in Saskatchewan. (Statsitics Canada, 2021) Off-reserve means Indigenous peoples who are not living within the reserve defined by the crown government.

Social license: An implicit form of agreement between a company and local stakeholders on the operations of a project, a company, or an industry to make sure it is socially and environmentally acceptable and legitimate. It involves a process by which the stakeholders collectively determine the minimal conditions to be implemented so that the short- and long-term risks/threats/negative impacts on the natural and human environment are socially and environmentally acceptable and legitimate.

Telecoupling: A telecoupling is a process that connects distant systems in which humans and nature interact. The study of telecoupling effects evolved from the studies on teleconnections (usually referred to as environmental interactions among climatic systems across long distances), and globalization (studies on socio-economic interactions between distant human systems). Telecoupling implicates complex effects of socio-economic and environmental interactions happening in global activities like trade, migration, tourism, air circulation, and technology or information transfer over distances. Telecouplings have five major components- systems, agents, flows, causes, and effects. This is a transdisciplinary and multi-level framework that can be used in both research and management to understand the increasingly visible threads connecting distant places for addressing large-scale global sustainability challenges (Liu et al. 2015; Hull & Liu, 2018).

Executive summary

Home to large tracts of intact forest and one quarter of the wetlands remaining in the world, Canada plays an indispensable role in maintaining global biodiversity. The past decade has been marked by significant progress in biodiversity conservation in Canada, in particular through the expansion of protected areas (PAs) to meet the Aichi 2020 target of conserving 10% of coastal and marine areas. Despite this progress, biodiversity loss continues to accelerate across the country, resulting from a range of complex and interrelated drivers including widespread extractive human activities, regional climate change, and many others. The impacts of more frequent disasters such as heat waves, floods, and zoonotic diseases are a warning signal: when our ecosystems are degraded, human well-being is also harmed.

As the world transitions towards a post-2020 global biodiversity framework to succeed the Aichi Biodiversity Targets (2011-2020), it is critical to explore how Canada can combat biodiversity loss within our own borders and where the greatest opportunities lie to leverage the value of our rich natural assets for a sustainable future. This report aims to draw on past knowledge and experiences in Canada to inform the development of potential pathways towards the attainment of Canada's commitments to this post-2020 global biodiversity framework and the Sustainable Development Goals (SDG). The Biodiversity Pathways for Sustainability in Canada project addresses these topics through *a research synthesis of the state of knowledge on biodiversity conservation and an outlook on potential solutions to tackle systemic barriers in Canada*. Supported by evidence from an extensive literature review and stakeholder consultations, this report proposes actionable suggestions for policy makers to chart biodiversity-centered pathways for sustainability in Canada and beyond. We specifically highlight the outcomes of an online workshop held on May 26-27, 2021 that convened conservation scientists and practitioners across Canada with diverse backgrounds and expertise to discuss barriers, strategies, synergies, and trade-offs for ecosystem and biodiversity conservation in Canada.

This work resulted in a set of recommendations based on lessons learned over the past decade to inform conservation policy in Canada and beyond in the context of the post-2020 global biodiversity agenda. It is also expected to inspire research agendas by identifying knowledge gaps and the need for developing new practices and tools in biodiversity science. The main lessons learned are summarized here:

- 1. Biodiversity degradation has occurred in lockstep with colonization and the disruption of Indigenous systems that steward ecosystems in what became Canada for millennia.**

Indigenous Peoples hold relations with aspects of the natural world that respect the inherent dignity and interconnectedness of peoples and Mother Earth. Indigenous systems prioritize the interrelationship between biodiversity and well-being, emphasizing identity and expression, stewardship, livelihoods and spiritual linkages that exemplify the vision of humans living in harmony with nature and remain to be scaled up. It is vital that Indigenous systems and their stewardship of lands and waters be elevated, respected and appropriately recognized. Meanwhile, they are also most vulnerable to ecosystem degradation and are likely to be hit hardest by the impacts of climate change and biodiversity loss. High attention must be paid to the recognition and empowerment of Indigenous Peoples in Canada.

2. **Canada has made considerable progress in PA conservation but is spatially imbalanced.** 12.5% of national terrestrial land and inland water (1.17 million km² PA) and 13.8% of national marine areas (0.51 million km² marine PA) are now Protected and Conserved Areas in Canada. But the main increase of PAs is in the north, while many important natural areas in the south subject to stronger human disturbances remain unprotected.
3. **Protecting Canadian ecosystems has global significance,** in particular due to the massive but declining extent of intact ecosystems in the north. Policies implemented in Canada can profoundly influence conservation outcomes inside and outside our national borders.
4. **Canada's exports to, and consumption of imports from, other countries can lead to biodiversity loss beyond our borders.** International trade, for example in farming and fishing products, forestry products, and energy, leads to imported/exported pressures on global biodiversity which may not be well-documented in national statistics.
5. **Biodiversity research in Canada remains predominantly focused on species conservation, with gaps in knowledge and data at genetic, functional, and biocultural levels.** Conservation research at the species level remains prevalent in Canada compared with studies at other levels. Genetic and functional diversity (including trophic level measurement) are equally important dimensions of biodiversity for sustainability. Biocultural diversity is likewise critical, as it holistically conceptualizes humans as one component of nature and recognizes the interconnections between diversity in human cultures and languages and diversity in species, habitats, and ecosystems.

Based on these lessons learned, we suggest below priority actions for Canada over the coming decade to develop integrated biodiversity pathways for sustainability. The details of each lesson and priority actions identified are elaborated in the full report.

1. **Enhance** research and increase political attention to address consumptive impacts and telecoupling effects on biodiversity loss.
2. **Decolonize** conservation frameworks by recognizing Indigenous rights, values, knowledge, and practices, and embrace their leadership in biodiversity and ecosystem conservation.
3. **Advocate** for the integration of socio-economic, cultural, pastoral, and spiritual values of biodiversity in policy frameworks.
4. **Embrace** innovative tools and mechanisms for behaviour change at community and individual levels.
5. **Improve** regulation and legal frameworks to enhance transparency, monitoring capacity, and accountability of extractive industries.
6. **Develop** high-quality inventory databases for biodiversity at multiple scales.
7. **Redirect and scale up** public and private investments for ecosystem and biodiversity conservation.
8. **Facilitate** cross-scale collaboration on biodiversity conservation and sustainable development.

Background

Biodiversity is declining at an unprecedented rate. The current extinction rate at the global level is tens to hundreds of times higher compared to the natural baseline (average over the last 10 million years), and the rate is accelerating (IPBES, 2019a; De Vos et al., 2015). Globally, two thirds of the terrestrial environment and more than half of marine environments have been severely altered by human actions (IPBES, 2019b). Among approximately 8 million animal, plant, and insect species currently on Earth, as many as 1 million are threatened with extinction, many within decades (IPBES, 2019b). Furthermore, as biodiversity is closely interconnected with other components of socio-ecological systems, biodiversity loss will likely compound other risks, such as natural disasters, water and food scarcities, and infectious disease, threatening all aspects of human well-being (Future Earth, 2020).

Increased frequency, intensities, and impacts of natural disasters (e.g., forest fires, floods, droughts, storms, and zoonotic diseases) represent a warning signal: when our ecosystems are degraded, human well-being is also degraded. Still reeling from the social, ecological, and economic impacts of the pandemic, the world urgently needs to seek integrated pathways to build forwards better from the crisis. As emphasized in the Kunming Declaration adopted by global leaders in the 15th meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD COP 15), biodiversity underpins human and planetary wellbeing, economic growth, and sustainable development (Secretariat of the Convention on Biological Diversity [SCBD], 2021a). Biodiversity must be a central consideration of any recovery formula as we cannot afford to rebuild a fragmented society lacking the support and sustenance of nature.

Notwithstanding its devastating socio-economic impact on the world, the pandemic also provides a rare opportunity for human societies to disrupt the systems keeping us locked onto an unsustainable and inequitable pathway and transform towards a greener future. Many countries have gone through lockdowns or other public health measures to combat the high transmission rate of COVID-19. The restriction of international travel and increased use of teleworking and tele-communication allow us to rethink and innovate the way we work and live. People have begun to rediscover the value of local economies and natural ecosystems. For example, the share of domestic tourism including visits to parks and other green spaces in total tourism expenditures are increasing in many countries (e.g., Canada, UK, Germany, Switzerland), and is expected to increase post-pandemic as well (OECD, 2020).

Adopting a hopeful framing for transforming the socio-ecological system brings to light new opportunities as well as the need for more ambitious commitments from policy makers to protect and restore natural habitats, unleash the potential of natural capital, and secure and value the ecosystem services that humans depend on. Canada supports a globally significant diversity of tundra, forest, grassland, freshwater, and marine ecosystems. In 2015, the average terrestrial biodiversity intactness in Canada was 84%, indicating a very high level of biodiversity remaining relative to a baseline ecosystem with minimal human impact (Newbold et al., 2016). There is great potential for Canada to lead a biodiversity-centered model for resilient recovery if policy makers act now.

And yet, to date, biodiversity protection efforts in Canada and the world have been far from sufficient. The Aichi Biodiversity Targets set between 2011-2020 as part of a broader effort to consolidate global efforts to halt biodiversity loss have largely been a failure. Despite partial progress, none of the 20 Aichi Targets have been fully achieved. Around the world, natural habitats continue to be degraded, vast numbers of species remain threatened by extinction, and more than half a trillion dollars of environmentally damaging government subsidies are still in effect (SCBD, 2020a). In line with these global trends, Canada is also not doing enough. While its total territorial area is larger than the United

States, the extent of PAs in Canada (1.68 million km²) is only half of that in the U.S. (2.8 million km²) (UNEP-WCMC, 2021). In Canada, of the 38.2% of terrestrial area covered by forest in 2020, only 8.5% is conserved as part of a system of legally established PAs (United Nations, 2021). The biocapacity in Canada was once 26.8 global hectares (gha) in 1963, nearly three times of the ecological footprint of consumption, making it one of the most important ecological reserves in the world. Now, however, Canada's biocapacity has dropped to 15 gha, placing its critical role as a key biocapacity reserve for the world at risk (Global Footprint Network, 2021).

To accelerate progress towards halting biodiversity loss by 2030 and supporting biodiversity recovery by 2050, the United Nations Convention on Biological Diversity is convening the global community to develop a post-2020 global biodiversity framework. Following up on the virtual meeting held this past October, global decision-makers will convene in-person early next spring to conclude the negotiations of the post-2020 global biodiversity framework for a post-COVID world. Capitalizing on this global momentum, Canada must build on past knowledge and experiences to set new ambitious and effective goals that align with the post-2020 biodiversity framework and must position biodiversity as a central consideration within a green and resilient COVID-19 national recovery plan.

This report is developed through a SSHRC-funded project – Biodiversity Pathways for Sustainability in Canada (BPSC). Supported and facilitated by Future Earth, Sustainability in Digital Age, and Concordia University, the BPSC team conducted an extensive literature review and organized a Canada-wide workshop in May 2021 convening diverse stakeholders to discuss the past and future for Canada's biodiversity conservation. This report presents the outcomes of this literature review and workshop.

Objectives

This report synthesizes different types of knowledge and experience on biodiversity and conservation policy in Canada to produce evidence-based insights to inform the development of potential pathways towards the attainment of Canada's commitments to a post-2020 global biodiversity framework. We also aim to support the creation of a nature-based development plan for Canada over the next decade and to inspire conservation researchers and practitioners to contribute to a green transformation through Indigenous leadership, scientific research, innovative conservation practices, and cross-scale collaborations. We achieve this through a retrospective assessment of Canada's progress against the Aichi 2011-2020 Biodiversity Targets and a synthesis of the literature review, and through consultation with experts from across the country in a workshop, the outcomes of which highlight root problems, potential solutions, and priority actions.

The report focuses on addressing the guiding questions below:

What is the biodiversity status of Canada, where we have made good progress, and where are we lagging?

How can Canada combat biodiversity loss within and beyond our own borders?

Where are the biggest opportunities to leverage the value of our rich natural assets for a sustainable future more broadly?

Methods

This report is a knowledge synthesis of a wide range of scientific and grey literature, as well as outcomes of a workshop. Four methods were applied: Aichi Target analysis, literature review (137 articles), policy review (122 legislations), and a two-day, multi-stakeholder expert workshop with follow-up interviews. Below are the detailed descriptions of each method.

Aichi Target analysis

Guided by the global Aichi Biodiversity Targets, Canada developed 19 national targets in 2015 (Secretariat of the Convention on Biological Diversity [SCBD], 2020b). These targets were contextualized for Canada as part of its National Biodiversity Strategy and Action Plan and involve 4 parts (Goals): (1) protecting ecosystem and biodiversity resources, (2) mitigating direct and indirect pressures, (3) collecting information to support conservation planning, and (4) engaging communities for environmental stewardship. To facilitate the analysis, we categorized the detailed targets as environmental, economic, governmental, and socio-cultural components (Table 1). Environmental components focus on the protection, management, and restoration of natural assets. Economic components focus on mitigating the impacts of extractive human activities and re-organizing capital, industry, and trade. Governmental components focus on institutional mechanisms, legal frameworks, and other governance-related aspects of society. Finally, socio-cultural components include knowledge generation and mobilization, cultural and ethical concerns, as well as scientific research and education. Evidence and data were collected on each target to assess the progress. Data were sourced primarily from SCBD (2021b).

In the analysis, the “Progress” column (see Tables 7, 8, and 9) was used as a summary of progress Canada has achieved on each target, which was based on the synthesis of related literature, data, and workshop discussions. “Sufficient progress” indicates that Canada has met the targets by 2020 and is expected to continue making progress in the future. “Insufficient progress” indicates that Canada has not met the targets by 2020 but is closing the gap and requires more efforts in the next decade. “Off track” indicates that Canada has not met the targets by 2020 and is deviating from the target, thus requiring specific attention and re-examination of action plans.

Table 1. Categorization of Canada’s Aichi Biodiversity Targets by component type. The four goals (Goals A, B, C, D) and the nineteen targets (represented by “No.”) were collected directly from the Canada Aichi Biodiversity framework (SCBD, 2020b). The keywords and component types were identified by the research team. The colours were used to differentiate the four different goals (Blue: Goal A, Yellow: Goal B, Red: Goal C, Green: Goal D).

No.	Goals	Keywords	Detailed Targets	Component type
1	Goal A: By 2020, Canada’s lands and waters are planned and managed using an ecosystem approach to support biodiversity conservation outcomes at local, regional, and national scales	Protected areas (PAs) and Other Effective Conservation Measures (OECMs)	By 2020, at least 17 percent of terrestrial areas and inland water, and 10 percent of coastal and marine areas are conserved through networks of protected areas and other effective area-based conservation measures.	Environmental
2		Species	By 2020, species that are secure remain secure, and populations of species at risk listed under federal law exhibit trends that are consistent with recovery strategies and management plans.	Environmental
3		Wetlands	By 2020, Canada’s wetlands are conserved or enhanced to sustain their ecosystem services through retention, restoration and management activities.	Environmental
4		Municipal planning	By 2020, biodiversity considerations are integrated into municipal planning and activities of major municipalities across Canada.	Governmental

5		Climate change adaptation	By 2020, the ability of Canadian ecological systems to adapt to climate change is better understood, and priority adaptation measures are underway.	Governmental
6	Goal B: By 2020, direct and indirect pressures as well as cumulative effects on biodiversity are reduced, and production and consumption of Canada's biological resources are more sustainable	Forests	By 2020, continued progress is made on the sustainable management of Canada's forests	Environmental
7		Farmland	By 2020, agricultural working landscapes provide a stable or improved level of biodiversity and habitat capacity	Economic
8		Aquaculture	By 2020, all aquaculture in Canada is managed under a science-based regime that promotes the sustainable use of aquatic resources (including marine, freshwater and land based) in ways that conserve biodiversity.	Economic
9		Fishing	By 2020, all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem-based approaches.	Economic
10		Water quality	By 2020, pollution levels in Canadian waters, including pollution from excess nutrients, are reduced or maintained at levels that support healthy aquatic ecosystems.	Economic
11		Invasive Alien Species	By 2020, pathways of invasive alien species introductions are identified, and risk-based intervention or management plans are in place for priority pathways and species.	Environmental
12		Indigenous governance	By 2020, customary use by Aboriginal peoples of biological resources is maintained, compatible with their conservation and sustainable use.	Governmental
13		Innovation	By 2020, innovative mechanisms for fostering the conservation and sustainable use of biodiversity are developed and applied.	Governmental
14	Goal C: By 2020, Canadians have adequate and relevant information about biodiversity and ecosystem services to support conservation planning and decision-making	Scientific Knowledge	By 2020, the science base for biodiversity is enhanced and knowledge of biodiversity is better integrated and more accessible.	Environmental
15		Aboriginal knowledge	By 2020, Aboriginal traditional knowledge is respected, promoted and, where made available by Aboriginal peoples, regularly, meaningfully, and effectively informing biodiversity conservation and management decision-making.	Governmental
16		Spatial inventory	By 2020, Canada has a comprehensive inventory of protected spaces that includes private conservation areas.	Socio-cultural
17		Natural Capital accounting	By 2020, measures of natural capital related to biodiversity and ecosystem services are developed on a national scale, and progress is made in integrating them into Canada's national statistical system.	Governmental
18	Goal D: By 2020, Canadians are informed about the value of nature and more actively engaged in its stewardship	Education	By 2020, biodiversity is integrated into the elementary and secondary school curricula	Socio-cultural
19		Participation	By 2020, more Canadians get out into nature and participate in biodiversity conservation activities.	Socio-cultural

Literature review

To develop a broad understanding of biodiversity change in Canada, we reviewed 528 articles found on Web of Science by entering the keywords “Ecolog*”, “Biodiversity”, or “specie*” associated with “Driver*”, “pressure*”, “stress*”, “factor*”, “benefit*”, “impact*”, or “influence*”, searching for articles published between 2015 and 2020 to focus on the most recent understanding and trends. A first screening of the titles removed papers unrelated to biodiversity and duplicates. A second screening of the abstract and of the article removed papers related to methodology and tools for biodiversity surveys. Papers on past extinctions and which exclusively focus on climate change were removed because they do not specifically address the questions guiding this literature review. These screening processes reduced the total number of papers reviewed from 528 to 137.

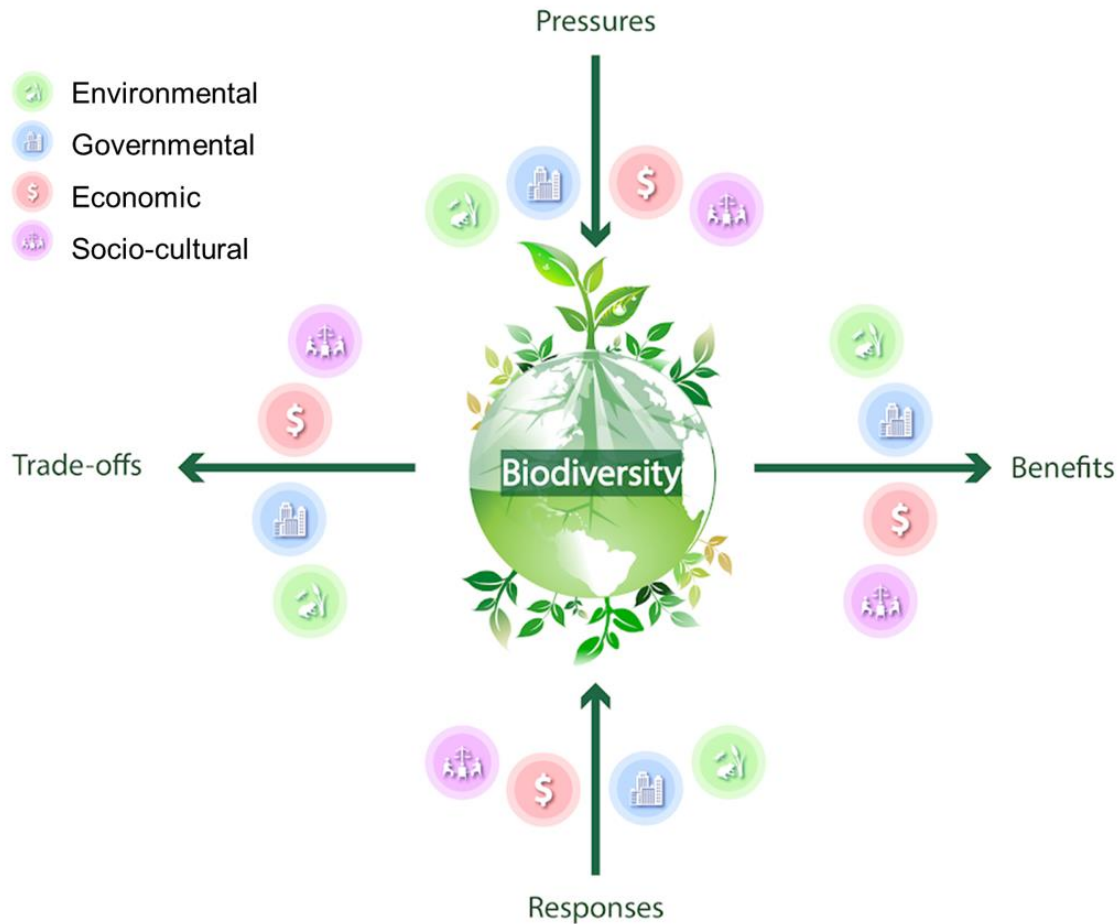


Figure 1. Conceptual framework guiding the literature review on biodiversity status in Canada. The arrows represent the flow direction of the impact. The arrows pointing to the center represent the negative (Pressures) and positive (Responses) impacts of the socio-ecological system on the status of biodiversity. The outward arrows represent the positive (Benefits) and negative (Trade-offs) impacts of biodiversity change on other parts of the socio-ecological system.

Based on the framework developed to guide the review of biodiversity status (Figure 1), information was compiled on each paper regarding: study scope, biodiversity type, contributing factors, flow (inflow/outflow), relationship type (positive/negative), dimensions (environmental, economic, governmental, and socio-cultural), and detailed relationship with biodiversity. Solutions to slow or halt biodiversity loss proposed by each study were also recorded and categorized. *A posteriori*, the different factors were regrouped in narrower groups (Table 2). For instance, temperature, heat, and moisture were regrouped under the category *Climate*. The information was summarized by counting how often (numbers of papers) the factors were associated with a particular trend. In the same way, proposed solutions were summarized into categories: *PAs* (Protected Areas), *Sustainable Harvest Strategies*, *Sustainable Forest or Fisheries Management*, *International Collaboration*, etc. We counted how often each solution was proposed.

Table 2. List of categories used to summarize the different factors that impact biodiversity.

Categories	Example Factors
Climate	Climate change, hydraulic stress, drought, fire, temperature, moisture, extreme heat, carbon dioxide, humidity
Biotic	Beetle attack, plant communities, invasive species (e.g., rats), disease, algal bloom
Biogeochemical cycles	NPC (Nitrogen, Phosphorous, and Carbon cycles), water cycles, nutrients, ozone
Socio-cultural	Societal characteristics (local involvement, social taboos), stakeholders' perceptions, human density, stakeholder engagement, livelihood, well-being
Geophysical	Environmental conditions (depth, substrate), hydrodynamics, biomes
Governance	Jurisdiction, political will, scientific and citizen engagement in decision-making
Construction	Hydropower, local direct impacts, construction, urban development, roads
Economic	Economic pressures, e-commerce, economic sustainability, payment for ecosystem services
Habitat degradation	Salinization, water quality, natural causes, habitat destruction, habitat loss, habitat fragmentation, disturbance
Harvest	Fishing industry, plant productivity, harvest, harvesting
Land management	Land use, land management, stream management, deforestation
Legislation	POPs (Persistent Organic Pollutants) regulations, fish restriction
Ocean changes	Ocean acidification, decalcification, stratification, water warming, oxygen depletion
Protected Areas (PAs)	Marine PAs, interventions to rebuild marine life, marine reserves, enforcement of PAs, delineation of PAs
Pollution	Contaminants, microplastics, light, noise, mercury exposure, interactions between stressors, UVR (Ultraviolet Radiation), chemical pollution, metal, toxins, macroplastics, insecticides
Species conservation	Captivity, conservation policies by animal tracking

Policy review

In response to Canada's commitment to the 1992 United Nations Convention on Biological Diversity, provincial and territorial governments developed and implemented legislation, policies, and regulations to support Convention objectives. To assess policies on biodiversity conservation across Canada, we evaluated provincial and territorial acts developed to protect biodiversity for all 10 provinces and 3 territories. We limited our policy evaluation to legislations categorized by Environment and Climate Change Canada in the ministerial briefing handbook as "Biodiversity and Wildlife". Repealed or expired laws were excluded from the analysis. For each piece of legislation, we analyzed sections related to biodiversity and summarized how biodiversity was defined, the main conservation strategy employed, and methods of implementation.

To understand how biodiversity is defined differently across jurisdictions, we first identified whether biodiversity and different levels of biodiversity were defined. We then categorized legislation using the three commonly used levels of biodiversity identified in the literature: genetic, species, and ecosystem level diversity (Harper & Hawksworth, 1994; Lyashevskaya & Farnsworth, 2012; Verma, 2016).

We categorized conservation strategies employed in legislation into groups representing common methods utilized by jurisdictions (Table 3). One legislation may include multiple biodiversity strategies.

For legislation where PAs were identified as a strategy, we further classified legislation by main purpose (Table 4).

For the implementation of conservation strategies, we focused our summary on how frameworks, rules, and regulations outlined in legislation interacted with the public, groups of interest, and with other jurisdictions. We identified general categories of stakeholders that were engaged in strategies as an actor through consultation, planning, development, or implementation processes (Table 5). For groups of interest, we focused on how legislation involved Indigenous groups, beyond responsibilities and rights detailed in treaties for each jurisdiction. Here, we noted if Indigenous involvement is mentioned in the legislation and how involvement was carried out.

Table 3. Biodiversity conservation strategies described in legislation.

Strategy	Description
Protected areas (PAs)	Legislation with provisions for setting aside land for protection. PAs under these pieces of legislation set limits on allowable activity.
Resource management	Legislation detailing rules and regulations on the management and exploitation of natural resources. Rules and regulations here apply to the sustainability of natural resources and can entail strategies to mitigate or manage impact on biodiversity.
Species protection	Legislation with provisions specifically for the protection of identified species of interest through protection, rehabilitation, and/or education.
Land management	Legislation with provisions regarding land use planning, focusing on mitigating the impacts of human development on biodiversity.
Invasive species	Legislation identifying criteria for identifying invasive species and methods for mitigating, managing, and preventing the impact of invasive species on biodiversity or resources.
Habitat rehabilitation	Legislation detailing provisions for the restoration of habitat for species of interest or wildlife.
Pollution/contaminants	Legislation with rules, regulations, and frameworks for addressing pollution or contamination. Legislation must include some reference to biodiversity. Under this category, some legislation considers biodiversity as a component of the environment.
Climate change mitigation/adaptation	Legislation with rules, regulations, and frameworks for tackling the effects of climate change or reducing greenhouse gas emissions. Legislation must contain some mention of biodiversity.
Research	Legislation supporting or promoting research on biodiversity. Research can be broad and can include support of local efforts.
Outreach/education	Legislation with provisions aimed at increasing public engagement with the outdoors, nature, and biodiversity in Canada.

Table 4. Main purpose of PAs for biodiversity conservation.

Purpose	Description
Recreation	PAs set aside for the purpose of promoting or maintaining outdoor recreation. These areas can be mixed use with hunting and fishing but are separate from areas whose goals are primarily focused on hunting and fishing.

Biodiversity	PAs set aside for biodiversity conservation. These areas have rules and regulations limiting most human activity on the land and contain few exceptions, generally reserved for research on threatened species or ecosystems.
Stewardship	PAs managed through stewardship. These areas have conservation goals that are developed in agreement with local governments, provincial or territorial governments, and/or non-profit organizations.
Hunting/fishing	PAs set aside to create and conserve opportunities for hunting or fishing. Rules, regulations, and strategies can be put in place for limits around harvest and for the continuation of sustainable harvests into the future.

Table 5. Parties involved in the planning, development, and/or consultation process of conservation strategies.

Purpose	Description
Landowners	Legislation that includes agreements with legal owners of land for stewardship, management, or sale of land for conservation.
General public	Legislation that details the involvement of public bodies or selected individuals in advisory councils or committees, or that requires public consultation for the implementation of conservation strategies.
Local communities	Local communities include community members, local governments, or groups. Legislation involves these communities in planning, consultation, or development of conservation strategies.
Non-governmental organizations (NGOs)	Legislation involving non-governmental organizations (NGOs), frequently those with the purpose of protecting the environment. Legislation involving NGOs typically outlines the responsibilities of said NGOs in managing conservation strategies.
Industry	Legislation detailing involvement of industries and their responsibilities. Does not include individuals like farmers.
Academic institutions	Legislation detailing the involvement of individuals from western, academic institutions in the planning, development, or implementation of conservation strategies.

Workshop

The goal of the workshop was to co-develop biodiversity-centered pathways for sustainable development in Canada with shared targets and vision, based on Canada’s commitment to reach the Sustainable Development Goals (SDG) by 2030 and build a society where “humans live in harmony with nature” by 2050. Through facilitated dialogue and exchanges between experts in many sectors engaged in biodiversity conservation, the workshop’s objectives were to:

- i) define goals for biodiversity conservation in Canada in the short- and long-term,
- ii) identify key challenges and opportunities for sustainable development more broadly when addressing biodiversity needs, and
- iii) develop a set of key strategies for Canada to tackle systemic barriers and to transform society across sectors and scales towards a resilient and equitable future.

Workshop participants were recruited via email. A first round of participants was identified through Advisory Committee recommendations, and then through the snowball method (where existing participants suggested new participants). The workshop was conducted online through the Zoom

platform over two days (three one-hour sessions per day). A follow-up interview was also conducted with each participant. Participants represent different stakeholder groups and communities engaged with biodiversity conservation in Canada. Their roles include but are not limited to biodiversity conservation researchers and professionals, Indigenous scholars/leaders, governmental employees, SDG experts, digital innovators, social activists, private sector employees, and scientists in other research domains (e.g., sociology, anthropology, climate science, etc.). Under the guidance of lead expert facilitator Erin Dixon, four facilitators took turns to lead the six sessions, and four additional co-facilitators guided conversations in breakout rooms. Participants were able to share inputs through Jamboard (jamboard.google.com/), Zoom chat, as well as in Google Docs. Workshop participants also completed a survey (<https://ee.kobotoolbox.org/x/5sBXuGKh>) and received the preparation materials described below prior to the workshop:

- Equity and inclusion protocol,
- Pre-read document containing information on the workshop flow and related concepts (Aichi targets and SDGs),
- Invitation to complete a short survey about their thoughts on the Aichi targets,
- Consent forms for video/audio recording during the workshop and follow-up interviews, and
- Technical guidance for setting up Zoom, and Jamboard.

The workshop was held on May 27-28, 2021 from 1:00pm-4:30pm EDT, with 28 stakeholders across Canada participating. The workshop consisted of six sessions, each of which centered around a key topic for the development of biodiversity pathways (Table 6).

Table 6. Session targets and discussion questions.

Session target (Session outcomes in brackets)	Questions <i>(Q represents the main question used as a prompt for speakers to brainstorm using chat and Jamboard. Q1-Q4 are specific questions asked during breakout groups)</i>
Session 1. Target-setting (A well-articulated vision and suggestions for target-setting to enhance biodiversity in Canada in the next few decades)	Q: How do Canada's past biodiversity targets align with your vision? Anything missing? Q1: What do we need to change - what's missing? For example, what could be the targets - how could we approach them differently?
Session 2. Key strategies (A list of key strategies for biodiversity conservation)	Q: What is holding Canada back from achieving our vision? Q1. What are the barriers to achieving targets? Q2. What do you suggest are the strategies/key steps to address these barriers? (Aim to identify 5 or so strategies)? Q3: What are the features behind each strategy (from the perspectives of time scale, value, feasibility, and knowledge systems)?
Session 3. Linking to SDGs (Mapping between biodiversity strategies and SDGs, along with points of explanation for synergies and tradeoffs)	Q: How do the strategies proposed connect to the SDGs and to other goals? Q1: What are the connections between the 5 or so strategies you identified and the SDGs and other goals?

<p>Session 4. Tackling the trade-offs (Identify potential tradeoffs, explore a list of possible innovative solutions)</p>	<p>Q1: What do you sense are the biodiversity needs behind the five strategies your group proposed? Q2: Are there any corresponding development needs? that conflict with each biodiversity need respectively? Q3. Considering the needs on both ends, where does the current focus in Canada tend towards? Q4. What is emerging in terms of potential pathways/solutions to address the conflicts and tension?</p>
<p>Session 5. Refining the scenarios (Clarify the details of the pathways with indicators, actors, enabling factors, and risks. Revise the strategies and targets for both short- and long-term)</p>	<p>Q1: If we are to implement these proposed strategies, how do we measure the progress? (<i>indicators</i>) Q2: Who are the main actors that could support these strategies? (<i>actors</i>) Q3: What are the constraints/barriers for the success of these strategies? (<i>risks and uncertainties</i>) Q4: How can barriers be overcome? (<i>enabling factors</i>)</p>
<p>Session 6. Systemic reflection and transformation (Apply systems thinking, facilitate mutual understanding and behaviour changes through reflection)</p>	<p>Q1: What struck you in the process, what have you learned? What is making you rethink and go deeper? Q2: What do you sense is still missing in the system? Q3: What might you change for the next steps?</p>

Assets obtained throughout the workshop included the following:

- Graphic visualizations for plenary and breakout sessions,
- Thoughts represented as post-it notes collected through Jamboard,
- Meeting notes drafted by facilitators, and
- Audio recordings and transcripts of each recording using otter.ai to supplement meeting notes.

In summary, the knowledge synthesis presented in this report is based on the Aichi target analysis, literature review, policy analysis, and insights from the workshop. Results are categorized into four components:

- **Environmental component:** focus on the protection, management, and restoration of natural assets.
- **Economic component:** focus on mitigating the impacts of extractive human activities and re-organizing capital, industry, and trade.
- **Governmental component:** focus on institutional mechanisms, legal frameworks, and other governance-related aspects of society.
- **Socio-cultural component:** focus on knowledge generation and mobilization, cultural and ethical concerns, as well as scientific research and education

Results: Canada’s progress and challenges in biodiversity protection

The results shared in this report are a synthesis of the knowledge obtained from assessing Canada’s progress towards the Aichi Biodiversity Targets, from the literature review on biodiversity status and drivers of change, the policy review on Canada’s biodiversity conservation strategies, as well as insights from the workshop on biodiversity pathways. For each component described in the methods section above, we assess Canada’s progress and failures with regards to the Aichi Biodiversity Targets, supported by the literature review and policy review. Workshop outcomes are embedded to fill any knowledge gaps not found in the literature and to provide targeted suggestions of actions to address challenges.

Environmental component

In the environmental component, Canada’s Aichi targets include establishment of protected areas (PAs), other effective conservation measures (OECMs), the protection, management, and recovery of species at risk, wetlands, and forests ecosystems, as well as interventions related to invasive and alien species. While progress towards most of the targets is sufficient, protection of terrestrial lands and species at risk remain to be improved (Table 7).

Table 7. Environmental components of progress towards Canada’s Aichi Biodiversity Targets. Five targets were identified as environmental components of biodiversity conservation as they focus on the protection, management, and restoration of natural assets. The colours represent the Goals they belong to in the Canada Aichi Target framework (SCBD, 2020b, Table 1). Environmental components can be found in Goal A (blue) and Goal B (yellow). The keywords are used for the ease of reading and understanding (also see Table 1). An explanation of each value in the “Progress” column can be found in the Methods section. A detailed analysis can be found in the main text of Results.

No.	Goals	Keywords	Detailed Targets	Progress
1	Goal A: By 2020, Canada’s lands and waters are planned and managed using an ecosystem approach to support biodiversity conservation outcomes at local, regional and national scales	PAs and other effective conservation measures	By 2020, at least 17 percent of terrestrial areas and inland water, and 10 percent of coastal and marine areas, are conserved through networks of PAs and other effective area-based conservation measures.	Sufficient progress for marine. Insufficient progress for terrestrial
2	Goal A: By 2020, Canada’s lands and waters are planned and managed using an ecosystem approach to support biodiversity conservation outcomes at local, regional and national scales	Species	By 2020, species that are secure remain secure, and populations of species at risk listed under federal law exhibit trends that are consistent with recovery strategies and management plans.	Insufficient progress
3	Goal A: By 2020, Canada’s lands and waters are planned and managed using an ecosystem approach to support biodiversity conservation outcomes at local, regional and national scales	Wetlands	By 2020, Canada’s wetlands are conserved or enhanced to sustain their ecosystem services through retention, restoration and management activities.	Sufficient progress
6	Goal B: By 2020, direct and indirect pressures as well as cumulative effects on biodiversity are reduced, and production and consumption of Canada’s biological resources are more sustainable	Forests	By 2020, continued progress is made on the sustainable management of Canada’s forests	Sufficient progress
11	Goal B: By 2020, direct and indirect pressures as well as cumulative effects on biodiversity are reduced, and production and consumption of Canada’s biological resources are more sustainable	Invasive Alien Species	By 2020, pathways of invasive alien species introductions are identified, and risk-based intervention or management plans are in place for priority pathways and species.	Sufficient progress

Canada has made considerable progress in PA conservation but is spatially imbalanced. 12.5% of national terrestrial land and inland waters (1.17 million km² PA) and 13.8% of national marine areas (0.51 million km² marine PA) are now Protected and Conserved Areas in Canada. We have achieved the target of 10% for marine PAs but conservation efforts remain to be improved for terrestrial PAs. The situation is especially challenging in the south of Canada, where population density is high, land is fragmented, and there are significantly more pressures from extractive activities (Figure 2).

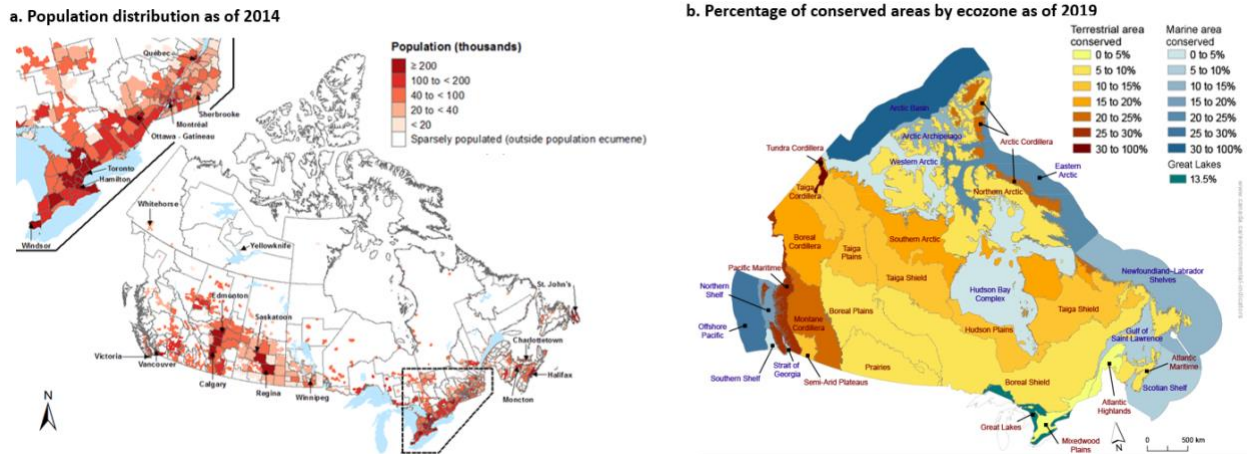


Figure 2. Population distribution (2014) and respective conserved areas (2019) in Canada. Population distribution (2014) and respective conserved areas (2019) in Canada (Statistics Canada, 2015; Environment and Climate Change Canada [ECCC], 2020). Note: Adapted from “National Conserved Areas,” by Environment and Climate Change Canada, 2019. Retrieved from <https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/conserved-areas.html>. Copyright (2021) by Government of Canada.

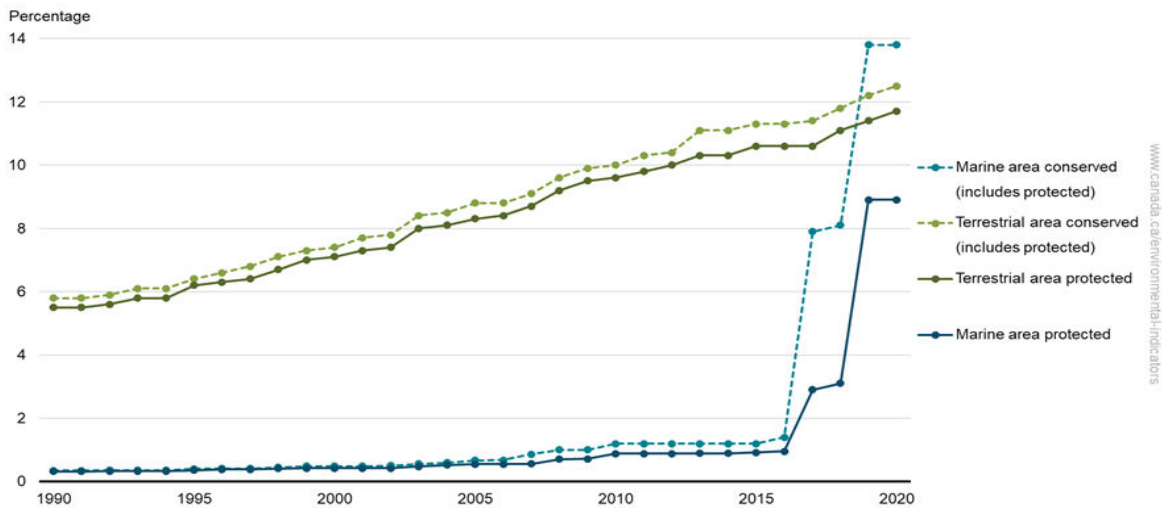


Figure 3. 1990-2020 time series of % Canadian terrestrial and marine areas that are protected and/or conserved. (Canadian Environmental Sustainability Indicators Program [CESI], 2021). Note: Reprinted from “National Conserved Areas,” by Environment and Climate Change Canada, 2020. Retrieved from <https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/conserved-areas.html>. Copyright (2021) by Government of Canada.

Significantly more conservation work remains to be done to meet 2025 targets. The Government of Canada is now committed to conserving 25% of Canada’s land and 25% of its oceans by 2025 (Government of Canada, 2021). While it took 30 years to double the percentage of PAs on land (from <6% in 1990 to 12.5% in 2019, see Figure 3), a target of doubling the percentage within the next 5 years is very ambitious and requires much more effort from all actors.

Looking beyond the numbers, the quality of the protection is also of concern. Taking a closer look at progress in marine areas, the percentage of conserved areas did not improve significantly until 2016, when the federal government established the Pathway to Canada Target 1 initiative (Pathway team, 2021). From a geographical perspective, a large increase in conserved area over the past few years results primarily from the recent addition of arctic basins as marine PAs (Figure 4). While this implies significant progress and commitments by the federal government for marine PAs, the supporting infrastructure, management and maintenance mechanisms, and coordination with and capacity building for local communities may take longer and require more attention and monitoring indicators.

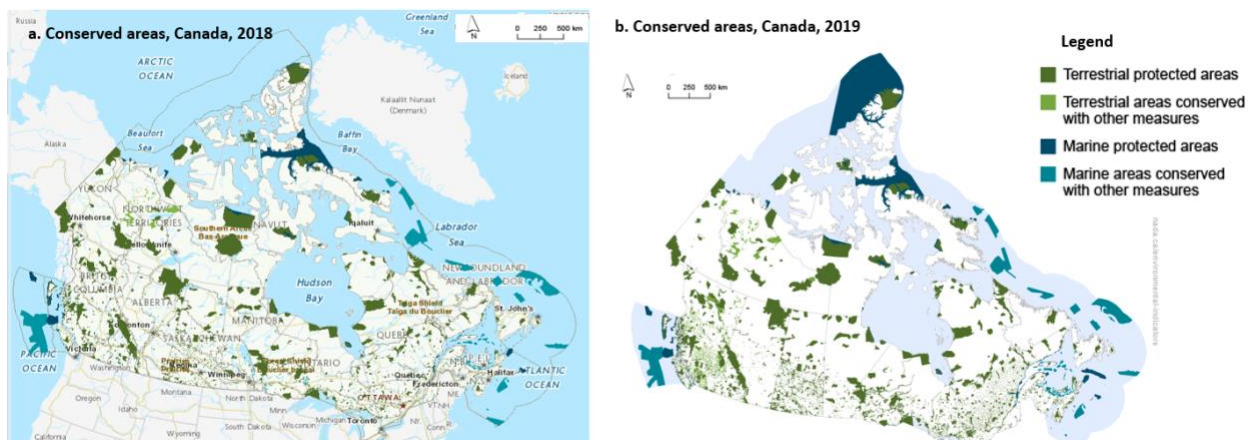


Figure 4. Conserved areas between 2018 and 2019. The dark blue polygon in the north in panel b is one of the largest newly established marine PAs in Canada (Canadian Environmental Sustainability Indicators Program (CESI), 2021). Note: Adapted from “National Conserved Areas,” by Environment and Climate Change Canada, 2019. Retrieved from <https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/conserved-areas.html>. Copyright (2021) by Government of Canada.

At the species level, recovery progress is slow and information for assessment is lacking. According to a study in 2014, of 369 species that were assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), the status of more than 115 species (30%) had deteriorated, twice as many as those species whose status had improved (52 species) (Favaro et al., 2014). As of November 2019, there are still only 55 species that have shown progress towards achieving objectives related to improving population size and distribution. Among 189 species that were re-assessed in 2021, we do not have sufficient information to assess 30% (59 species) and more than 10% (14 species) show mixed evidence of both improvement and deterioration (The Committee on the Status of Endangered Wildlife in Canada [COSEWIC], 2021).

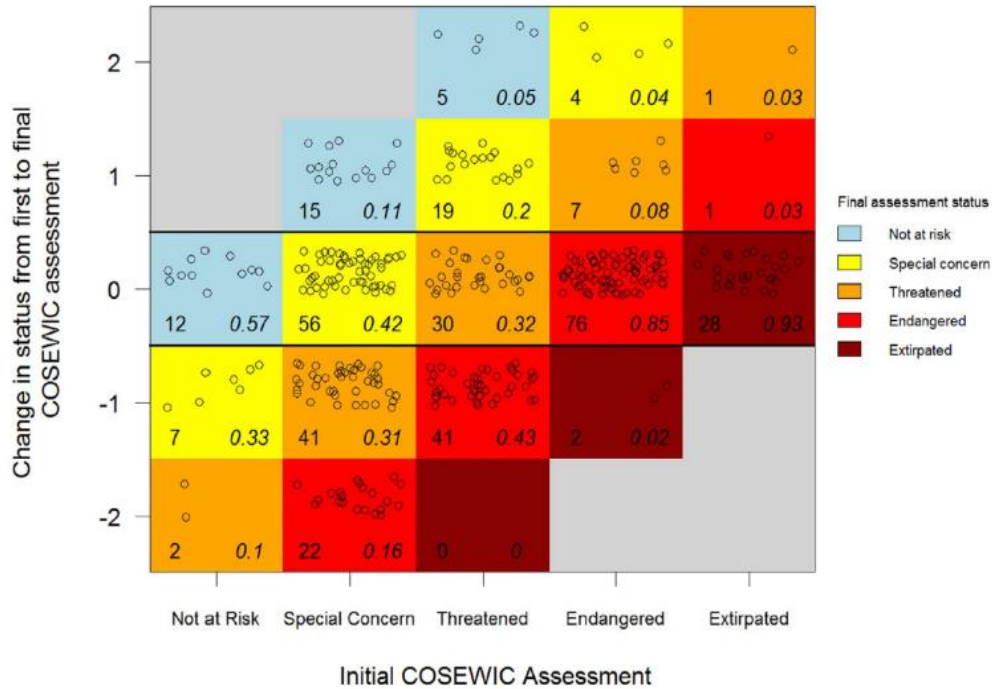


Figure 5. Change in species status based on COSEWIC's assessment from 1977 to 2013. The x-axis represents the initial COSEWIC Assessment in 1977 and the y-axis represents the recent COSEWIC assessment in 2013. In each box, the number on the left represents the total number of species and the fraction on the right represents the percentage of species within the box with reference to all species in the column. The status of all species listed below the horizontal zero line has deteriorated since 1977 (Favaro et al., 2014) Note: Reprinted from "Trends in Extinction Risk for Imperiled Species in Canada," by B. Favaro et al., 2014. Retrieved from <https://doi.org/10.1371/journal.pone.0113118>. Copyright (2014) by PLoS ONE.

Biodiversity research at the species level remains prevalent, compared with other indicators of biodiversity which are nonetheless equally important. According to our literature review on drivers of change in biodiversity, many types and levels of biodiversity were reportedly impacted. Of these, species and ecosystem biodiversity are the most common reported, but others such as genetic, behavioural, functional, and biocultural are represented in the literature as well. However, species level research continues to be the dominant focus of conservation science. This has led to a potential over-reliance on measures of abundance and population size as key indicators of the state of biodiversity, which may fail to capture the breadth of changes in biodiversity resulting from drivers of change.

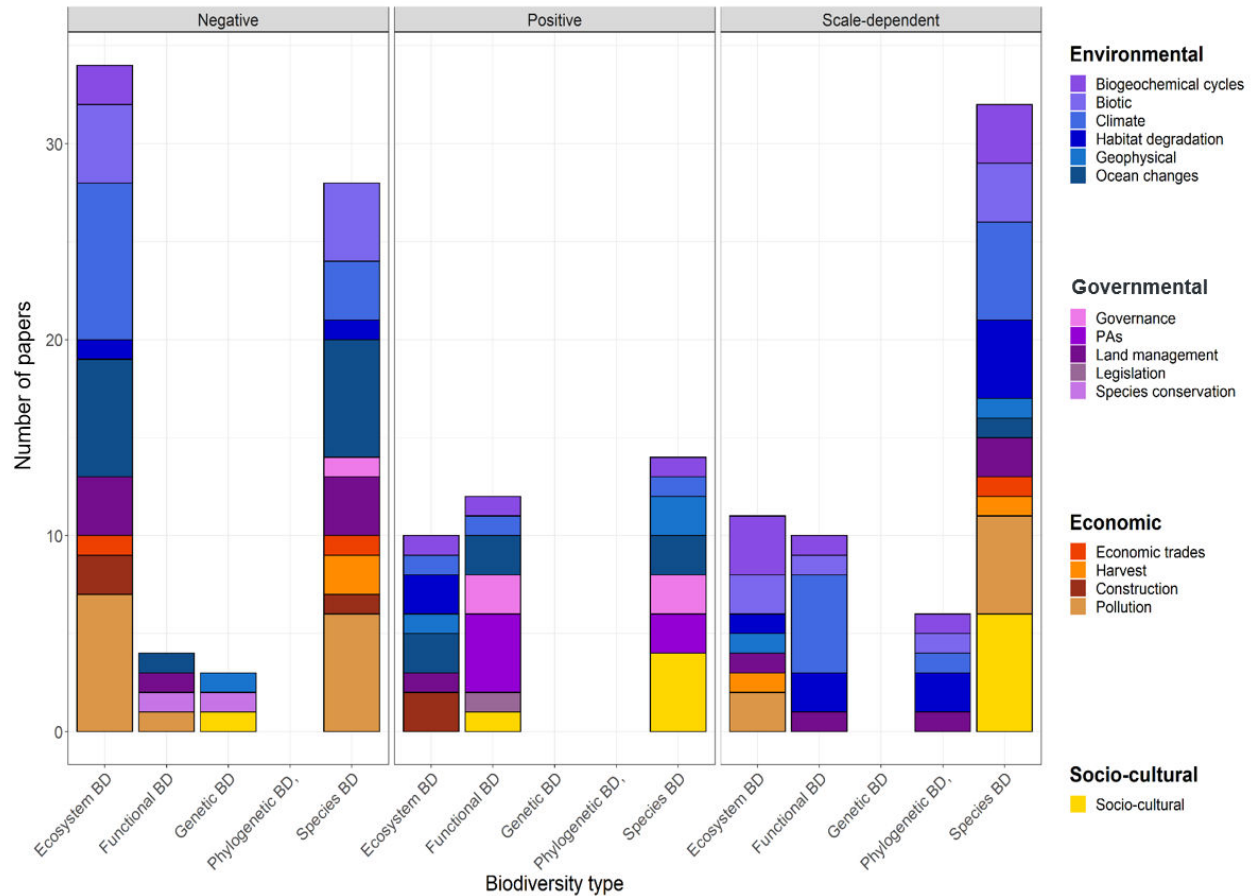


Figure 6. Directional impacts of drivers of change on different drivers of biodiversity. The x-axis represents the type of biodiversity investigated by each paper. The height of each bar represents the total number of papers looking at this dimension of biodiversity. The results are divided into three columns from left to right (headings at the top of the figure) based on the reported direction of the impact of the driver on biodiversity: negative, positive, and scale-dependent. The colour of the bars represents different drivers impacting biodiversity, which align with the four component types used to categorize aspects of Canada’s Aichi Biodiversity Targets (e.g., environmental, governmental, economic, and socio-cultural).

Studies also show that different drivers may incur positive, negative, and/or scale-dependent impacts on biodiversity. As shown in Figure 6, environmental factors like climate change and ocean change are the most well studied. Interestingly, while their impacts on species diversity are primarily scale-dependent, their impacts on ecosystem biodiversity are predominantly negative. Governmental factors like legislation or PAs can usually help to improve biodiversity while economic factors like construction, land management, trade, and harvest tend to reduce biodiversity. The socio-cultural dimension of biodiversity is mostly scale-dependent, indicating the complexity of this factor and that the design of related biodiversity measures should be based on the local context and take into account the effect of scale.

Economic component

In the economic component, Canada’s Aichi targets focus on mitigation and management measures on farmland, aquaculture, fishing, and water quality. The targets collectively aim to reduce direct and indirect pressures as well as addressing their cumulative effects on biodiversity. While there is good progress in reducing pressures in the agriculture and aquaculture sectors, fishing and water quality remain considerable pressures on the ecosystem.

Table 8. Economic components of progress towards Canada’s Aichi Biodiversity Targets. Four targets were identified as economic components of biodiversity conservation as they focus on mitigating the impacts of extractive human activities and re-organizing capital, industry, and trade. The colours represent the Goals they belong to in the Canada Aichi Target framework (SCBD, 2020b, Table 1). Economic components can be found in Goal B (yellow). The keywords are used for the ease of reading and understanding (also see Table 1). An explanation of each value in the “Progress” column can be found in the Methods section. A detailed analysis can be found in the main text of Results.

No.	Goals	Keywords	Detailed Targets	Progress
7	Goal B: By 2020, direct and indirect pressures as well as cumulative effects on biodiversity are reduced, and production and consumption of Canada’s biological resources are more sustainable	Farmland	By 2020, agricultural working landscapes provide a stable or improved level of biodiversity and habitat capacity	Sufficient progress
8	Goal B: By 2020, direct and indirect pressures as well as cumulative effects on biodiversity are reduced, and production and consumption of Canada’s biological resources are more sustainable	Aquaculture	By 2020, all aquaculture in Canada is managed under a science-based regime that promotes the sustainable use of aquatic resources (including marine, freshwater and land based) in ways that conserve biodiversity.	Sufficient progress
9	Goal B: By 2020, direct and indirect pressures as well as cumulative effects on biodiversity are reduced, and production and consumption of Canada’s biological resources are more sustainable	Fishing	By 2020, all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem-based approaches.	Insufficient progress
10	Goal B: By 2020, direct and indirect pressures as well as cumulative effects on biodiversity are reduced, and production and consumption of Canada’s biological resources are more sustainable	Water quality	By 2020, pollution levels in Canadian waters, including pollution from excess nutrients, are reduced or maintained at levels that support healthy aquatic ecosystems.	Insufficient progress

Canada’s water quality requires improvement for human and ecosystem health and is insecure for Indigenous peoples and local communities. Strongly affected by the distribution of human activities, water quality in the south of Canada is worse than in the north, especially in the Great Lakes and St. Lawrence River region where more than 20% of water remains marginal (i.e., water quality is frequently threatened or impaired, conditions often depart from natural or desirable levels) (Figure 7). This is one of the key leading factors for species extinction/extirpation in aquatic environments in Canada in addition to overfishing (e.g., in the case of the original St. Lawrence River Striped Bass, once considered extinct) (COSEWIC, 2019). The main pressures on freshwater ecosystems are anthropogenic, including industrial effluent from mining, agricultural runoff, and municipal sewage pollution and waste accumulated as a result of urbanization. Canada faces real threats to its water security, especially Indigenous peoples who suffer from insecure access to clean freshwater with limited infrastructure (Cecco, 2021). Furthermore, there is an increasing threat of contamination as municipal waste and the risk of pipeline ruptures increases (Pettipas et al., 2016; Environmental Defense Canada, 2021, The Conference Board of Canada, 2013). Canada ranks 4th out of 17 peer OECD countries for water quality, following Sweden, Norway, and Austria (The Conference Board of Canada, 2013). Still, increases in toxic

algal blooms in Canadian lakes and coastal water have heightened risks to human health (Winter et al., 2011; Environment and Climate Change Canada [ECCC], 2021). Water-related incidents (e.g., *E. coli* contamination, lead-laced drinking water) concern not only people but also impact the abundance and health of aquatic species (Chattha, 2021; Radio-Canada, 2010; Kimmitt & Wrobel, 2019; Spehar & Fiantdt, 1986; Meshesha et al., 2020). Considering issues related to increasing municipal waste (Figure 8) and other marine pollution (e.g., plastic pollution and radioactive wastewater), water quality in the next decade in Canada, especially in coastal regions, should be closely monitored and carefully regulated, incorporating elements of waste management and emergency response systems.

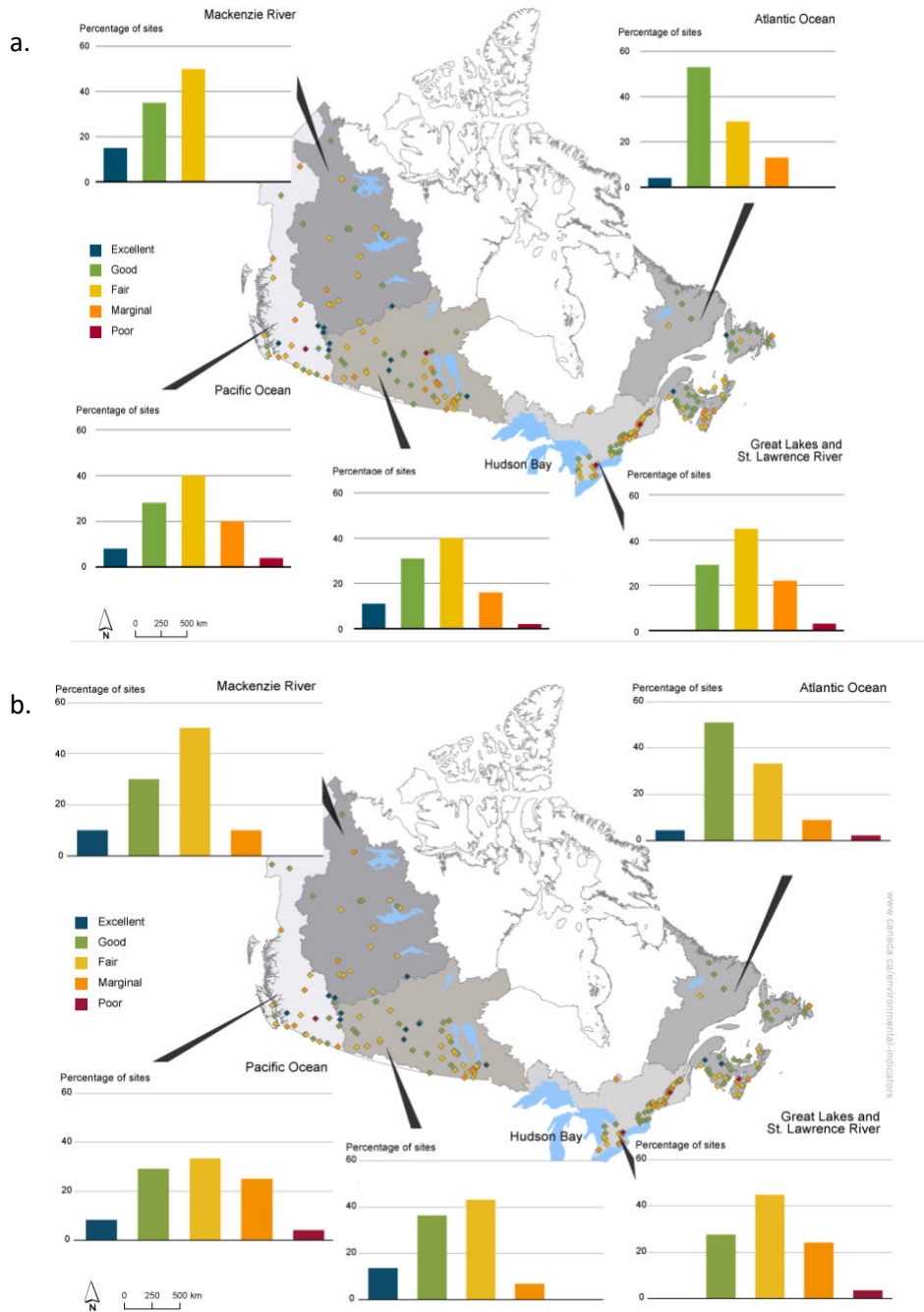


Figure 7. Regional water quality in Canada (a. Monitoring data collected during 2016-2018 and b. Monitoring data collected during 2017-2019) (ECCC, 2021). The water quality levels include: Excellent (blue): Water quality is protected with a virtual absence of threat of impairment, conditions are very close to natural; Good (green): Water quality is protected with only a minor degree of threat or impairment, conditions rarely depart from natural or desirable levels; Fair (yellow): Water quality is usually protected but occasionally threatened or impaired, conditions sometimes depart from natural or desirable levels; Marginal (orange): Water quality is frequently threatened or impaired, conditions often depart from natural or desirable levels; Poor (red): Water quality is almost always threatened or impaired, conditions usually depart from natural or desired levels. Note: Adapted from “Water quality in Canadian rivers,” by Environment and Climate Change Canada, 2021. Retrieved from <https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/water-quality-canadian-rivers.html>. Copyright (2021) by Government of Canada.

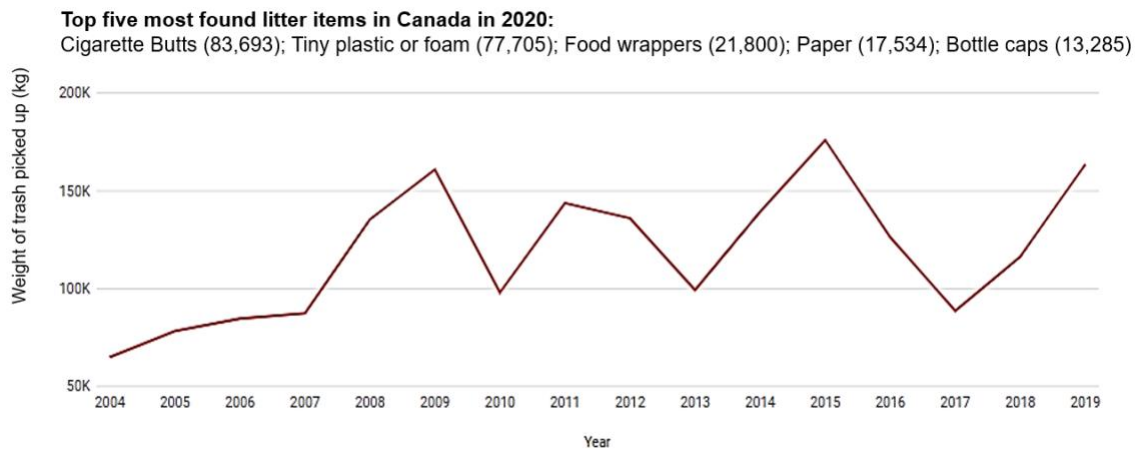


Figure 8. Weight of trash and type of litter picked up on Canadian shorelines based on citizen science data (Ocean Wise, 2021).

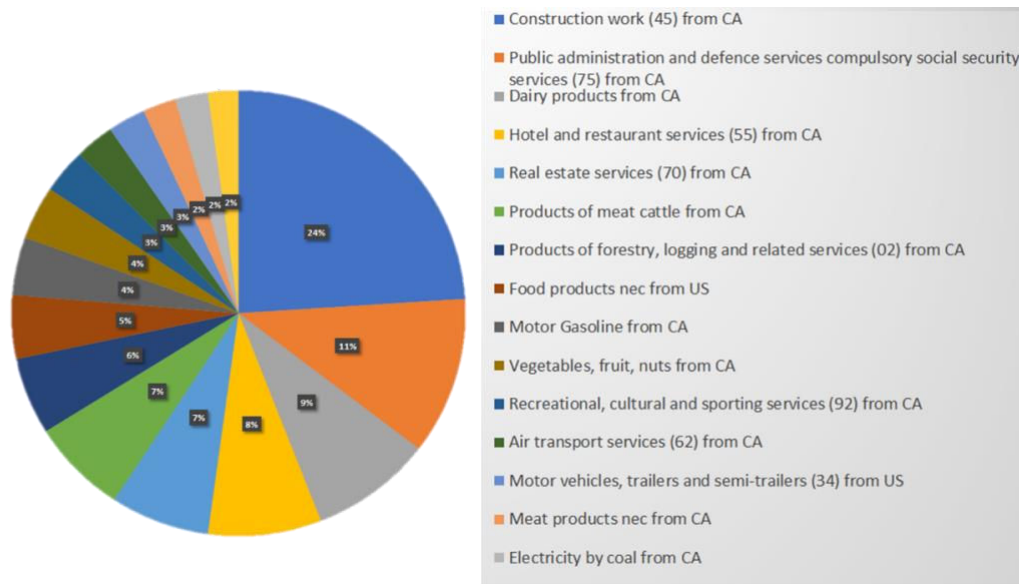


Figure 9. Top 15 commodities with potential for associated biodiversity loss due to consumption in Canada in 2018. CA refers to products produced in Canada, US refers to products produced and imported from the United States of America, and “nec” refers to products not classified elsewhere. (Stadler et al., 2018; Bulle et al., 2019).

Canada's exports to, and consumption of imports from, other countries can lead to biodiversity loss beyond our boundaries. In addition to the main pressures on biodiversity like climate change and habitat modification, international trade, for example the trade of farming and fishing products, forestry products, building and packaging materials, chemicals, plastic, rubber, and energy, leads to imported and exported pressures on global biodiversity. For example, consuming timber, fish, and other species imported from outside of Canada can result in biodiversity loss in other countries, increased risk of encroachment of invasive species, and increased waste pollution. These pressures occur across borders and thus may not be well-documented in national statistics. With the dramatic increase of environmental and socio-economic interactions between distant regions of the world (known as tele-coupling effects) due in large part to a proliferation in transportation, information, and communication technologies, international trade will continue to be a considerable threat to biodiversity loss at the global scale (Carrasco et al., 2017).

The private sector continues to exhibit strong potential for facilitating green transformations and should be engaged in biodiversity conservation along with public sectors. In addition to reducing the economic pressures on nature, we must consider applying economic levers to strengthen biodiversity conservation. More precisely, privately-owned businesses, often the main providers of goods and services in society, should be actively engaged in biodiversity financing and green business innovation (MacDonald, 2010). Biodiversity cannot be at heart of sustainable development if the supply chains led by private sectors continue environmentally harmful practices (Adam, 2017). Furthermore, a thriving, nature-positive private sector can be an essential component of poverty reduction and job creation. As of December 2019, there were 1.23 million businesses in Canada, of which 1.2 million (97.9 percent) were small businesses (Innovation, Science and Economic Development Canada, 2020). In many cases, private sector businesses are extractive and pollutive, affecting biodiversity in a negative way (Addison et al., 2019). Still, we found many examples across the world where companies have managed to align biodiversity and development needs. For example, Yorkshire Water restored over 280 km² of peatlands in UK, IBIS Rice engaged in conservation efforts for the ibis bird species and protected over 500km² of forest habitat in Cambodia, Kering restored 100,000 km² of rangelands in Mongolia, Chevron restricted invasive species in Australia, and Rabobank conserved forest through sustainable agriculture at the global level (Smith et al., 2020). These examples demonstrate the potential of the private sector to support biodiversity conservation while maintaining corporate profits and will likely become a winning business model over the coming decade as environmental risks translate to financial risks (World Economic Forum, 2020). The public sector should work closely with the private sector to enhance corporate accountability for environmental impacts and to tap into the potential for innovation in the private sector that can facilitate transformations towards a green economy (Fox et al., 2002; Skomoroshchenko et al., 2021).

Governmental component

In the governmental component, Canada’s Aichi targets include mainstreaming the consideration of biodiversity into municipal planning, climate change adaptation plans, Indigenous governance, innovation systems, and natural capital accounting. While there has been sufficient progress towards most governmental targets, support for Indigenous peoples and Indigenous governance has been insufficiently addressed to date.

Table 9. Governmental components of progress towards Canada’s Aichi Biodiversity Targets. The listed five targets were identified as governmental components of biodiversity conservation as they focus on institutional mechanisms, legal frameworks, and other governance-related aspects of society. The colours represent the Goals they belong to in the Canada Aichi Target framework (SCBD, 2020b, Table 1). Governmental components can be found in Goal A (Blue), B (yellow), and C (Red). The keywords are used for the ease of reading and understanding (also see Table 1). An explanation of each value in the “Progress” column can be found in the Methods section. A detailed analysis can be found in the main text of Results.

No.	Goals	Keywords	Detailed Targets	Progress
4	Goal A: By 2020, Canada’s lands and waters are planned and managed using an ecosystem approach to support biodiversity conservation outcomes at local, regional and national scales	Municipal planning	By 2020, biodiversity considerations are integrated into municipal planning and activities of major municipalities across Canada.	Sufficient progress
5	Goal A: By 2020, Canada’s lands and waters are planned and managed using an ecosystem approach to support biodiversity conservation outcomes at local, regional and national scales	Climate Change adaptation	By 2020, the ability of Canadian ecological systems to adapt to climate change is better understood, and priority adaptation measures are underway.	Sufficient progress
12	Goal B: By 2020, direct and indirect pressures as well as cumulative effects on biodiversity are reduced, and production and consumption of Canada’s biological resources are more sustainable	Indigenous governance	By 2020, customary use by Aboriginal peoples of biological resources is maintained, compatible with their conservation and sustainable use.	Off track
13	Goal B: By 2020, direct and indirect pressures as well as cumulative effects on biodiversity are reduced, and production and consumption of Canada’s biological resources are more sustainable	Innovation	By 2020, innovative mechanisms for fostering the conservation and sustainable use of biodiversity are developed and applied.	Sufficient progress
17	Goal C: By 2020, Canadians have adequate and relevant information about biodiversity and ecosystem services to support conservation planning and decision-making	Natural capital accounting	By 2020, measures of natural capital related to biodiversity and ecosystem services are developed on a national scale, and progress is made in integrating them into Canada’s national statistical system.	Sufficient progress

Recognizing and respecting Indigenous rights and self-determination is key for biodiversity protection.

Globally, Indigenous peoples are disproportionately impacted by environmental degradation, and this is also true in Canada. Many Indigenous peoples conduct themselves in profound relationality to the natural environment and therefore exercise a different ethic, attributing different values to aspects of the natural environment and all living beings upon Mother Earth. Indigenous Peoples have taken on key roles as environmental stewards and guardians to protect, manage, and restore traditional territories (P. Fox, pers. comm., 2021). But they are too often estranged from their lands, waters and resources by Crown governments (federal, provincial and territorial) in order to facilitate tenure systems based on colonization and private ownership (The Indigenous Circle of Experts [ICE], 2018; Aboriginal Awareness Canada, 2021). We need to make room for ethical spaces to support Indigenous-led conservation movements, enable communication across different knowledge systems, and heal the relationships

between humans and our planet (Ermine 2007; ICE, 2018; Buxton et al., 2021; Baxter & Trebilcock, 2010). Evidence has shown that resurgent Indigenous governance provides potential for increased conservation effectiveness (Artelle et al., 2019). The importance and necessity of protecting Indigenous rights, upholding their values, and respecting their own governance systems has been affirmed by the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) (UN, 2007) which is now enshrined in federal legislation in Canada (Statutes of Canada 2021 c-14). This was also emphasized at Article 15 in the recent Kunming Declaration, a global pledge to take urgent and integrated actions to integrate biodiversity considerations in all sectors of the global economy, to position biodiversity at the heart of recovery plans and development agendas around the world and to carry this out with the full participation of Indigenous Peoples (SCBD, 2021a).

The concrete mechanisms to recognize Indigenous knowledge systems and self-determination are severely lacking. As of 2018, there are 147 mechanisms at federal and provincial levels that allow for inclusion or integration of Indigenous knowledge to inform government decision-making (ECCC, 2016; ECCC 2018). While 34 additional mechanisms have been added since 2014, only four of them are new mechanisms established since 2014 (i.e. the Commission for Environmental Cooperation (CEC) Traditional Ecological Knowledge Expert Group; the Intergovernmental Council established by the Northwest Territories Intergovernmental Agreement on Lands and Resources Management; the SK2 Central woodland caribou integrated range planning table; and the SK2 West woodland caribou integrated range planning table), all others being either old ones, duplicated, or not yet founded (Table 10; ECCC, 2018). The Aboriginal Peoples Survey also shows a decline in customary use of biological resources by Indigenous peoples off the reserve, especially in youth and young adults (from 41% in 2006 to 33% in 2017 for hunting, fishing, and trapping, and from 26% in 2006 to 22% in 2017 for gathering wild plants or berries) (Figure 10). While most respondents to this survey indicate willingness to spend more time in keeping these traditional activities, practices, and life ways, several barriers persist, including lack of time due to other forms of employment, remote location, lack of money or equipment, lack of companions, and/or physical disabilities. Some respondents also felt constrained by quota restrictions (Kumar et al., 2019).

Table 10. Status of Indigenous Knowledge Decision Mechanisms added to the table since 2014. (ECCC, 2018)

Note: Adapted from “Canada Target 15: Detailed Assessment Report,” by Environment and Climate Change Canada, 2018. Retrieved from <https://chm.cbd.int/api/v2013/documents/7987131F-C55F-9831-37F2-A4E906A8A156/attachments/Canada%20Target%2015%20Detailed%20Report.pdf>. Copyright (2018) by Government of Canada.

Type of mechanisms added to the table since 2014	Count number of mechanisms
New mechanisms founded since 2014	4
Mechanisms founded before 2014	7
Mechanisms with no info on date founded	15
Mechanisms in plan but not yet founded	3
Mechanisms suggested to be removed	5
Total added mechanisms	34

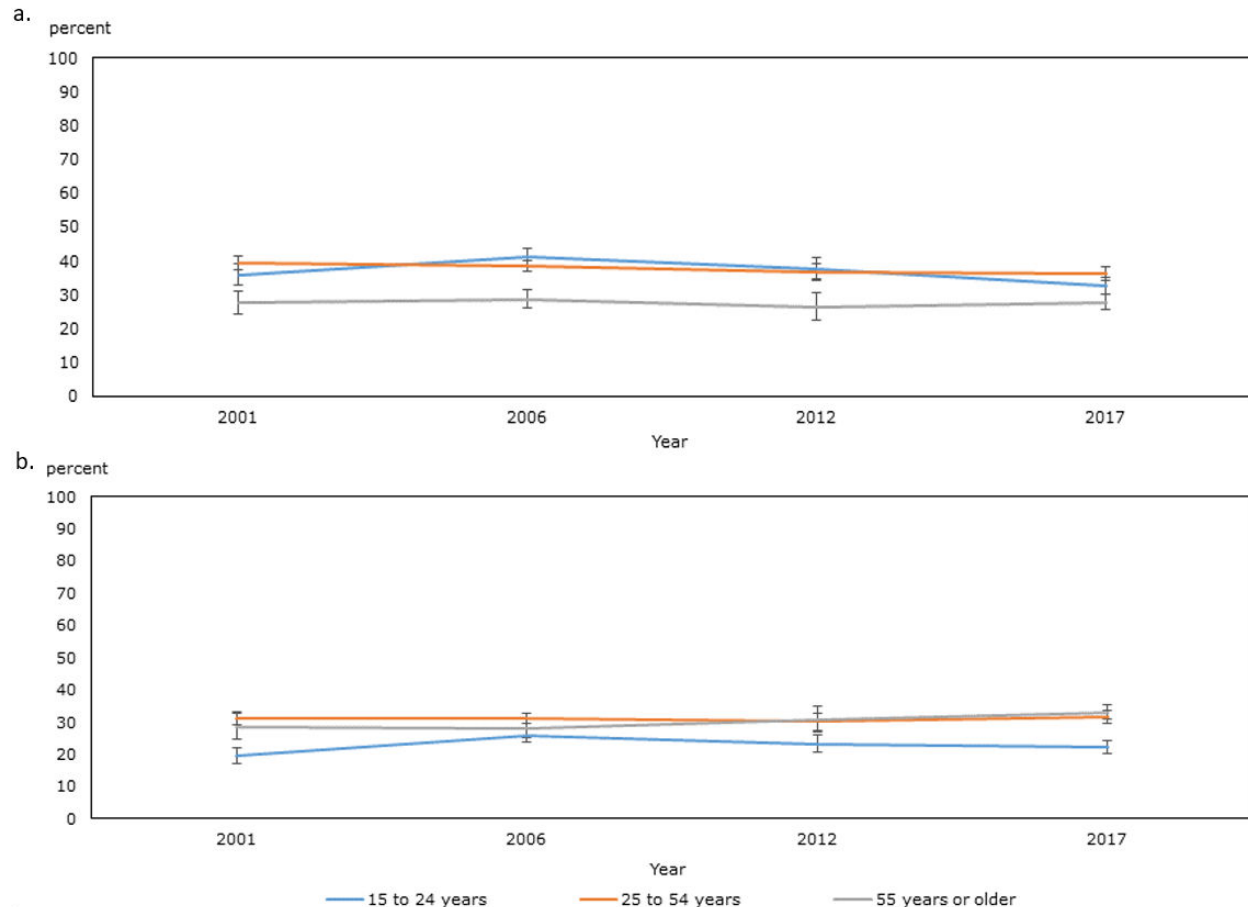


Figure 10. Annual prevalence of natural resource-dependent activities among Indigenous adults living off reserve (2001-2017). The data used for this figure is from the Aboriginal Peoples Survey (Statistics Canada, 2020). Panel a shows the percentage of Indigenous respondents who go hunting, fishing, and/or trapping by age class where blue represents individuals 15 to 24 years, orange 25 to 54 years and grey 55 years or older. Panel b shows the percentage of Indigenous respondents who go gathering wild plants or berries. Error bars denote 95% confidence intervals. Adapted from “Aboriginal Peoples Survey,” by Kumar et al., 2019. Retrieved from <https://www150.statcan.gc.ca/n1/pub/89-653-x/89-653-x2019001-eng.htm>

Biodiversity degradation has occurred in parallel with colonization and the disruption of Indigenous systems that stewarded ecosystems in what became Canada for millennia. Over Canada’s history, lands, waters and resources were appropriated from Indigenous peoples without their consent. Indigenous peoples suffer from historic and ongoing injustice as a result of being dispossessed and at times forcibly removed from their lands and territories, preventing them from exercising their right to development in accordance with their own needs and interests (See p. 2 in UNDRIP). The relationship between Indigenous peoples and their ecosystems have been disturbed, thus harming entire socio-ecological processes (K. Artelle, pers. comm., 2021). To make it worse, the reserves to which the Crown governments forcibly re-located Indigenous peoples are mostly remote, 80% of which are distant from service centers where basic goods can be obtained (Aboriginal Awareness Canada, 2021). The basic needs of potable water, adequate wastewater systems, food security, and shelter are not met in many Indigenous communities. Despite the improvements of funding and government-led efforts in Canada over recent decades, the well-being of Indigenous peoples still lags behind non-Indigenous populations with an exponentially increasing gap (Leach et al., 2020). Whether it be through a lens of human rights

or biodiversity, it is imperative to respect and protect the right to self-determination for Indigenous Peoples (D. Littlechild, pers. comm., 2021)

Another related issue is a lack of integrated approach in biodiversity governance in Canada. The complex feature of biodiversity conservation in terms of its scales, scopes, and factors intrinsically asks for a multi-sectoral, interdisciplinary, and systematic approach in governance. However, the weakness in breaking silos between jurisdictions in Canada is well recognized by many studies (Standing Committee on Environment and Sustainable Development, 2016; Commissioner on Environment and Sustainability, 2018; Ray et al., 2021). A whole-of-government instrument has not been effectively adopted in implementing Canada's National Biodiversity Strategy and Action Plan (NBSAP) (Ray et al., 2021). While reporting responsibility falls under one federal ministry (i.e., ECCC), many other bodies across Canada's federal, provincial, and territorial level assume important roles in the implementation of biodiversity conservation. There requires a stronger leadership to align multi-level efforts to national targets in biodiversity protection, building a society that lives and develops as a vibrant part of nature.

While progress has been made to mainstream biodiversity in municipal planning, **more explicit definitions of scope and monitoring mechanisms are required for effective implementation.** We reviewed the provincial and territorial acts and strategic plans across Canada and found a total of 85 pieces of legislation across all provinces and territories that had active legislation categorized by Environment and Climate Change Canada as "Biodiversity and Wildlife". On average, each province or territory had six pieces of active legislation relating to biodiversity conservation, with Ontario having the most. Still, biodiversity conservation strategies were often buried within other policies, without reference to explicit monitoring mechanisms, measures of conservation success, or clear regulations. For example, biodiversity was not always defined (28% undefined); when it was defined, the definition was often inconsistent across the legislation. Again, as mentioned earlier, the most common level of biodiversity referred to was species diversity, followed by ecosystem diversity, then genetic diversity. Many pieces of legislation mentioned only one level of biodiversity and only two pieces of legislation out of the 85 found in total touched on all the three levels of biodiversity.

Similarly, **conservation strategies prescribed in the legislation are mostly focused on PAs and many are one-sided.** Biodiversity conservation strategies described in legislation varied across provinces and territories; however, a few strategies were found commonly across Canada. The most common biodiversity conservation strategy was the use of PAs (or area-based conservation), encompassing 63% of all legislation reviewed, followed by resource management (37%) and land management (33%). More than one third of the pieces of legislation analyzed included only one type of conservation strategy. For others who adopted at least two strategies, the most common combinations identified were pollution/contaminants and land management, and resource management and PAs.

Most pieces of legislation require the involvement of the general public and local communities for the implementation of biodiversity strategies, but the extent is sometimes superficial and biased.

Biodiversity conservation requires efforts from all types of stakeholders. Many scholars have demonstrated the importance of collective action and bottom-up approach for managing natural assets which are common pool resources (Ostrom, 1990; Levin, 2010; Berkes, 2008). According to our study, 89% of the acts reviewed relied on the involvement of local communities for biodiversity conservation. Involvement was generally framed as taking place through consultations or through committees and advisory boards. Involvement of the public in committees or advisory boards was typically through appointment by the minister responsible for administering legislation. Indigenous groups were not frequently involved or mentioned in legislation beyond their treaty rights. 28% of legislation reviewed provided further details on the involvement with Indigenous peoples and local communities through

membership on committees or advisory boards, consultations, or through joint planning processes or agreements entailed. Other jurisdictions outside of the province or territory were mentioned in 32% of legislation, mainly through mentions of agreements or management with the federal government.

Protecting Canadian ecosystems has global significance. Canada’s contribution to global ecosystem values is among the highest, particularly considering its massive but declining extent of intact ecosystems in the north (Figure 11). Policies implemented in Canada can profoundly influence conservation outcomes inside and outside its borders (Coristine et al., 2019). As a signatory to the United Nations Convention on Biological Diversity (UNCBD), and a member in “High Ambition Coalition for Nature and People”, Canada has the mandate to spare no efforts to protect its ecosystem assets for the benefit of Canadians and global communities. This requires not only significant investments, like the Canada Nature Legacy Initiative (Government of Canada, 2019), but also cross-sector, cross-scale, and cross-border collaborations to collectively stem the loss of biodiversity and the degradation of nature.

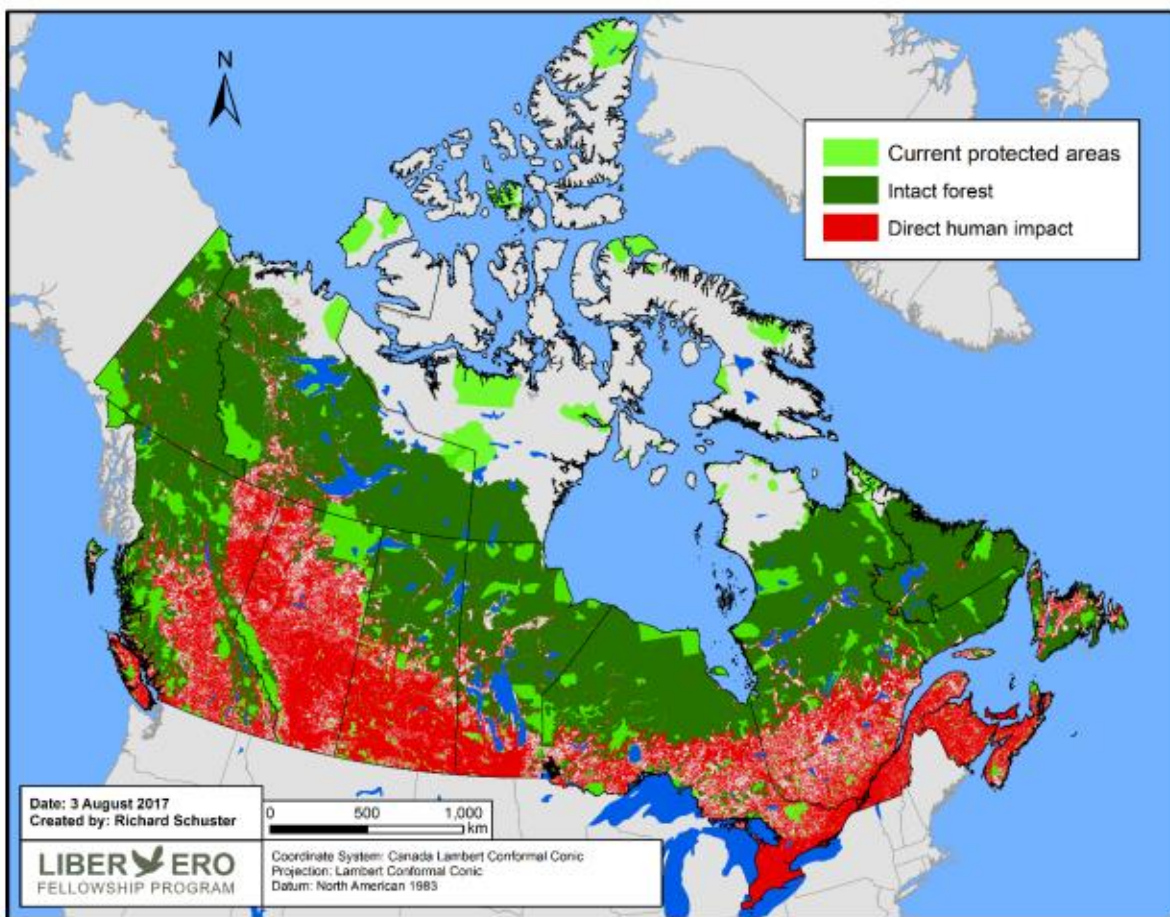


Figure 11. Distribution of current PAs in relation to intact forest landscapes and areas of direct human impact. (Robertson et al., 2017).

Socio-cultural component

In the socio-cultural component of biodiversity conservation efforts, Canada’s Aichi targets include enhanced scientific knowledge, respect for and promotion of Indigenous knowledge, comprehensive spatial inventory, education, and participation. Of all four components examined in our analysis, this is

the component where the most targets have demonstrated insufficient progress according to both the literature review and workshop discussions (Table 11).

Table 11. Socio-cultural components of progress towards Canada’s Aichi Biodiversity Targets. The listed five targets were identified as socio-cultural components of biodiversity conservation as they focus on knowledge generation and mobilization, cultural and ethical concerns, as well as scientific research and education. The colours represent the Goals they belong to in the Canada Aichi Target framework (SCBD, 2020b, Table 1). Socio-cultural components can be found in Goal C (Red) and D (Green). The keywords are used for the ease of reading and understanding (also see Table 1). An explanation on each value in the “Progress” column can be found in the Methods section. A detailed analysis can be found in the main text of Results.

No.	Goals	Keywords	Detailed Targets	Progress
14	Goal C: By 2020, Canadians have adequate and relevant information about biodiversity and ecosystem services to support conservation planning and decision-making	Scientific Knowledge	By 2020, the science base for biodiversity is enhanced and knowledge of biodiversity is better integrated and more accessible.	Insufficient progress
15	Goal C: By 2020, Canadians have adequate and relevant information about biodiversity and ecosystem services to support conservation planning and decision-making	Aboriginal knowledge	By 2020, Aboriginal traditional knowledge is respected, promoted and, where made available by Aboriginal peoples, regularly, meaningfully and effectively informing biodiversity conservation and management decision-making.	Insufficient progress
16	Goal C: By 2020, Canadians have adequate and relevant information about biodiversity and ecosystem services to support conservation planning and decision-making	Spatial inventory	By 2020, Canada has a comprehensive inventory of protected spaces that includes private conservation areas.	Insufficient progress
18	Goal D: By 2020, Canadians are informed about the value of nature and more actively engaged in its stewardship	Education	By 2020, biodiversity is integrated into the elementary and secondary school curricula	Sufficient progress
19	Goal D: By 2020, Canadians are informed about the value of nature and more actively engaged in its stewardship	Participation	By 2020, more Canadians get out into nature and participate in biodiversity conservation activities.	Sufficient progress

Biodiversity research in Canada remains predominantly focused on species conservation, with gaps in knowledge and data at genetic, functional, and biocultural levels. As mentioned in the Environmental component, conservation research in Canada at the species level remains prevalent compared with studies at other levels. Genetic and functional diversity are equally as important as species diversity but are understudied. Biocultural diversity intrinsically places humans as one part of nature and recognizes the interconnection between diversity of human cultures and languages and the diversity of species, habitats, and ecosystems. Biocultural diversity is also under-investigated compared to species diversity.

Despite its importance to decision-making and action, our knowledge of biodiversity across spatial and temporal scales is lacking. Most data on the status and trends of Canada’s biodiversity remains fragmented and scattered across institutions and libraries. The wealth of information hidden in unstructured biodiversity datasets has not been effectively translated into decision-making. For example, we need a more comprehensive observation network in Canada to collect more complete knowledge on species richness and composition (taxonomic diversity), functional diversity, and on ecosystem diversity. The work of the Group on Earth Observations Biodiversity Observation Network, headquartered in Montreal, Canada, and the recently launched United Nations Biodiversity Lab are helping to shift us in this direction – but more support is needed. Comprehensive and consistent data

collection is a prerequisite to exploring complex questions such as how climate change and other interconnected anthropogenic and biophysical factors impact biodiversity.

Equally important, **Indigenous knowledge includes profound understanding of genetic resources and the relationship between humans and nature.** Indigenous knowledge has been developed through the beliefs and understandings that Indigenous peoples acquired through long-term observations and associations with a place. It is well-established that Indigenous knowledge can make significant contributions to sustainable development, including by elevating values of biological resources for modern industry, agriculture, and other sectors (Townsend et al., 2020; Ried et al., 2021). Indigenous knowledge should be considered as a critical input to decision-making on biodiversity conservation (Buxton et al., 2021; Maseyk et al., 2019). This valuable knowledge has been built up and handed down over generations. It is essential that Indigenous and traditional knowledge is understood and valued appropriately by those who use it and that the rights of Indigenous and local communities are considered during negotiations over access to and use of genetic resources. Failing to do this can put the knowledge, the resources, and the communities at risk.

During the workshop, participants specifically discussed the potential barriers that prevent Canada from moving forward as a leader for biodiversity-centered development. In addition to above-mentioned factors like extractive economy, consumption, insufficient implementation strategies, lack of knowledge, and lack of consolidated data on biodiversity, participants specifically pointed out multiple barriers stemming from dominant worldviews, mindsets, and human greed. Indeed, **cultural and philosophical barriers for developing integrated biodiversity conservation pathways persist.** While not easy to identify and even more difficult to shift, these barriers requiring shifts in value systems have the highest potential to truly transform systems (Meadows, 1999) and incentivize behaviour change and stronger commitments by all actors in the long-term (Neves, 2019).

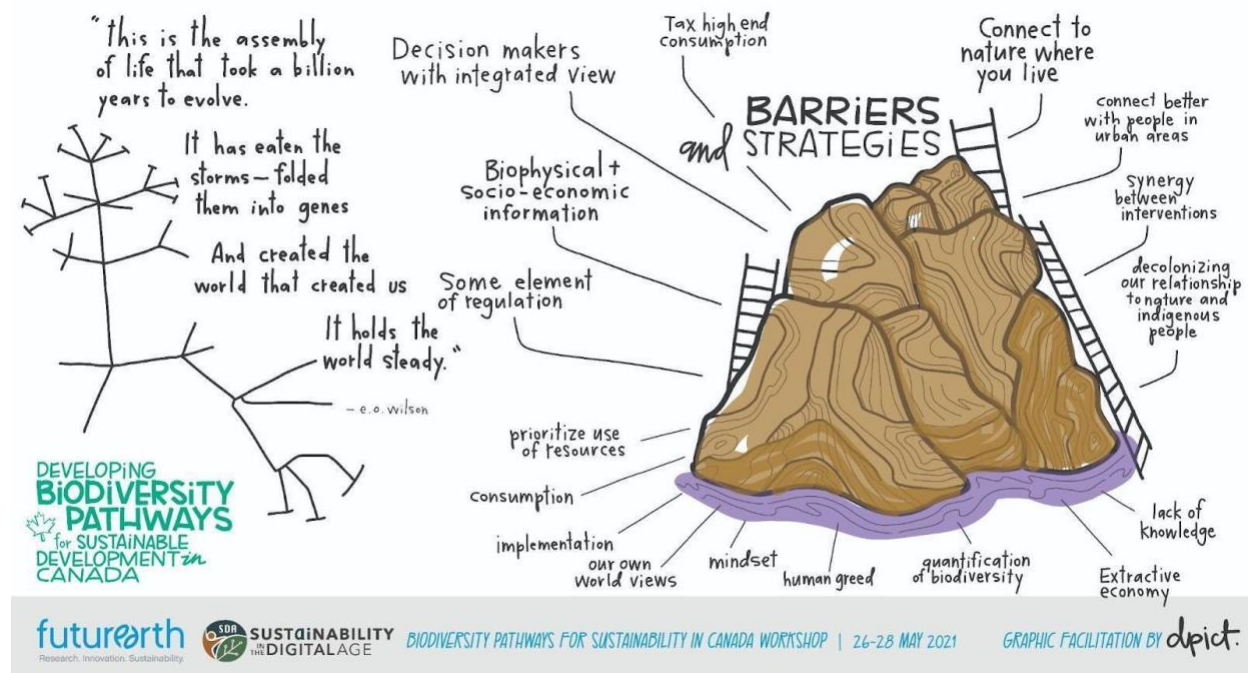


Figure 12. Graphic depiction of the workshop session exploring the barriers and corresponding strategies for achieving the vision of “human living in harmony with nature”.

Implications for policy making

Integrating biodiversity for sustainable development

The biodiversity crisis is well observed and acknowledged to be largely human-driven (e.g., Campbell et al. 2017; Smith et al. 2020). A large part of the challenge is that there is such a wide diversity of drivers that negatively impact biodiversity. For example, threats can be either local (i.e., dams, construction) or global (i.e., climate change, ocean changes, etc.). They also can be highly variable in type; for instance, global changes will modify environmental conditions on a large scale and over a long period of time while construction is punctual in space and time. Social norms and customary management of land can also have significant impact on the biodiversity trends that can be either positive or negative depending on the context. Yet, overall human development and biodiversity conservation are not necessarily antagonistic. Indeed, biodiversity can help reach some of our sustainable development goals (Wood et al. 2018). Table 12 summarizes the key needs and trade-offs of biodiversity conservation that need to be considered in policy making, according to workshop participants.

Table 12. Needs for biodiversity conservation and potential trade-offs and solutions. This table summarizes discussions held by participants of the workshop with added notes by the authors (*italics*).

Biodiversity Needs	Potential Trade-offs	Solutions
Connectivity across scales	Road development, resource extraction	Coordinated and polycentric systems
Maintaining biodiversity at different scales	Federal planning vs. other governmental levels, private land planning	Harmonizing goals across municipalities (operational goals), biocentric development goals
Long-term commitment	Short-term commitment of private sectors, capitalism	Economic incentives, sustainable market initiatives, redefining temporal baselines
System of accountability and transparency	Traditional economic development model	Subnational monitoring, federal systems, evaluation tools for corporations, natural capital accounting
Minimum environmental standards for human activities	Economic profit, economic growth	Social license, regulations, and legal framework for accountability
Integration of ethics considerations in industry funding	Profits for developers and <i>donors</i>	Independent board for public-private funding
Personal and communities' involvement in local Biodiversity	Housing development, equitable access to quality of living	Green spaces and parks in urban areas
Resources and support for Indigenous people	N/A (<i>existing governance regime and historic bias/discrimination</i>)	Highlight bright spots and wise practices (<i>recognize, respect, and protect self-determination rights of Indigenous people, support Indigenous governance systems</i>)
Support to Indigenous knowledge systems	N/A (<i>expansion of western knowledge system for technology development economic growth</i>)	Cross-cultural dialogues, Two-Eyed Seeing, education on Indigenous knowledge systems

Maintaining fully functional and resilient ecosystems	Fossil fuel economy, resource-based economy	Disruption of the concept of sustainable development, intergovernmental and third-party collaboration
Maintain intact forests	Paper production, renewable energy	Incentives to protect nature
Decolonizing conservation framework	Capitalist society	Respect rights and sovereignty of Indigenous people, breaking the dichotomy between humans and nature
Moving from quantitative to traditional and holistic knowledge	Capitalist society	Learn to see beauty, forest touch-feel, meditation being bored

In addition to Table 12 we present some key policy considerations under each of the four components (environmental, economic, governmental, socio-cultural) analyzed in this report. These recommendations have been summarized more succinctly in a related Evidence Brief and are intended to provide avenues for further reflection.

Environmental component

- **Develop** high-quality inventory databases and maps for biodiversity at multiple scales.
- **Apply** standardized indicators (both quantitative and qualitative) to support evidence-based policy making.
- **Compile** high-quality records of biodiversity across multiple dimensions, including rural and urban areas, northern and southern areas of Canada, and on both habitat quality (species abundance and richness) and wildlife permeability (habitat connectedness).

Related tools and resources:

- [Essential Biodiversity Variables](#)
- [GEOBON](#)
- [UN Biodiversity Lab](#)
- [EarthMap](#)
- [Global Biodiversity Information Facility](#)

Economic component

- **Support** the advancement of research and increase political attention and general awareness to address consumptive impacts on biodiversity loss. Reframe a virtuous pattern of consumption with environmental accounting and social marketing.
- **Redirect and scale up** public and private investments for ecosystems and biodiversity. Employ effective economic levers to retrofit extractive/polluting industries. Identify financial incentives for investing in the long-term well-being of nature and society.
- **Develop** effective economic mechanisms (e.g., subsidies, green stocks, taxes, and rebates) that retrofit polluting/destructive industries and finance for biodiversity and green transformation.

Related tools and resources:

- [Life Cycle Assessment](#)
- [Task Force on Nature-related Financial Disclosure \(TNFD\)](#)
- [Biodiversity Finance \(BIOFIN\) Approach](#)

- [Green New Deal](#)
- [Sustainable Stock Exchange](#)
- [Carbon market](#)
- [Payment for ecosystem services](#)
- [Debt-for-environment swaps](#)
- [The Lion's Share](#)

Governmental component

- **Decolonize** conservation frameworks in Canada by recognizing Indigenous leadership in nature-based conservation, secure self-determination rights for Indigenous peoples, build trust, and continue learning from Indigenous peoples.
- **Embrace** innovative tools and mechanisms for behavioural changes at community and individual levels. Leverage the power of digital innovation and citizen science.
- **Improve** regulation and legal frameworks to enhance transparency, monitoring capacity, and accountability of industry and other activities that are destructive to nature. Use tools like social licenses to develop a sound and transparent system and hold extractive industries accountable for nature-related financial impacts. Co-develop and deliver a risk management and disclosure framework to report and act on evolving nature-related risks and support a shift in financial flows away from nature-negative outcomes and towards nature-positive outcomes.

Related tools and resources:

- [The United Nations Declaration on the Rights of Indigenous Peoples \(UNDRIP\)](#)
- [Recommendations from 'We rise together' report](#)
- [Two-Eyed Seeing framework](#)
- [System of Environmental Economic Accounting](#)
- [Gross Ecosystem Product](#)
- [Natural capital accounting](#)
- [Behavioural Science](#)
- [Botanic gardens for biodiversity governance](#)
- [The little book of green nudges](#)
- [Social license](#)

Socio-cultural component

- **Adhere** to FAIR (Findable, Accessible, Interoperable, Reusable) data principles and CARE (Collective benefits, Authority to control, Responsibility, and Ethics) principles of Indigenous data governance to guide the collection, use, and sharing of data.
- **Encourage** the sharing of wise practices and tools for Indigenous-led biodiversity conservation. Provide space for Indigenous peoples to tell stories and educate using their own languages. Respect Indigenous values, cultures, and customary use of natural resources and seek guidance from Indigenous peoples for biodiversity conservation.
- **Advocate** for integrating the consideration of socio-economic, cultural, pastoral, and spiritual values of biodiversity in decision-making. Encourage interdisciplinary research and capacity building to identify, clarify, and communicate socio-economic, cultural, and spiritual values of biodiversity. Transform prevailing development models through value-led conservation and biocultural approaches.

- **Facilitate** cross-scale collaboration on biodiversity conservation and sustainable development. Establish a multi-partner network for environmental awareness-raising and coordinated actions with the support of advertisement companies, media organizations, social activists, and digital innovators.

Related tools and resources:

- [FAIR Principle](#)
- [CARE Principle](#)
- [Wise Practices](#)
- [Iportal - Indigenous studies portal research tool](#)
- [Conservation through reconciliation](#)
- [Biocultural indicators](#)
- [Interactive maps for truth and reconciliation](#)
- [Indigenous perspectives education guide](#)
- [iNaturalist](#)
- [Key information needs to move from knowledge to action for biodiversity conservation in Canada](#)

Conclusion

Biodiversity is an intrinsic characteristic of nature, which human beings are both a part of and heavily dependent on, yet the value of biodiversity is not well-understood by the general public. The Kunming Declaration emerging from the recent United Nations Convention on Biological Diversity 15th Conference of the Parties (Part 1) has reconfirmed global commitments to work together for biodiversity and ecosystem protection. The vision of “humans living in harmony with nature” is a beautiful picture requiring contributions from all actors. Canada, as host of a globally significant wealth of biodiversity and endowed with rich knowledge and wisdom from Indigenous peoples, can take the lead in demonstrating how we might value and protect such a biodiversity-rich society. While many of the suggestions proposed in this report fall on the shoulders of local, provincial, and federal governments, we also urge other sectors of society like business, citizens, and educators to stand up and take action. Your knowledge and efforts can help to increase public awareness of the issues surrounding biodiversity conservation and contribute to the development of innovative disruptions, leveraging digital technology and citizen science to shift values and transform the system. Biodiversity protection is not just a policy, or a measure, or a campaign. Protecting Canada’s biodiversity calls for long-term commitments, transformation of societal and cultural values, self-healing, and reconciliation with nature.

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Appendices

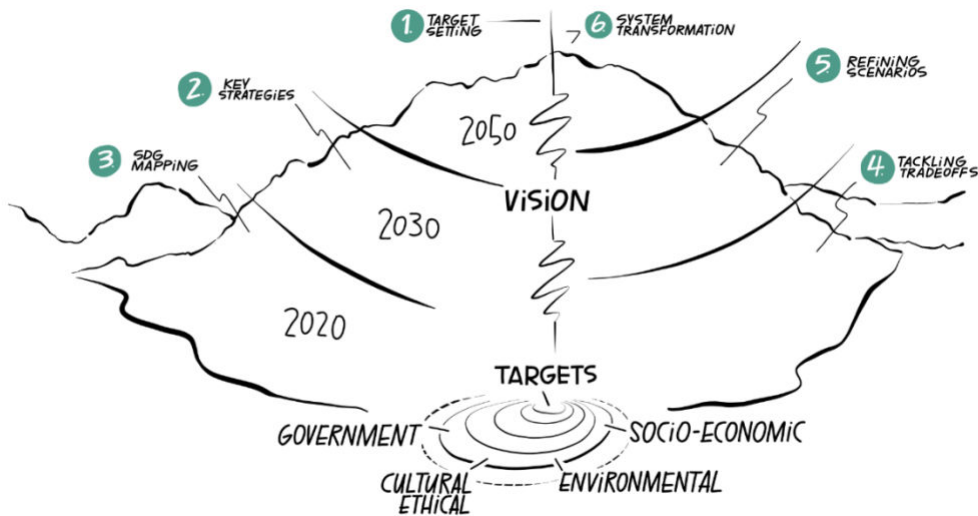


Figure A1. Conceptual framework of the workshop. In the workshop, we adopted six steps to explore the biodiversity pathways following a theory of change. Over the two days, we followed the mountain paths: soaring with vision, into the targets, barriers and strategies, visiting the whole system externally and from within, returning to care for and fill in the gaps, tackling the trade-offs, and reimagining the future. We closed our circle by awakening a biodiversity-centered pathway for system transformation.

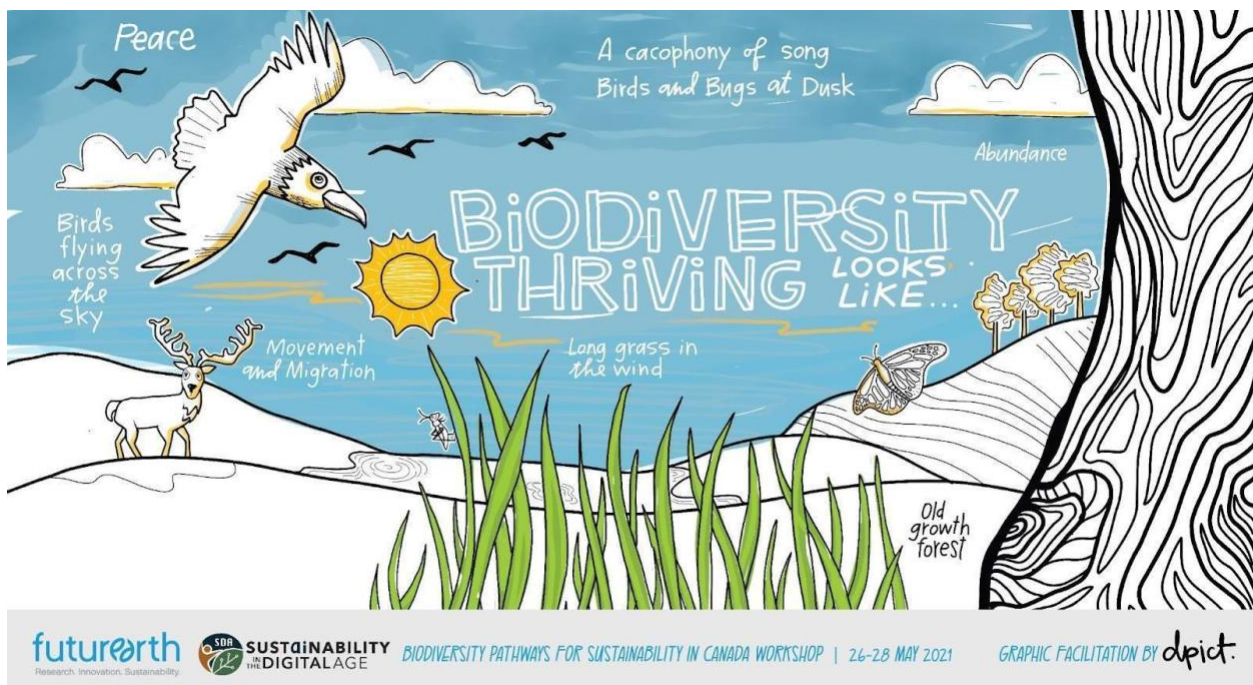


Figure A2. An impression of “thriving biodiversity” collectively described by the workshop participants.



Figure A3. Illustration of a vision beyond the Aichi Biodiversity Targets. Participants recognized the mismatch between policies and targets.

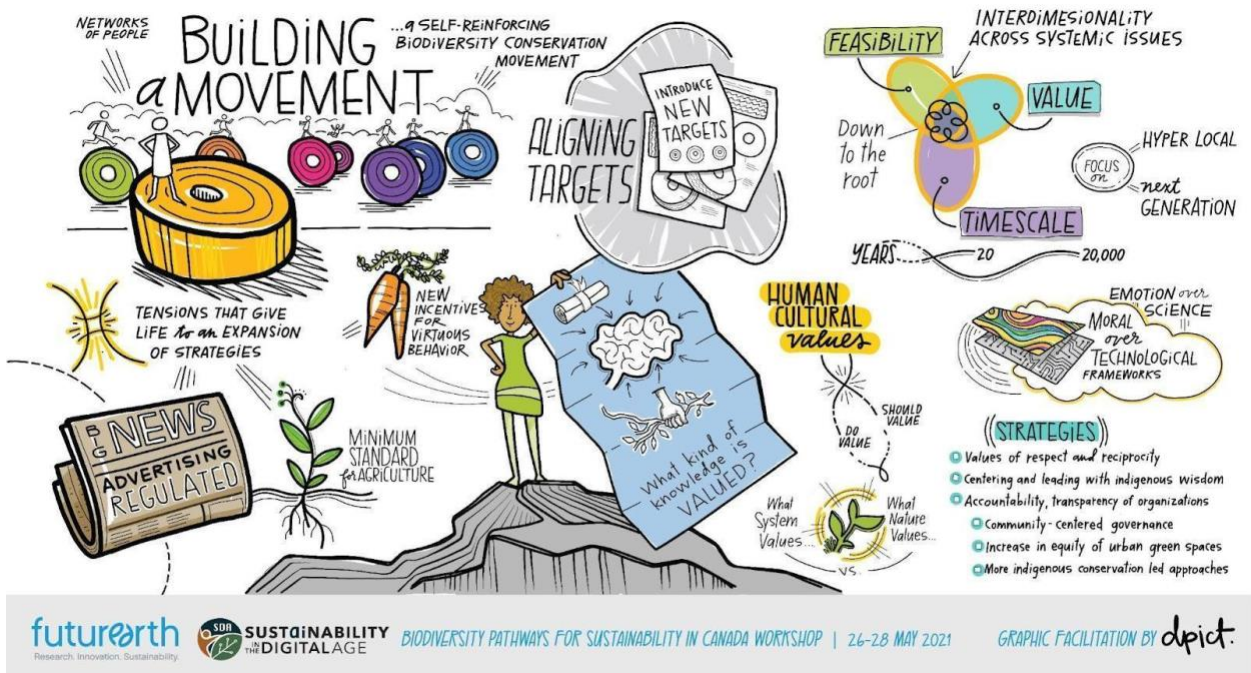


Figure A4. Visualization of strategies proposed across sectors and disciplines for biodiversity conservation proposed by workshop participants.

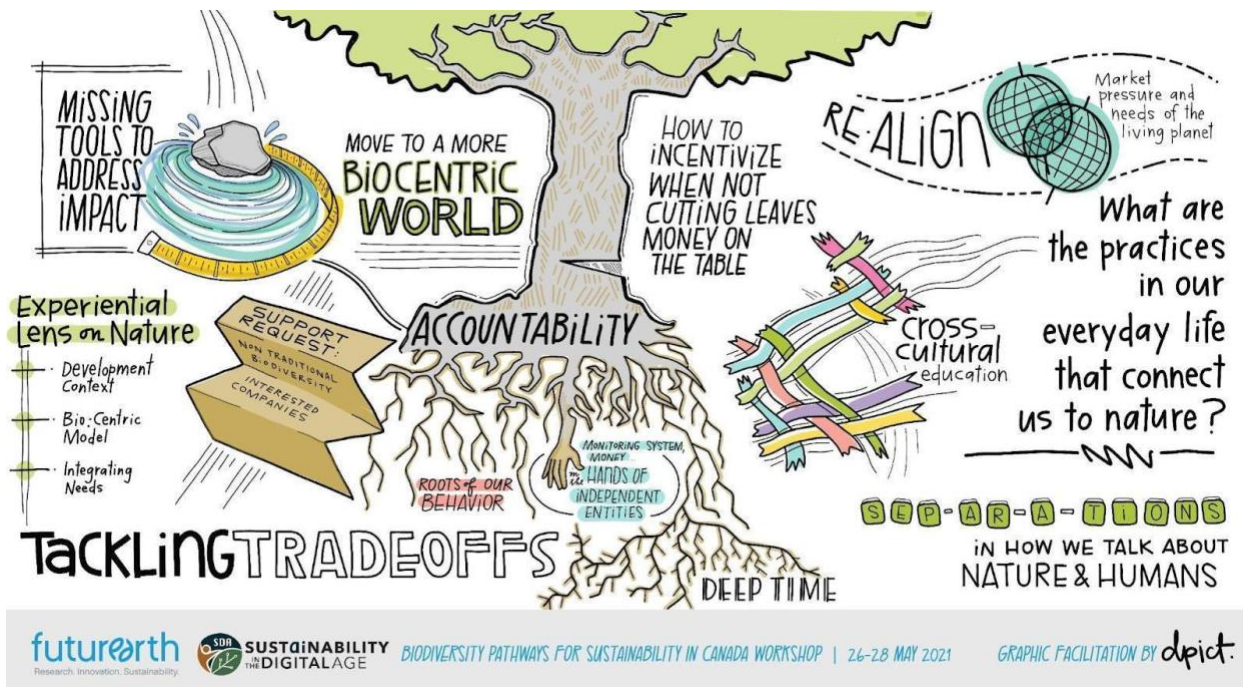


Figure A5. Highlights on the key questions, statements, and suggestions raised by workshop participants when discussing trade-offs between realizing biodiversity needs and other development needs.

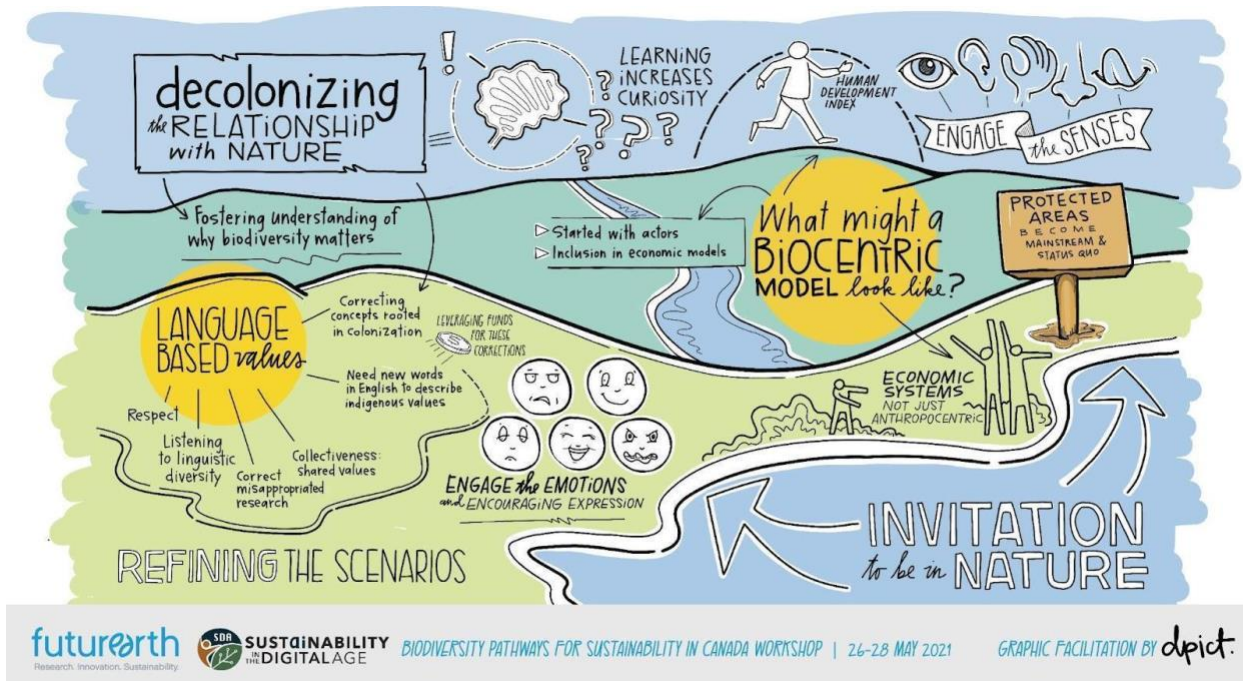


Figure A6. A manifestation of thoughts collected when workshop participants were asked to revisit and refine the scenarios for possible future after talking through the deep causes of biodiversity loss and trade-offs.

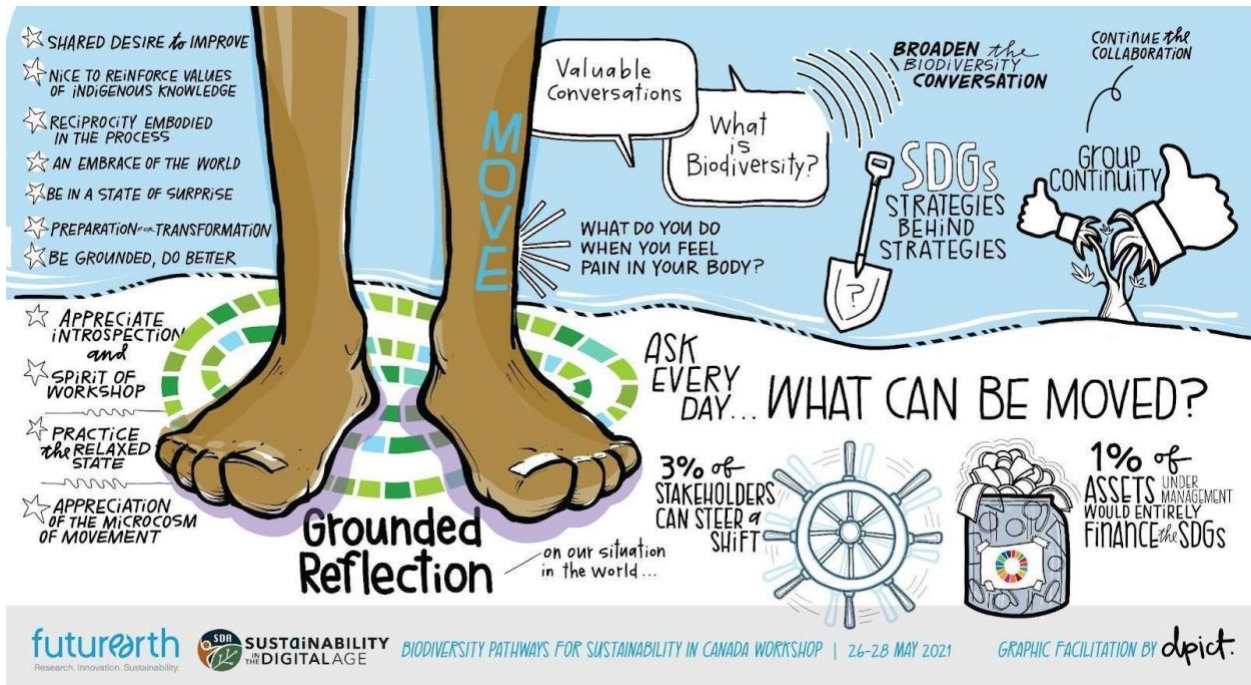


Figure A7. A visual crystallization of workshop participants’ reflections on system transformation and potential ways forward.