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THE CANADIAN MOUNTAIN ASSESSMENT: WALKING TOGETHER TO ENHANCE UNDERSTANDING OF MOUNTAINS IN CANADA

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CHAPTER 1

Introduction

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1.1 Mountains and Mountain Knowledge in Canada

Canada is a country of mountains. Around one-quarter (2.26 million km²) of the country is covered by mountainous terrain, an area large enough to encompass Switzerland 54 times and to position Canada as the fourth most mountainous country globally. Mountain areas in Canada—from high peaks of the St. Elias range in the northwest to the jagged Rocky Mountains of the western interior, and from Arctic ranges of Inuit Nunangat to the rolling hills of the Laurentian highlands—play an important role in shaping the biogeophysical and socio-cultural characteristics of the country (Fig. 1.1). Furthermore, the distribution of mountain areas across a wide range of latitudes, elevations, and climate zones in Canada produces a remarkable diversity of ecosystem types, socio-cultural characteristics, and associated biocultural relationships and interdependencies. Since well before the country of Canada existed, these mountain places have sustained and been stewarded by Indigenous Peoples who continue to know and care for them. Mountain systems in Canada are therefore best understood as dynamic, living, and deeply relational spaces where physical, human, and other-than-human worlds are woven together across space and time.

Mountains in Canada contain unique geological features, play an important role in influencing regional weather and climate patterns, and are critical sources of freshwater for downstream ecosystems, communities, and economic activities. They also provide habitat, migration corridors, and refugia for plants and animals, including species that are endemic to mountain environments. Canada is also one of the most glacier-rich countries in the world, second only to Greenland, and the snow and ice adorning mountain tops in Canada from coast to coast to coast are defining features of these regions. For example, Canada hosts roughly 33,600 glaciers covering an area of 204,000 km² (Pfeffer et al., 2014).

Mountains have been homelands for Indigenous Peoples since time immemorial and, accordingly, many Indigenous territories and linguistic regions are associated with mountain areas in what is now referred to as Canada (Fig. 1.2 and 1.3). These connections highlight diverse, place-based, and long-standing relationships that Indigenous Peoples have with mountains in Canada. Today, around 1.3 million people live within the mountainous areas of the country (Fig. 1.4), a number equivalent to 3.5% of the total population of Canada but that is greater than the population of small countries such as Bhutan (McDowell & Guo 2021). A further 29 million people live within 100 km of mountains, indicating that 82% of the total population of the country lives within or adjacent to mountains. This value contains portions of populations in mountain-oriented cities in the west such as Vancouver and Calgary, as well as cities in the east such as Ottawa and Montreal
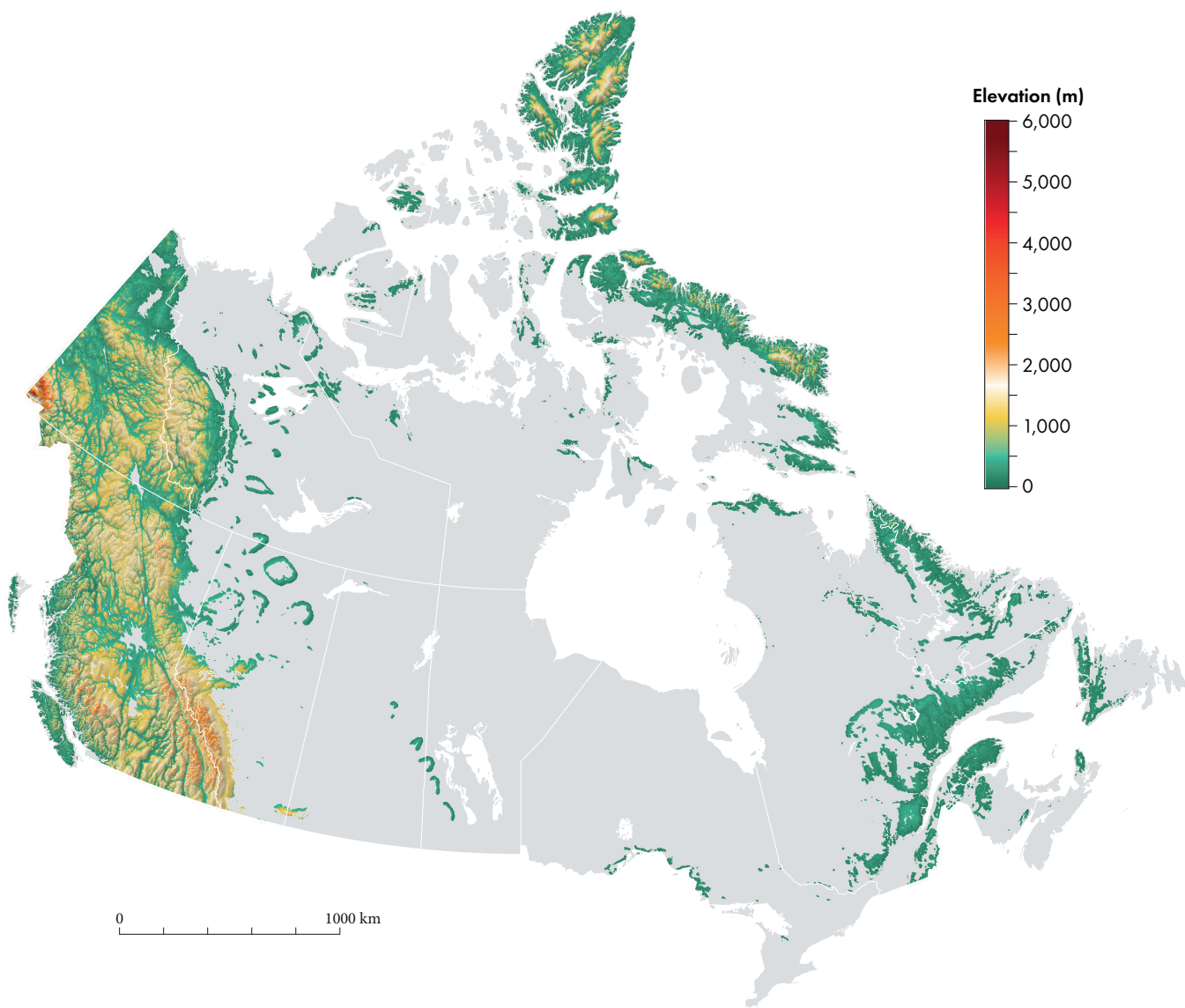
Figure 1.1: Mountainous areas in Canada based on McDowell & Guo (2021), following definition given by Kapos et al. (2000).

that are located within 100 km of minor mountainous features (note, this buffer distance has been used for population assessments in other contexts such as coasts, e.g., Millennium Ecosystem Assessment, 2005).

Mountains in Canada contribute to human well-being in myriad ways, including by providing freshwater, food, and medicine; sites of spiritual significance and places of solace and meaning; inspiration for art, literature, and storytelling; and destinations for recreation and mountain sports. These gifts from mountains play an important role in the culture, identity, and livelihoods of

people across Canada, even those who do not live in mountain areas. At the same time, mountains can be foreboding, with hostile winds, unpredictable weather, and dynamic landscapes and river courses that present challenges to safe passage. The rumbles of mountain hazards such as rockfall and avalanches freezes even seasoned alpine guides as they echo off mountain walls, a reminder of the volatility of these environments.

As in other mountain areas globally (see Adler et al., 2022; Hock et al., 2019), climate change is leading to transformative changes in mountain systems across Canada, with implications

Percentage of individual Indigenous Territories within K1 Mountain Region

- 100
- 90.1 - 99.9
- 80.1 - 90
- 70.1 - 80
- 60.1 - 70
- 50.1 - 60
- 40.1 - 50
- 30.1 - 40
- 20.1 - 30
- 10.1 - 20
- <10

0   1000 km

Polygons of territories are imperfect, incomplete, and static representations that do not fully represent the relationships, rights, and responsibilities that Indigenous Peoples have to places portrayed on this map. Numerous territories overlap; portions of territories extend beyond mountain areas are not shown.

Figure 1.2: Indigenous territories associated with mountain areas in Canada. Based on McDowell & Guo (2021). Data from Native-Land.ca.

Indigenous languages spoken within K1 Mountain Region

Polygons of languages are imperfect, incomplete, and static representations that do not fully represent the relationships, rights, and responsibilities that Indigenous Peoples have to places portrayed on this map. Numerous language areas overlap; portions of territories extend beyond mountain areas are not shown. Colours imply linguistic diversity.
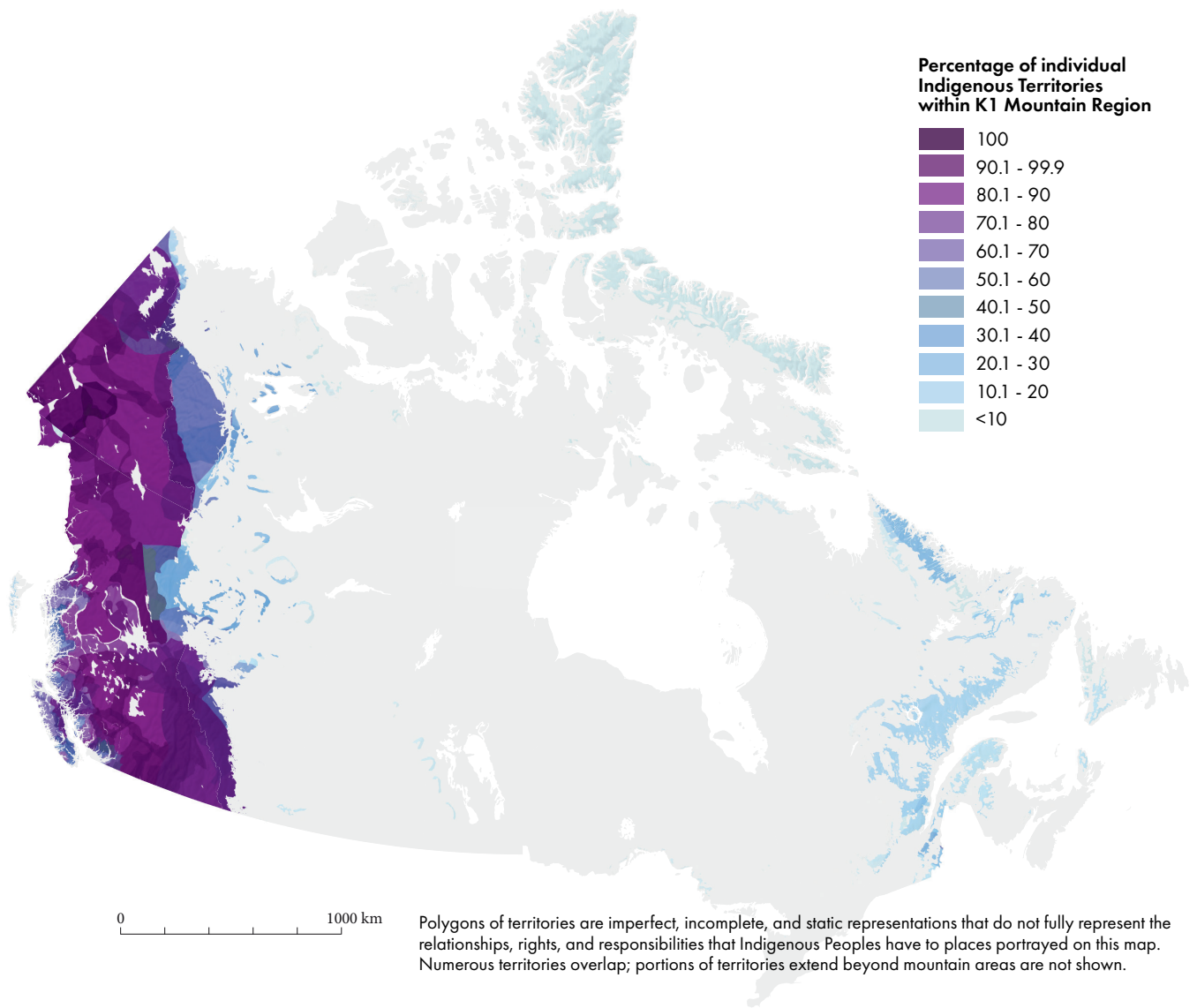
0   1000 km
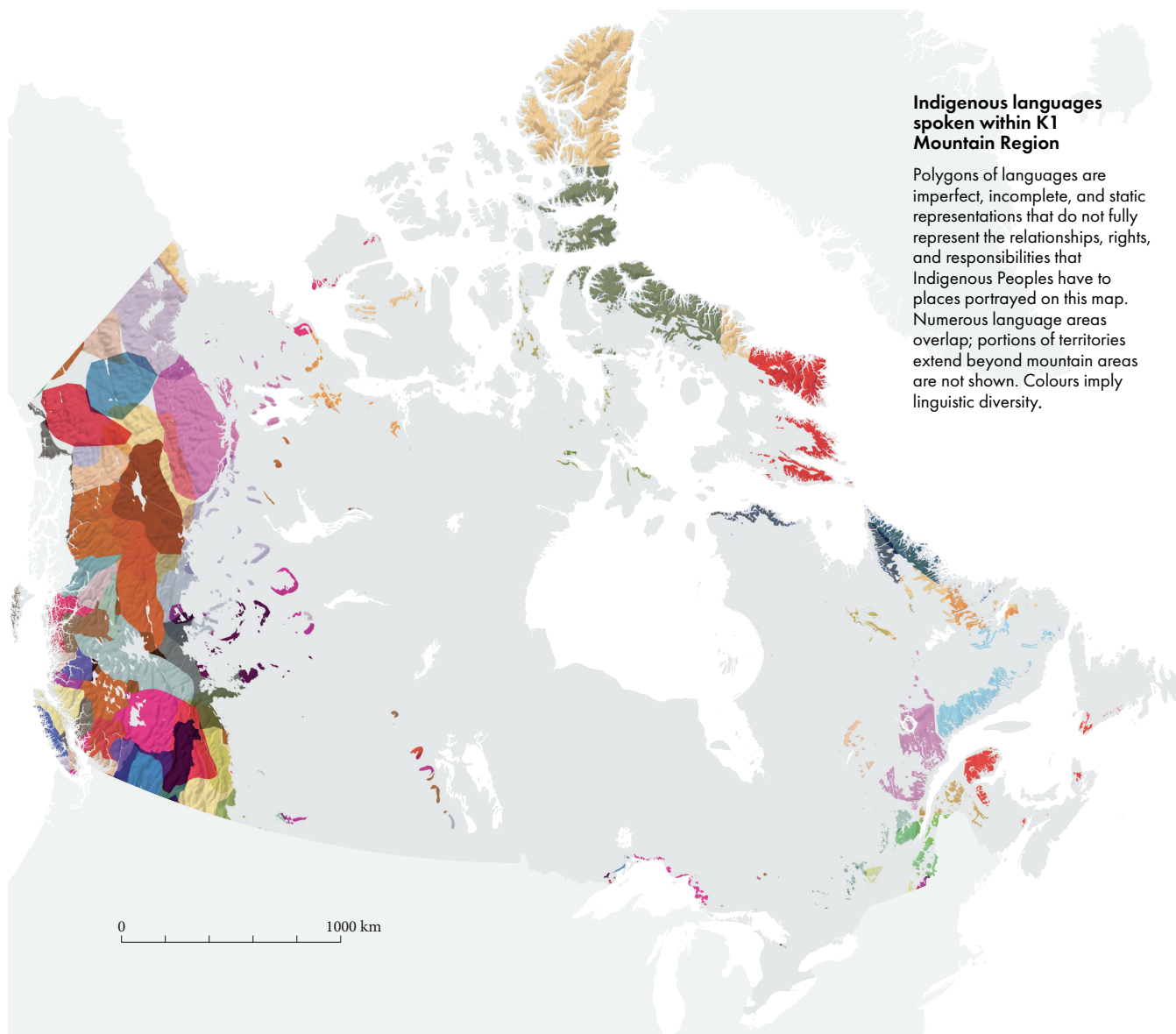
Figure 1.3: Indigenous linguistic regions associated with mountain areas in Canada. Based on McDowell & Guo (2021). Data from Native-Land.ca.
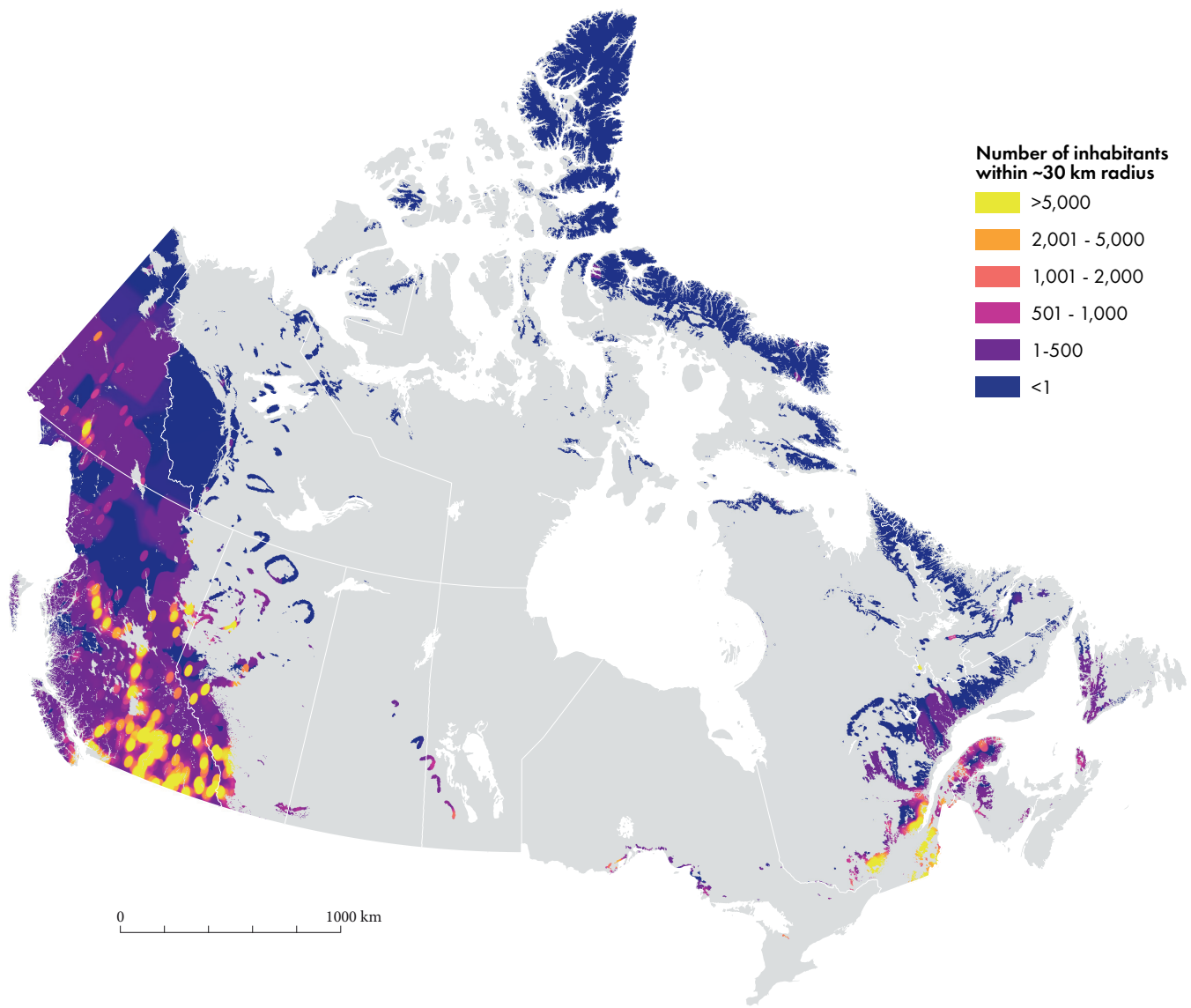
Figure 1.4: Population densities in mountain areas in Canada. Based on McDowell & Guo (2021).

for water resources, ecosystems, hazards, livelihoods, and the recreational, cultural, and spiritual values associated with these places. For example, what will the Icefields Parkway be named when the ice is gone, as expected by the end of this century (Clarke et al., 2015), and will this route through the Canadian Rockies evoke the same sense of wonder when the mountain peaks are bare? Climate change is also a threat to many alpine species that are adapted to the cooler temperatures or the snow regimes at high elevations. These species have nowhere higher to go in the face of increasing temperatures, and also face competitive pressures from lower-elevation

species that are migrating upwards in search of respite from heat, wildfire, or population pressures. Similar to Arctic-adapted species, alpine flora and fauna might simply run out of habitat. This is also true in mountain streams and their downstream reaches, should water temperatures warm to conditions that support the upstream migration of lower-elevation aquatic ecosystems or invasive species.

The benefits mountains provide to people are increasingly threatened not only by climate change, but also other impacts related to human activities, such as land use development, resource extraction, and environmentally and

socially damaging governance practices. The implications of these drivers of change are unevenly distributed within and across communities and ecosystems, but cumulatively are rapidly transforming mountain systems across Canada.

Despite the importance and sensitivity of mountain systems in Canada, there has never been a formal assessment of the state of mountain systems knowledge in the country. However, the lack of an existing assessment of mountain systems in Canada does not imply a paucity of knowledge about mountains. Indigenous Peoples have gathered profound bodies of knowledge through close connections to mountain places and by observing and experiencing the dynamics of weather and seasons, ecosystems and animal behaviour, water and rocks, and non-material features and presences in mountains. This has led to nuanced, holistic, and sophisticated knowledges of mountain systems across the continent, many of which focus on interconnectedness and purposefully include an ethic of care to honour past, current, and future generations of living and inanimate beings (Muller et al., 2019). These Indigenous knowledges, which in many traditions have been held by Elders and passed down intergenerationally following place-specific protocols for sharing stories and oral histories, often recognize the mountains and other-than-human beings as teachers and kin. Accordingly, environmental features in mountains (land, water, ice, biota) can be strongly connected to Indigenous identity (Berry, 1999; Downing & Cuerrier, 2011), or the knowledge and emotional significance of belonging to a group. Each Indigenous Nation or group has its own distinct knowledge system and Traditional Territory, including certain areas exclusive to them. Furthermore, based on their socio-cultural traditions, this territory is often subdivided, with certain areas associated with particular individuals and/or social groups like clans, moieties, or phratries. As such, First Nations, Métis, and Inuit knowledges of mountains are inextricably tied to relationships with their respective territories.

More recently, non-Indigenous settlers and migrants who have established communities in and adjacent to mountains in present-day Canada have come to know mountains through the lens of their own epistemologies. These individuals and their associated institutions typically applied the principles, techniques, and assumptions of Western sciences to measure and characterise mountain systems. Since the 1900s, this has led to an extensive and ever-growing body of research focused on mountains in Canada. Indeed, nearly 3000 peer-reviewed articles about mountain systems in Canada have been published to date (McDowell & Hanly, 2022). These publications are in addition to numerous scholarly books, literary texts, popular accounts, alpine journal reports, and artistic works that collectively contribute to a rich and diverse body of Western knowledge of mountain systems in Canada.

Much of the mountain research in Canada to date has been conducted in the mountain west and has focused on the physical environment and ecosystems that make these regions unique, including as homes to flora, fauna, landforms, glaciers, weather and climate regimes, and Earth system processes that can only be found in these environments. It has also shown that mountains in Canada serve as critical 'water towers'—locations that play an outsized role in providing freshwater for downstream populations and ecosystems (Vivrioli et al., 2007, Immerzeel et al., 2020)—for all of western Canada (e.g., Elmore et al., 2020), and much of the world's leading research into mountain snow, glaciers, and hydrological processes has been led out of long-term studies that trace to the 1960s in the St. Elias, Coast, and Rocky Mountains. Similar advances have been made through long-term study of alpine ecosystems (e.g., Krebs et al., 2014). Much of what we understand today about mountain ecological and landscape dynamics in Canada has its origins in this foundational research, including a legacy of student training and capacity building that has enabled ongoing advances in mountain research (Danby et al., 2014). While mountain research in Canada has been concentrated in the mountain west and has been focused primarily on the natural sciences to date, there is a strong foundation to build upon; there is also growing awareness of regional and topical gaps that warrant attention in the future (McDowell & Hanly, 2022).

Notwithstanding the contributions of Western academic mountain research activities, it is important to recognize that much of this work has tended to ignore or delegitimize other ways of knowing, and it has sometimes been explicitly linked to colonial ambitions of territorial control,

including exploiting the resources of the Americas and subjugating and dispossessing Indigenous Peoples of their lands (Akena, 2012; Muller et al., 2019). Relevant examples of this colonial rationale can be found in information-gathering exercises such as surveying and characterising wildlife (Eichler & Baumeister, 2018; Hessami et al., 2021; Higgs et al., 2009).

In light of the fraught history of colonial settlement and its ongoing consequences, there are clear and repeated calls from Indigenous Peoples that Indigenous ways of knowing, doing, and being should be recognized as both equal to and distinct from Western academic knowledge. There is also widespread understanding that historical inequities, exclusions, and colonialism continue to create important obstacles to such inclusion and recognition (Fernández-Llamazares et al., 2021). Indigenous Peoples are seeking to level the playing field while overcoming colonial power asymmetries that have been reinforced by time, epistemic racism, and dominance (Battiste, 2002; Borrows, 2002; Kassi et al., 2022; McGregor, 2014; Reid et al., 2021; K. Whyte, 2017). There are likewise many vocal non-Indigenous advocates for more inclusive and just forms of engagement with Indigenous ways of knowing (Berkes et al., 2000; Cruickshank, 2005; Johnston & Mason, 2020; Lamb et al., 2022; Latulippe & Klenk, 2020; Nadasdy, 1999; Tengö et al., 2014). We recognize here that Indigenous and Western academic approaches to understanding mountain environments are both different and complementary. In this context, the Canadian Mountain Assessment was envisioned as an opportunity to work towards a more inclusive approach to characterising the state of mountain systems knowledge in Canada, while also acknowledging the impossibility of exhaustively assessing the state of Indigenous knowledges of mountains across Canada.

1.2 Introducing the Canadian Mountain Assessment

The Canadian Mountain Assessment (CMA) provides a first-of-its-kind look at what we know, do not know, and need to know about diverse and rapidly changing mountain systems in Canada. The assessment includes insights from both Indigenous and Western academic knowledge systems and represents a unique effort to enhance understanding of mountains through the respectful inclusion of multiple bodies of knowledge. It is the country's first formal assessment of mountain systems knowledge. It was undertaken to:

- Provide a detailed account of the state of mountain systems knowledge in Canada
- Enhance appreciation of the diversity and significance of mountains in the country
- Deliver insights that are salient for a variety of end users (e.g., researchers, Indigenous communities, decision makers)
- Clarify challenges and opportunities pertinent to mountain systems in Canada
- Motivate and inform mountain-focused research and policy
- Cultivate a community of practice related to mountains in Canada
- Provide a tangible step towards reconciliation efforts in Canada

The CMA was inspired by the Hindu Kush Himalaya Assessment (Wester et al., 2019) and recent mountain-focused assessment activities by the Intergovernmental Panel on Climate Change (IPCC) (Adler et al., 2022; Hock et al., 2019), as well as prior efforts to elevate Indigenous knowledges in major assessment activities, such as the Arctic Climate Impact Assessment (ACIA), the Millennium Ecosystem Assessment (MEA), and work by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (ACIA, 2005; IPBES, 2019; Millennium Ecosystem Assessment, 2005). While the CMA was informed and motivated by these prior assessments, it was shaped by the specific priorities, challenges, and opportunities of the Canadian context.

The CMA was hosted at the University of Calgary, situated on the territories of the Peoples of Treaty 7, including the Blackfoot Confederacy (Siksika, Piikani, and Kainai First Nations), Îyârhe (Stoney) Nakoda (including the Chiniki, Bearspaw, and Goodstoney First Nations), and Tsuut'ina First Nation. The City of Calgary is also home to Métis Nation of Alberta, Region 3. The project was supported by funding from the Canadian Mountain Network (CMN) and the Natural Sciences and Engineering Research Council (NSERC). It was initiated in May 2020, and was prepared over the course of 3.5 years (Fig. 1.5). During this time, the CMA played an important role in catalysing
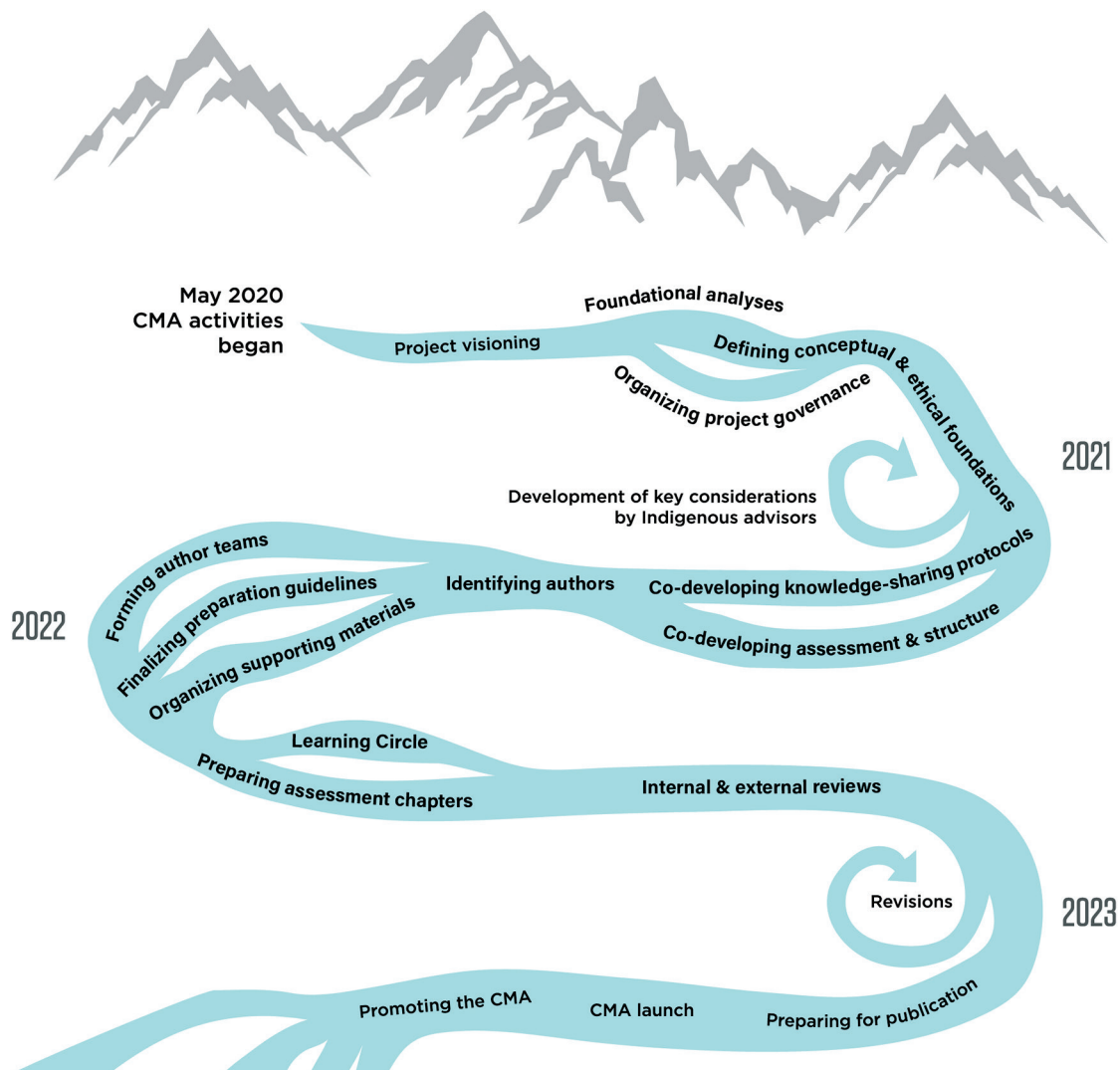
Figure 1.5: CMA timeline and key activities

a community of practice related to mountains by connecting and cultivating relationships between mountain knowledge holders from across Canada (Fig. 1.6).

The following sections detail the CMA's governance, visioning activities, and methodology, as well as key project innovations and limitations.

1.2.1 *Project governance*

The governance model for the CMA was conceptualised as a 'Stewardship Circle' (Fig. 1.7), a characterization that reflects the CMA's prioritisation of inclusivity, respectful dialogue, reciprocity, and shared responsibility. The Stewardship Circle—which included a Project Leader, Project Advisors, Assessment Authors, Project

Assistants, and members of CMN leadership (Table 1.1)—was composed of a diverse group of Knowledge Holders and experts. Members worked collaboratively to enhance the integrity, relevance, and positive impact of the project and to work towards the inclusion of Indigenous Peoples' values and aspirations, which have historically been marginalised, misrepresented, or absent in knowledge assessment initiatives.

When inviting potential contributors to the assessment, efforts were made to balance representation according to First Nations, Métis, and Inuit/non-Indigenous identity; gender; career stage; and major mountain region of origin (Fig. 1.8). Despite some shortcomings, the overall composition of CMA's Stewardship Circle was relatively inclusive and diverse. For example, of the

Figure 1.6: CMA contributors coming together from across mountain geographies and knowledge systems (not all contributors pictured). Photos courtesy of David Borish and Graham McDowell, 2022.

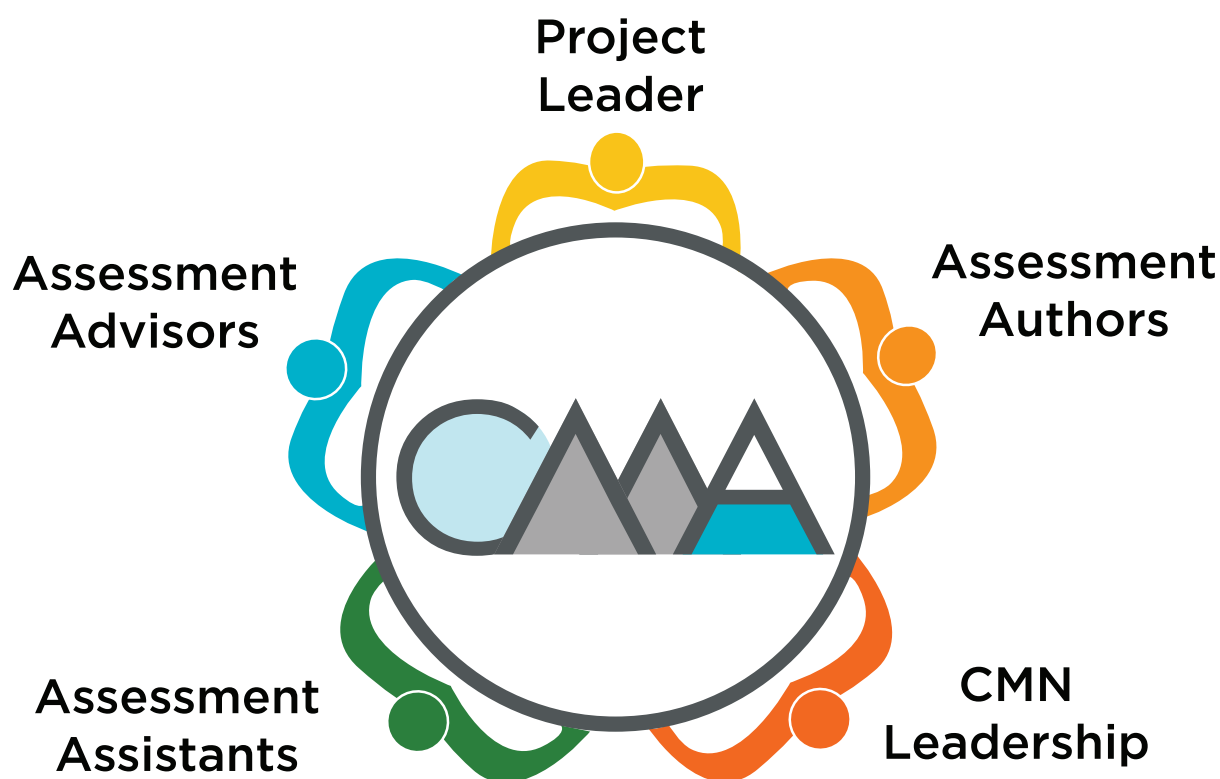Figure 1.7: CMA Stewardship Circle

Table 1.1: Stewardship Circle: Roles and responsibilities.

PROJECT LEADER	The Project Leader conceptualised the project idea, secured project funding, and bore ultimate responsibility for defining, coordinating, and delivering the CMA. They worked closely with Project Advisors to co-develop key elements of the CMA, and with Authors and Project Assistants to operationalize the project vision and approach. The Project Leader also led foundational analyses/publications that underpin the CMA.
PROJECT ADVISORS	Project Advisors worked closely with the Project Leader to co-develop the vision and approach of the CMA, and to support the salience and impact of the project.
Canadian Advisors	Canadian Advisors were the primary individuals involved in providing guidance to the Project Leader. They played a key role in shaping the spirit, intent, and structure of the CMA, as well as providing guidance on practical, methodological, and strategic matters.
International Advisors	International Advisors supported the CMA by providing germane insights from prior mountain-focused assessments and other relevant international initiatives, as well as providing guidance on practical, methodological, and strategic matters.
ASSESSMENT AUTHORS	Assessment Authors worked to identify and engage with relevant information and knowledges, to prepare assessment chapters, and to adequately revise chapter content following external review.
Lead Authors	Lead Authors oversaw the coordination and preparation of specific chapters of the CMA.
Contributing Authors	Contributing Authors made specific contributions to one or more chapters of the CMA.
PROJECT ASSISTANTS	Project Assistants performed various essential tasks including conducting analyses, providing logistical support, and facilitating report preparation activities.
Project Assistant	The Project Assistant acted in a supportive capacity to implement the vision and approach of the CMA and was involved on a regular, ongoing basis in strategic planning and day-to-day activities. They worked closely with the Project Leader and communicated frequently with members of the Stewardship Circle.
Research Assistants	Research Assistants carried out specific research tasks to support the CMA.
CMN LEADERSHIP	CMN Leadership worked with the Project Leader to facilitate coherence between the CMA and the goals and priorities of the CMN.
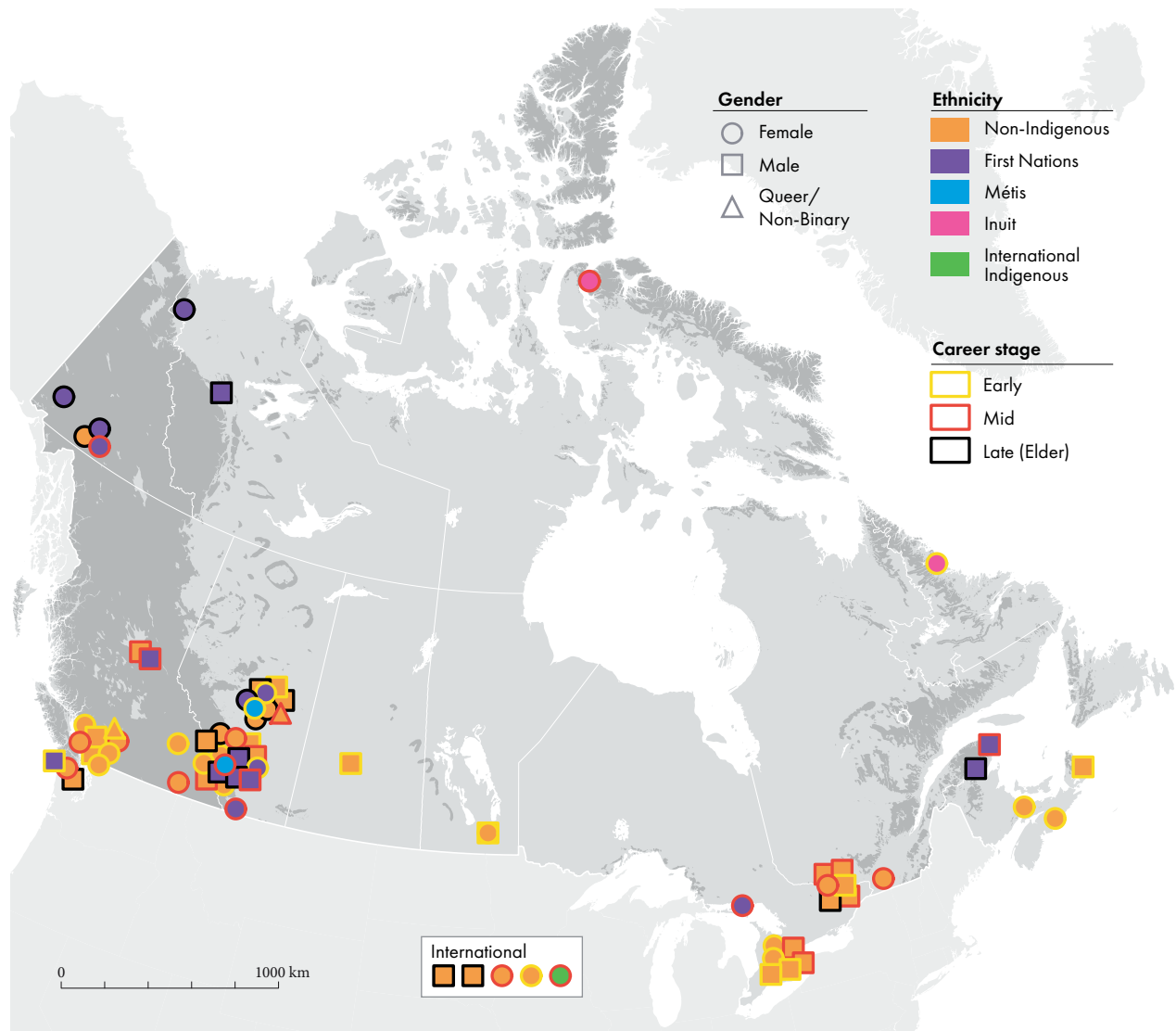
Figure 1.8: CMA contributors by First Nations, Métis, and Inuit/non-Indigenous identity; career stage; location; and gender (does not include external reviewers).

CMA's 80 core contributors, 30% of participants identified as First Nations, Métis, or Inuit, and 55% identified as female, queer, or non-binary. Furthermore, representation across career stages was nearly balanced and the overall geographical diversity of participants was fairly high. Contributor bios can be found in Appendix I.

1.2.2 Visioning

Visioning for the CMA involved members of the Stewardship Circle (primarily the Project Leader and Advisors) working collaboratively to define the spirit and intent of the project, the project's conceptual and ethical foundations, the kinds of content that would be included in the CMA, and the structure of the Assessment. This period of the CMA process involved a diversity of perspectives from the outset. It was also informed by findings from a survey that was sent out to members of the CMN network, which asked for input on the assessment design and focal topics from potential end-users of the CMA (108 respondents), as well as guidance from an independent consultant on ethics and knowledge sharing.

During the visioning period of the CMA, formal Stewardship Circle meetings were convened regularly via Zoom (due to Covid restrictions). There were also numerous virtual meetings between individual project members, as well as members of a working group composed of Indigenous

members of the Stewardship Circle. Meetings were conveyed with the intention of cultivating "ethical space" (Ermine, 2000, 2007; Ermine et al., 2004), which involved respecting individuals' diverse ways of knowing, being, and doing; making space for Indigenous protocols, including starting meetings with opening words or blessings (as appropriate) from Elders; providing reflexive land acknowledgments; and honouring the unique expertise and circumstances of individual participants. Through this highly intentional collaboration approach—which elicited moments of difficulty but also stimulated deep reflection, creativity thinking, and innovation—Stewardship Circle members successfully defined key elements of the project, as described below.

Conceptual foundations

The CMA's conceptual foundations were informed by a multiple evidence base (MEB) approach, which "emphasises the complementarity of knowledge systems and the values of letting each knowledge system speak for itself, within its own context, without assigning one dominant knowledge system with the role of external validator" (Tengö et al., 2014). This approach highlights the integrity of knowledge systems on their own terms, while also bringing attention to the possibility of respectfully braiding multiple sources of evidence together to enhance understanding of a particular issue (Fig. 1.9). This requires making space for diverse manifestations of knowledge (e.g., text, oral, visual), and ensuring
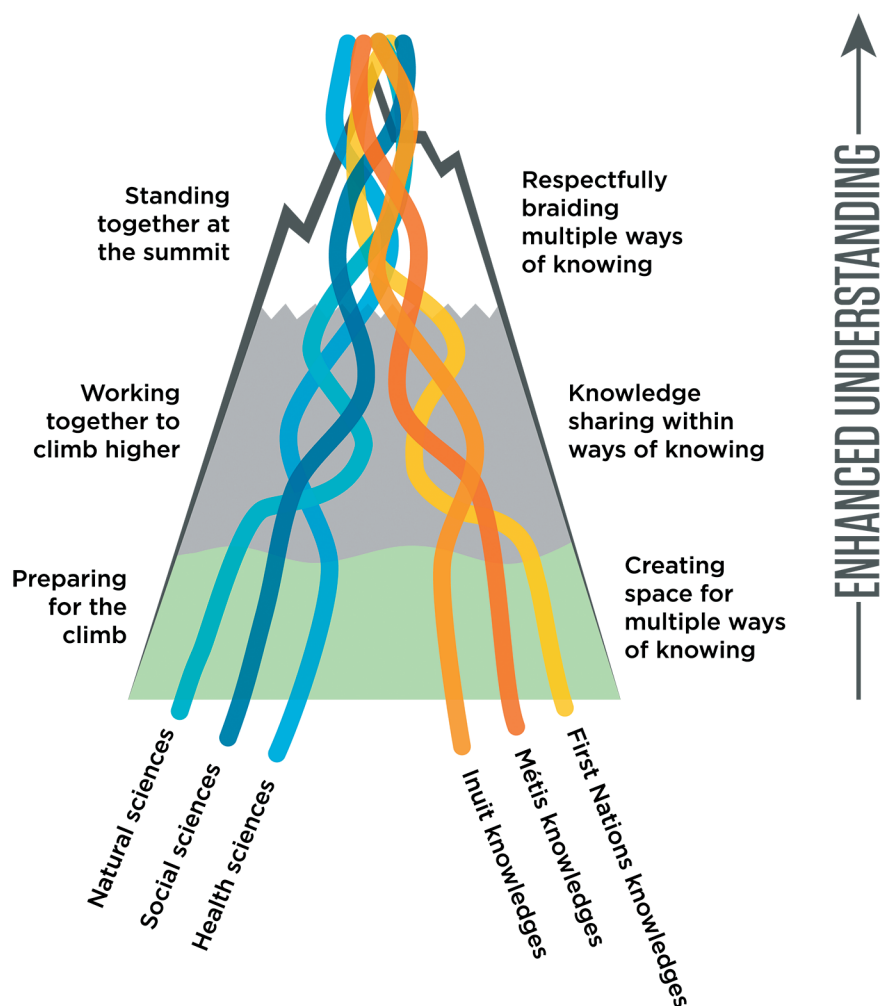

Figure 1.9: Simplified depiction of a multiple evidence base approach in the context of the CMA. Much like climbing to the summit of a mountain, respectfully braiding ways of knowing is an aspiration, but such an outcome is not guaranteed. The success of the effort can be determined not only by the point the climbers reach, but also by the learning along the way.

that determinations about which knowledge is appropriate, credible, and relevant occurs within knowledge systems (e.g., according to Indigenous protocols, according to scientific method). It also requires avoiding any attempt to integrate diverse knowledges into a unified truth (Kimmerer, 2020; Reid et al., 2021). The MEB therefore foregrounds issues of power involved in connecting different knowledge systems (and associated complexities, limitations, and opportunities), and emphasizes the need for deeply collaborative and reflexive co-creation processes from the outset. In these ways, an MEB approach aims to enhance the legitimacy and relevance of project outcomes for a broad range of groups, particularly those whose ways of knowing, being, and doing have tended to be marginalised.

Ethical foundations

The CMA's involvement with Indigenous Peoples and knowledges was guided by standards for ethical conduct described in the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans TCPS 2* (2018) (Canadian Institutes of Health Research et al., 2018), particularly those elaborated in Chapter 9 'Research Involving the First Nations, Inuit and Métis Peoples of Canada'. However, members of the CMA aspired to exceed this guidance, and were particularly inspired and motivated by the transformative vision articulated in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP, 2007), which was adopted by Canada in 2016. In particular, Article 31 states that "Indigenous peoples have the right to maintain, control, protect and develop their cultural heritage, traditional knowledge and traditional cultural expressions, as well as the manifestations of their sciences, technologies and cultures." We also drew guidance and motivation from the Truth and Reconciliation Commission of Canada's Calls to Action (Truth and Reconciliation Commission, 2015), which were endorsed by all levels of government in Canada, and OCAP® Principles (Ownership, Control, Access and Possession)[1] (First Nations Information

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1 OCAP® is a registered trademark of the First Nations Information Governance Centre (FNIGC): https://fnigc.ca/ocap-training/

Governance Centre, n.d.), which are widely used and promoted by First Nations communities and organisations in Canada. The CMA's engagement with academic knowledge was guided by principles of scientific integrity—transparency, reproducibility, high quality, avoidance of conflict of interest, and adherence to research ethics—as elaborated in the Government of Canada's Policy on Scientific Integrity (Government of Canada, 2017).

Inclusion of diverse content

A cornerstone of the CMA is making space for diverse manifestations of knowledge about mountains. This approach is an outcome of the CMA's conceptual and ethical foundations and reflects recognition that knowledge about mountains is held in diverse forms and that text is not always a culturally appropriate way to convey such knowledges. Accordingly, while the CMA is a text-based document, it also includes a variety of visual materials (e.g., maps, paintings, photographs) as well as video recordings of knowledges and stories shared by First Nations, Métis, and Inuit individuals from across mountain areas in Canada. Video recordings of conversations—and the underpinning methodology (see 'First Nations, Métis, and Inuit knowledges' section below)—are specifically intended to respect and uplift oral knowledge transmission traditions, which are central for many Indigenous Peoples in Canada. We encourage the reader to engage with these videos, which can be found throughout the CMA, and which provide unique insights into the depth, specificity, and diversity of First Nations, Métis, and Inuit knowledges about mountains in Canada. The printed version of the CMA includes QR codes, which can be scanned to view videos on phones or tablets. The online version of the CMA has videos embedded in the text, which can be viewed within the document. Full URLs for videos are provided in Appendix II.

Guiding principles

Members of the Stewardship Circle elaborated five overarching principles that summarise the spirit and intent of the CMA, and that steered the efforts of those involved in preparing the assessment (Fig. 1.10).

1 – Service

The CMA is guided by service to mountains and mountain-connected communities — Indigenous, non-Indigenous, and non-human — now and into the future.

2 – Inclusivity

The CMA celebrates the diversity, depth, and specificity of First Nations, Métis, Inuit, and Western academic knowledges related to mountains in Canada, and aspires to demonstrate the breadth of these knowledges, as well as points of tension, synergy, and emergence.

3 – Humility

The CMA aspires to collaboratively advance a good effort, acknowledging that our assessment of what we know, don't know, and need to know about mountains in Canada inherently reflects structural disparities, procedural limitations, and our own positionality.

4 – Responsibility

The CMA is committed to upholding the integrity of diverse knowledges shared into the assessment; respecting the privacy of culturally protected knowledges; enacting on-going consent; and ensuring open-access publication, traceability, and transparency.

5 – Action

The CMA aims to enhance understanding of the importance of mountains in Canada, and to stimulate relationships, research, and action that support the realization of desirable mountain futures.

Figure 1.10: CMA Guiding Principles

1.2.3 *Methodology*

The CMA characterises the state of knowledge related to mountains in Canada based on the respectful consideration of multiple lines of evidence, including: peer-reviewed literature; First Nations, Métis, and Inuit knowledges; insights from select grey literature; and video recordings, artistic, and photographic content. Foundational analyses that underpin the CMA are described below, followed by information about the methodologies used to gather and consider distinct forms of evidence. The section concludes with information about the selection and roles of CMA authors.

Foundational analyses

At the outset of the CMA, numerous fundamental aspects of mountain systems in Canada had yet to be systematically characterised and quantified in a nationally coherent manner. In response, numerous geospatial analyses were conducted to advance understanding of the biogeography, people, and economic activities associated with mountains in Canada (see McDowell & Guo, 2021 for full details). The mountainous area of Canada was delineated according to the K1 definition provided by Kapos et al. (2000), which considers elevation, local elevation range, minimum elevation, and slope. This is the most commonly used set of criteria for defining mountain areas in the Western academic literature, and one that provides a good approximation of regions generally considered mountainous in Canada. However, other valid approaches have been developed by Körner et al. (2011) and Karagulle et al. (2017), for example, which reflect differences in what is considered relevant in terms of attributes/criteria for delineation of mountainous terrain according to specific applications (see Sayer et al., 2018; Körner et al., 2021; Thornton et al., 2022). Results and maps based on the CMA's foundational analyses are found throughout this report. References for data used in these and other maps in the CMA are available in Appendix III.

To promote broad geographical consistency across CMA chapters, the CMA developed a classification scheme that divides the mountainous area of Canada into 10 major mountain regions (Fig. 1.11, interactive map here[2]). These regions are formed through an intersection of the K1 mountain area and the boundaries of existing 'terrestrial ecozones of Canada' (see Agriculture and Agri-Food Canada, 2016). Terrestrial ecozones represent areas with broadly consistent biophysical characteristics; they are not based on socio-economic or political criteria, which are inevitably contested. Authors were encouraged to use this framework as their primary geographical

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2 https://www.arcgis.com/apps/webappviewer/index.html?id=8b0239c85e62416b9f6ab11acfda5da8&extent=-18755806.0455%2C4769580.2594%2C-3727674.7884%2C11755313.1485%2C102100

Figure 1.11: Major mountain regions in Canada—The primary geographical framework used in the CMA. Based on McDowell & Guo, 2021.

framework when organising and assessing evidence. However, references to mountains in the west, north, and east (scaling up), or to specific mountain ranges or sub-ranges (scaling down), was also acceptable where relevant. Furthermore, First Nations, Métis, and Inuit authors were encouraged to reference mountain regions in other regionally/culturally appropriate ways, at their discretion (see 'Terminology' section below).

Peer-reviewed literature
The CMA aimed to provide a thorough assessment of peer-reviewed literature relevant to moun-

tains in Canada. Accordingly, the CMA conducted a national-scale systematic scoping review of peer-reviewed articles that are relevant to mountains in Canada. This effort yielded 2,888 articles, all of which were classified according to variables such as major mountain region, focal topics, and research approach (see McDowell & Hanly, 2022, for full details). Additionally, authors were asked to ensure that the 20 most influential publications in their respective area of expertise (that are relevant to mountains in Canada), as well as any relevant review articles were considered in their assessment activities. All publications relevant

to the CMA were organised in a centralised and searchable cloud-based bibliography that was accessible to all authors.

Authors assessed the peer-reviewed academic literature with qualitative statements—supported by summary statistics as appropriate—about the state of knowledge/evidence in relation to key chapter themes and major mountain regions. Here, authors were asked to consider the amount of literature, the quality of literature, and the level of agreement in the literature within a particular domain of knowledge, as well as across mountain geographies. This approach was informed by the confidence language model of the IPCC (Mastrandrea et al., 2010). However, the CMA does not use formal confidence language, given concern that the lack of a comparable criteria for Indigenous knowledges would have the effect of undermining the perceived validity of insights from First Nations, Métis, and Inuit knowledges.

In addition to peer-reviewed articles, authors of some chapters also engaged with scholarly books as sources of information about mountains, especially for content from the humanities, arts, and literature. The identification and inclusion of scholarly books was based on the expertise of chapter authors.

When reviewing peer-reviewed literature, authors were asked to be cognizant of the processes originally used to gather and disseminate information, including the fact that some academic literature reporting insights from Indigenous Peoples in Canada has been produced without the free, prior, and informed consent of Knowledge Holders; has lacked due credit or attribution; and has misrepresented First Nations, Métis, and Inuit knowledges in ways that continue to be harmful to Indigenous communities. CMA authors were not in a position to comprehensively assess the extent of such issues, nor to make a determination that certain materials should be excluded on this basis. Instead, authors were asked to reflect critically and constructively on these issues when assessing the literature to enhance awareness about ethical concerns vis-à-vis the production of knowledge about mountains in Canada.

First Nations, Métis, and Inuit knowledges

A key aspiration of the CMA was to elevate Indigenous knowledges of mountains and to bring these knowledges into conversation with Western academic understandings of mountains. The co-creation of knowledge is fundamental to the Canadian response to the United Nations Declaration on the Rights of Indigenous Peoples and the Calls to Action of the Truth and Reconciliation Commission; it also reflects recent case law. Among other things, court cases such as Haida (2004), Taku (2004), and Blueberry (2021) have clearly established an obligation under Canada law for genuine consultation with Indigenous Peoples. This is true regardless of treaty and highlights that, while a treaty relationship can provide guidance in this situation, it is not mandatory for consultation to occur.

To provide a respectful and more culturally appropriate way of engaging with First Nations, Métis, and Inuit understandings of mountains, the CMA organised an in-person Learning Circle with Indigenous Knowledge Holders from across mountain areas in Canada. The gathering (the CMA's first in-person event) was held from from 23–26 May 2022 in Banff, Alberta—Traditional Territories of Treaty 7 Peoples, including Niitsitapi from the Blackfoot Confederacy (Siksika, Piikani, and Kainai First Nations), the Îyârhe (Stoney) Nakoda (including the Chiniki, Bearspaw, and Goodstoney First Nations), and the Tsuut'ina First Nation, as well as the Métis Nation of Alberta, Region 3. The gathering aimed to provide an ethical space where knowledges and stories that participants wished to contribute to the CMA could be shared and appropriately included under their guidance. The Learning Circle was informed by advice from members of the CMA's Stewardship Circle and an independent consultant on ethics and knowledge sharing, as well as wishes expressed during an online pre-meeting with participants; it was reviewed and approved by the University of Calgary's Research Ethics Review Board before being convened (REB22-0070).

The Learning Circle was attended by 20 First Nations, Métis, and Inuit individuals, including a Chief, numerous Elders, and several youths; some participants were also involved in the CMA as Authors and Advisors prior to the gathering. After offerings of tobacco, in adherence to Indigenous protocols of the Nations on whose territories we gathered, the Learning Circle was opened by Elders from the region (Blackfoot and Stoney Na-

koda), followed by three days of conversations organised around the CMA's chapter themes. Following the guidance of Elders present, a chair at the circle was left open during the gathering as a sign of respect for the knowledge of, and responsibilities to, non-human kin that share mountain spaces. The Learning Circle conversations were facilitated by Indigenous CMA authors, the Project Leader, and the Project Assistant.

As Elder Pnnal Bernard Jerome, Micmacs of Gesgapegiag, shared during one of these conversations, the Learning Circle offered a space to reflect with humility on the mountains of his own home, to be reminded of his knowledge and identity as a Micmac person, and to learn from the stories and knowledges of diverse places shared during the gathering (LC 1.1). Offering closing words for the Learning Circle, Elder Hayden Melting Tallow of the Siksika Nation, Blackfoot Confederacy, affirmed the CMA efforts to follow protocol, honoured his ancestors, and reflected on the experience of visiting the mountains and Peoples of many Nations in Canada through the conversations held during the Learning Circle (LC 1.2). We closed the gathering with words of trust, coexistence, and shared aspiration to carry the sharing of knowledges forward with action.

With contributors' permission, conversations during the Learning Circle were video recorded by a videographer experienced in knowledge co-creation activities with Indigenous Peoples. After the event, these recordings were shared with participants, enabling them to request the removal of any culturally protected or otherwise sensitive content before it was shared more broadly. Shareable content was then uploaded to a video hosting and editing platform (frame.io), where video segments were time stamped by participants' name and Nation or community, as well as the themes and topics discussed during their remarks (Fig. 1.12). These searchable files were then shared with CMA authors, who were asked to weave videos into their respective chapters. With further guidance and review by Learning Circle participants, segments of these recordings have been included as videos in the CMA text (see videos in paragraph above, for example). Given their fundamental contributions to the CMA, Learning Circle participants are also recognized as CMA authors (all agreed to be recognized in this way).

Other manifestations of First Nations, Métis, and Inuit knowledges related to mountains in Canada were included in the CMA at the discretion of Indigenous chapter authors, including content reported in community reports and archival texts, as well as knowledge shared into the CMA by Indigenous chapter authors.

Unlike the CMA's engagement with academic literature, we did not aim to achieve a comprehensive understanding of First Nations, Métis, and Inuit knowledges of mountain systems across Canada. It would be impossible to include the diversity of First Nations, Métis, and Inuit knowledges of mountains in a single book. Moreover, as Learning Circle participant Gabrielle Weasel Head, Kainaiwa Nation, Blackfoot Confederacy, explains, learning from this knowledge requires heart-forward work to build meaningful relationships that advance specific Indigenous Nations' languages, protocols, and experiences (LC 1.3). In this spirit, the CMA approach reflects a commitment to confront colonial erasure of Indigenous lifeways and resist the imposition of *pan-Indigeneity* by

Pnnal Bernard Jerome, Micmacs of Gesgapegiag, 2022, LC 1.1

Hayden Melting Tallow, Siksika Nation, Blackfoot Confederacy, 2022, LC 1.2

Gabrielle Weasel Head, Kainaiwa Nation, Blackfoot Confederacy, 2022, LC 1.3
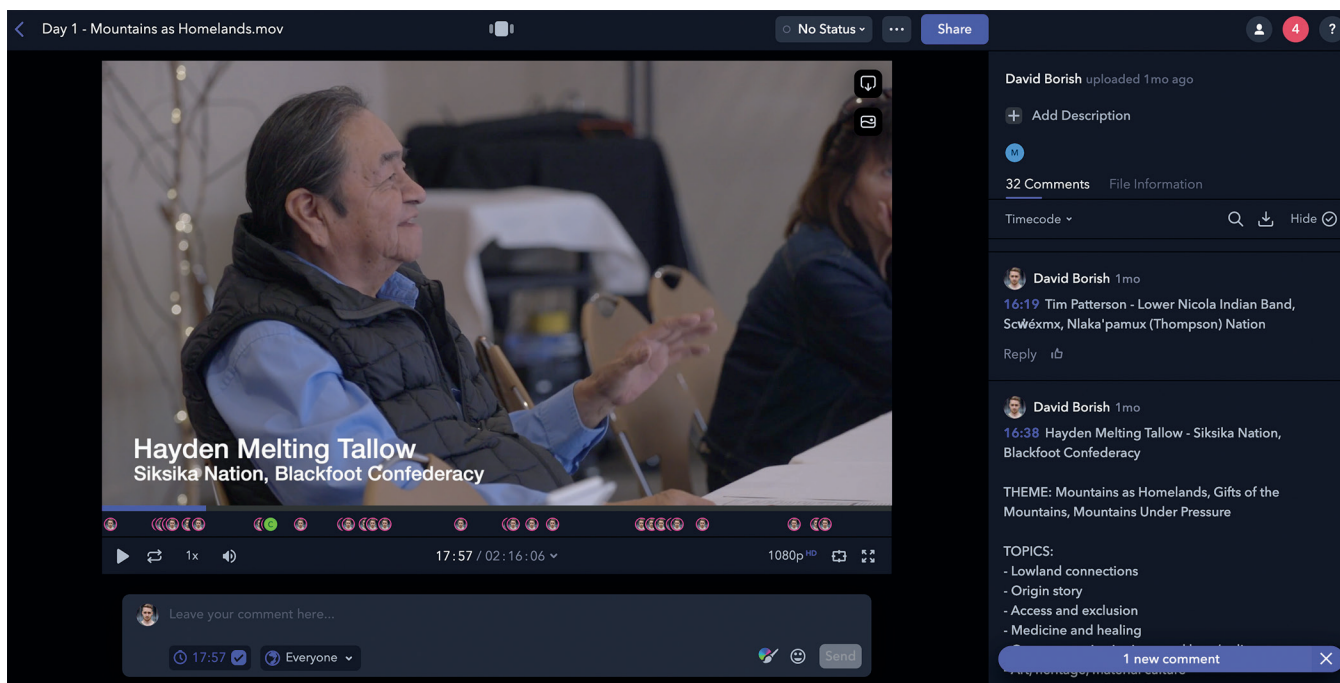
Figure 1.12: Learning Circle video with searchability according to participant name, community and/or Nation, themes, and topics

acknowledging and elevating the diversity of First Nations, Métis, and Inuit identities and ways of knowing mountains. In this context, the inclusion of certain First Nations, Métis, and Inuit knowledges should not be interpreted as endorsing those over others. Rather, the insights included in the CMA reflect the information that was available given the methodology described in this chapter, and decisions by authors about which knowledges were particularly effective in illustrating the depth, richness, and diversity of mountain-related experience and knowledges possessed by Indigenous Peoples in Canada.

Grey literature

Inclusion of credible information from grey literature—material not published in traditional academic outlets—is increasingly understood as a way to diversify and enhance assessment results (see Paez, 2017). While a comprehensive review of grey literature was beyond the scope of the CMA, authors were invited to engage with publicly available grey literature that was relevant to chapter themes. No formal inclusion/exclusion criteria were applied in relation to grey literature; instead, the selection of materials was based on the respective expertise of chapter authors. Authors were encouraged to comment briefly on the

nature and credibility of the grey literature referenced in the CMA.

Video, artistic, and photographic content

Video recordings and artistic and photographic content help to enrich and broaden understanding of mountains in Canada. The primary intention of video recordings was to present contributions from Indigenous Knowledge Holders in a more culturally appropriate way, as described above. In addition, the CMA recognizes that both Western academic and Indigenous knowledges of mountains are often presented in the form of art and photographs, and such content was therefore also included in the CMA. Authors used their own networks, knowledge, and expertise to identify relevant non-text content for inclusion in the CMA. There was no formal assessment process for such content.

Document management, bibliography, and citation formats

Documents related to the CMA were organised in a cloud-based 'Author Hub'. Notably, master copies of chapter drafts were hosted online and available to all authors. This facilitated real-time engagement with other chapter authors and the ability to check the content and status of other

chapters on an ongoing basis, all of which supported collaborative writing and review activities and increased transparency.

The CMA also created a cloud-based project bibliography using Zotero, with searchability functions linked to codes from the systematic scoping review (e.g., major mountain regions, primary focal topic). This approach had important benefits for chapter preparation activities, including most literature being available to author teams from the outset of writing and assessment activities, real-time access to documents contributed by other authors, and the ability to have any changes to references updated simultaneously across chapter master documents.

The citation formats for different kinds of materials in the CMA vary according to content-appropriate protocols. Specifically, reference to Learning Circle content includes the contributor's name and community and/or Nation, as well as time brackets for the relevant segment of the video recording. (Note that recordings include full statements to ensure that comments are not taken out of context.) In addition, in-text contributions from Indigenous Knowledge Holders have been attributed to Knowledge Holders and their communities, as appropriate, using a citation format developed to acknowledge Indigenous oral teachings (MacLeod, 2021). Other text and non-text materials are cited using American Psychological Association (APA) output style.

Data management and copyright

The CMA Stewardship Circle devoted considerable attention to balancing a commitment to open-access publication with Indigenous data sovereignty considerations. The CMA has been published by the University of Calgary Press under a restricted Creative Commons licence (Attribution-NonCommercial-NoDerivatives) which allows for free, non-commercial distribution with proper attribution to contributors, but does not allow the material to be changed or distributed in derivative forms. Under this licence, authors and Learning Circle participants retain copyright to their contributions.

Recorded Learning Circle contributions are retained in perpetuity in a cloud-based repository accessible to all Learning Circle participants. Portions of the recordings included as embedded videos within this report were subject to a rigorous review process to determine whether they were appropriate for inclusion and did not contain sensitive information which could pose risks to participants or their communities. Recognizing that such determinations can change over time, a data withdrawal process was developed with the University of Calgary Press, which allows for contributions to be removed beyond the publication date if they are deemed inappropriate to share. Such changes can be made quickly to content hosted on the University of Calgary Press web platform and will be reflected in future print runs of the CMA. The virtual component of this assessment is thus a living space, uniquely responsive to the principle of ongoing consent.

Author identification, roles, and activities

CMA authors were identified through a variety of strategies to support the establishment of an experienced, diverse, and capable author team. Members of the Stewardship Circle were asked to provide the names of potential authors, a review was conducted to identify Indigenous scholars with expertise relevant to mountains at Canadian universities, and an open call for authors was distributed through CMN social media and 64 departments/faculties within Canadian universities. These efforts yielded ~200 potential authors. The Project Leader and Project Assistant then extended invitations to a subset of potential authors, aiming to include individuals from diverse areas of expertise, geographies, career stages, and genders, and to balance participation by Indigenous and non-Indigenous individuals. This was a deeply intentional process that involved nearly a year of research and outreach. Nevertheless, some potentially appropriate authors were surely missed while others were not contacted given efforts to balance participation according to the criteria above. In other instances, potential authors were contacted but they did not have the capacity to join the project. Zoom meetings were held with most individuals to discuss the unique approach and aspirations of the CMA before confirming authorship roles. Learning Circle participants were also recognized as authors. In all, 75 individuals participated in the CMA as authors.

Individual CMA chapters were written by a group of chapter authors, with each chapter team being composed of both Indigenous and non-

Indigenous individuals. Each of the CMA's core chapters, chapters 2–6, had Co-Lead authors as well as contributing authors. Chapter co-leaders—one Indigenous and one non-Indigenous individual—oversaw the coordination and timely preparation of their respective chapters, while contributing authors contributed specific text and/or non-text content for key topics areas within each chapter. Several CMA authors contributed to multiple chapters where their expertise/knowledge pertained to topics that spanned multiple chapters. Note that Contributing Authors, which includes Learning Circle participants, are listed in alphabetical order in the author list for each chapter; thus, name order does not imply a hierarchy of contributions.

Initial chapter drafts were prepared between January–July 2022. Following the Learning Circle, a second in-person meeting was convened in Banff between 26–28 May 2022 with 20 of the CMA's authors. All other chapter preparation activities were coordinated through regular online meetings. Review and revision activities commenced in August 2022.

1.2.4 *Review and revision process*

The review process for the CMA focused on ensuring that the assessment of Western academic knowledge of mountains was consistent with scientific standards, and that culturally protected or otherwise sensitive Indigenous knowledges and stories were not shared publicly. It also sought to invite feedback about the appropriate representation and braiding of multiple forms of evidence. The review of the CMA involved three primary stages.

Internal review period
Following the completion of initial chapter drafts in July 2022, members of the Stewardship Circle undertook a month-long internal review of the CMA. This review stage focused on identifying and addressing remaining gaps in chapters, receiving further guidance from Learning Circle participants about the appropriate inclusion of their knowledges, increasing engagement with non-text materials, supporting discursive and structural continuity across chapters, and formatting.

External review period
Following internal review, the CMA underwent a six-week-long period of external review. Eligible reviewers included Indigenous Peoples in Canada and from other mountain regions globally, mountain researchers from Canada and abroad, and those with professional responsibilities pertinent to mountain areas in Canada. Potential reviewers were contacted through a variety of means, including outreach to the International Network of Mountain Indigenous Peoples (INMIP), notification through CMN and CMA social media, and announcements by the Mountain Research Initiative (MRI). To ensure potential reviewers had appropriate expertise, knowledge, and/or motivation, interested reviewers were asked to complete a form describing their relevant qualifications. In total, 28 individuals participated in the public review of the CMA, all of whom were either very familiar (79%) or somewhat familiar (21%) with mountains; 86% were mountain researchers, 11% were both mountain researchers and Indigenous Knowledge Holders, and 4% were involved with the NGO sector; 14% of reviewers self-identified as Indigenous individuals. 71% reviewers were based in Canada, 7% were living outside of Canada but had previously lived in Canada, and 21% were based outside of Canada and had never lived in Canada.

During the first week of external review, chapter drafts were available exclusively to Learning Circle participants and their communities, as an additional check to ensure that no sensitive content was shared with external reviewers. External reviewers were then sent the CMA manuscript and were given the opportunity to provide written or oral feedback, with the former being collated through Google Sheets (similar to the IPCC review model) and the latter being offered through Zoom meetings. In total, 773 comments and suggestions were received from external reviewers.

Revision and submission
Chapter revision and final report preparation activities took place between November 2022 and February 2023. Following external review, chapter teams were provided with comments and suggestions provided by reviewers. During revision activities, each chapter team was supported by a Chapter Review Editor (in addition to the

Project Leader and Project Assistant), who helped chapter authors engage appropriately and as thoroughly as possible with reviewer comments. Chapter Co-Lead authors, the Project Leader, Project Assistant, and select Chapter Review Editors then led the preparation of a penultimate CMA draft. This draft was shared with CMA Advisors for review prior to submission for publication. The final CMA manuscript was submitted for publication in July 2023.

Terminology

The CMA embraced a pluralistic approach to the use of terms and nomenclature, recognizing that diverse knowledge traditions have different conventions and approaches for using language. We did, however, aim for consistency in the use of certain key phrases and terms. For example, the term "mountain systems" is used throughout the CMA, and indicates that mountainous places are constituted through interconnected physical, social, and biological characteristics and processes. It is meant to broaden the view of mountains from immutable landscape features to dynamic, living, and deeply relational spaces. Furthermore, we followed the distinct major mountain regions in Canada defined by McDowell & Guo (2021) (see Figure 1.11).

Where First Nations, Métis, and Inuit place names were known to the author team, we strove to prioritise the use of these names, rather than defaulting to other colonial terms. Given the overlapping and often contested nature of Indigenous territories, we were not in a position to provide all applicable Indigenous toponyms for a given place or entity; in many cases, we referred to English and French names recognized by settler governments. Whether in Indigenous languages, English, or French, the names we chose were not intended to imply a hierarchy of one name above others, nor to align with one group's claim over others or replace other names and meanings. We used the name Canada, or terms such as "the place now known as Canada," to refer to the country established through colonisation of a continent which has held many different names through time. We avoided the use of the possessive "Canada's mountains" or "Canada's peoples" to eschew connotations of ownership.

Following from the work of scholars such as Max Liboiron (2021), we used capitalization intentionally to denote meaning in terms such as land/Land, where the use of "Land" refers to a context implying sacred meaning or identifying the Land as a living entity. For example, "I spend time on the land with my family," was written to be read as denoting a distinct meaning from "the Land has memory." Capitalization was also used to reflect respect, as in the case of capitalising the terms Elder, Nation, and Indigenous Peoples among others. Furthermore, to resist a default to assumptions of pan-Indigeneity, we aimed to prioritise use of the term First Nations, Métis, and Inuit to refer to the Peoples who have lived in the region now known as Canada since time immemorial. Likewise, we use the phrase Indigenous knowledges (plural) to denote an explicit recognition of the many distinct knowledges held by Indigenous Peoples in Canada. These choices reflect our best efforts to be consistent with emerging conventions within Indigenous Studies and the guidance of Indigenous authors and Advisors who contributed to this assessment.

1.2.5 *Innovations*

The CMA contributes numerous important innovations. For example, the CMA is the first formal assessment of the state of mountain systems knowledge in Canada; it also contributed several foundational analyses related to mountain systems in Canada (e.g. McDowell & Guo, 2021, McDowell & Hanly, 2022). Furthermore, CMA is the first 'national-scale' assessment of mountains in any country (importantly, the CMA can also be understood as an *inter*National assessment in that it brings together individuals from many Indigenous Nations across Canada). In addition, the CMA co-created and operationalized a pluralistic assessment approach that brings Indigenous and non-Indigenous individuals and knowledge systems into meaningful conversation to enhance understanding of a topic of shared interest. This is a first in the context of mountain-focused assessments and such approaches remain rare in large-scale assessment activities more broadly (see *Evaluación Nacional de Biodiversidad y Servicios Ecosistémicos de Colombia* (2021) for a notable recent example).

Specific elements of the CMA's pluralistic assessment approach warrant mention as important innovations. For example, the CMA's Stewardship Circle provides insights into how re-imaging governance arrangements can increase the salience, credibility, and legitimacy of cross-cultural knowledge co-creation initiatives. Likewise, the CMA's implementation of a multiple evidence base approach and its foregrounding of ethics demonstrate pathways for enabling more respectful, inclusive, and generative assessment practices. The CMA's authorship model follows from these innovations and is significant in its inclusion of Indigenous and non-Indigenous chapter co-leaders, who are supported by authorship teams composed of both Indigenous and non-Indigenous individuals.

The CMA also makes several substantive methodological innovations. For example, while systematic reviews have been used for targeted purposes in prior assessments, the CMA appears to be the first major assessment to use a formal systematic scoping review a point of departure for identifying, collating, and characterising the relevant peer-review literature across all topics and geographies (i.e., the state of Western academic knowledge). This approach has considerable benefits for transparency, traceability, and reproducibility, as well as workflow (e.g., avoiding the need for authors to conduct their own time-consuming literature searches). The associated cloud-based bibliography and 'Author Hub' provided additional benefits for collaboration in the context of a large, distributed project team. The CMA's Learning Circle approach is also innovative in an assessment context, especially in its emphasis on cultivating a more culturally appropriate space for sharing First Nations, Métis, and Inuit knowledges of mountains. Relatedly, the CMA's inclusion of video recordings from conversations with Learning Circle participants is an important innovation that strives to honour and uplift oral knowledge sharing traditions.

A final set of innovations pertains to the publishing model of the CMA. For example, in recognition of the rightful ownership of Indigenous Peoples over their cultural knowledges, the CMA's copyright model places ownership solely with the knowledge contributor (not the publisher), and derivative works are not permissible without express consent of the contributor. Furthermore, contributors can withdraw material in the future if they deem that it is no longer appropriate to share, making the CMA uniquely responsive to the principle of ongoing consent.

1.2.6 *Caveats and limitations*

Notwithstanding its important innovations, enacting the CMA's commitment to the principle of humility (Guiding Principle 3, Figure 1.10) requires recognition of the project's limitations. CMA tried hard to be more inclusive of Indigenous knowledges and to generate a knowledge assessment that began to braid different ways of knowing within a space of equality and respect. That is a high mountain to climb. Beyond exchange and sharing of information, "knowledge braiding has to recognize and seek to redress historical and systemic injustices, and must be supported by a commitment to working together over the long term toward equity, self-determination, reconciliation, and transformation" (Kassi et al., 2022, p. 1). The chapters that follow show how far we have come up that mountain, as well as the fact that much of the mountain remains to be climbed.

The CMA encountered specific constraints in its efforts to advance a more inclusive mountain assessment. For example, the CMA was limited by its format as a text-based document written primarily in English. First Nations, Métis, and Inuit Peoples across Canada are the keepers of more than 60 Indigenous languages—many of which are found in mountain areas in Canada (Fig. 1.4)—each encoding specific knowledge of the landscape, including place-names and stories. Many are traditionally not written, and meanings may change when translated into English and transcribed into text. Moreover, using predominantly settler-colonial languages such as English reinforces structures of power and hierarchy among knowledge systems. Including video recordings of conversations from the Learning Circle throughout the assessment was a response to this issue, which endeavoured to provide a more culturally appropriate platform for sharing teachings and stories expressed orally and, in some instances, in Indigenous languages.

Despite efforts to advance the inclusion of Indigenous knowledges, academic literature and Western knowledge predominate across the CMA chapters. Furthermore, the CMA has only

scratched the surface of First Nations, Métis, and Inuit knowledges of mountains, including the incredible diversity of traditions, laws, protocols, and ways of being encoded in these knowledge systems. This is related, importantly, to the fact that aspects of Indigenous knowledges are often kept private and therefore cannot and should not be included in publicly available materials like the CMA. It is also important to recognize that Indigenous Advisors, authors, and Learning Circle contributors do not represent all First Nations, Métis, and Inuit Peoples in mountain areas in Canada. In addition, the dichotomy between Indigenous and Western academic knowledge systems obscures the fact that many of those who contributed to this project hold multiple forms of knowledge, such as Indigenous individuals who have received Western academic training.

In addition, while the CMA aimed to comprehensively assess the peer-reviewed academic literature relevant to mountains in Canada, some pertinent peer-reviewed studies were undoubtedly missed by the systematic literature review (e.g., relevant studies that were missed due to their lack of terms used in the search protocol for the systematic review). Authors aimed to fill these gaps by adding additional relevant documents. Furthermore, other literature (e.g., grey literature, books) offers rich and meaningful insights about mountains in Canada, but a comprehensive review of such materials was beyond the scope of the project.

Notwithstanding the literature assessed and Indigenous knowledges included in the CMA, there are several content gaps in the chapters that follow. These gaps are largely related to difficulty in securing authors/subject experts for every topic the CMA intended to address. Each chapter contains a table that indicates a selection of topics that were not assessed. Finally, other sources of local and experiential knowledge of mountains including from mountain professionals and guides as well as non-Indigenous mountain community members largely fell outside the scope of the CMA due to time and resource constraints. We recognize and value these as important types of knowledge about mountains and encourage future assessment efforts to engage with these groups.

In view of these limitations, the CMA should be understood as an extensive but inevitably im-

perfect and incomplete assessment of the state of mountain systems knowledge in Canada.

1.3 Organisation of Assessment

The CMA includes six chapters that bring together Indigenous and Western academic knowledge of mountains in Canada. Each chapter provides a reflection of the unique approaches of diverse author teams, so chapters are distinctive in terms of content but also tone. This is a result of the CMA's support for experimentation and emergence within chapter teams and reflects the unique ways in which authors have brought together diverse knowledges of mountains within specific CMA chapters. Likewise, it is important to emphasise differences in the scope of engagement with First Nations, Métis, and Inuit knowledge in individual chapters, which is a reflection of the framing of specific chapters, the composition of author teams, and the availability of shareable Indigenous knowledges pertinent to the chapter theme (e.g., what was shared during the Learning Circle). An overview of content included in the CMA is provided below.

The Introduction to the CMA (Chapter 1) provides context and rationale for the assessment, as well as details about the CMA's governance, conceptual and ethical foundations, methodology, and innovations and limitations. Chapter 2, Mountain Environments, covers biogeophysical aspects of mountains in Canada, including origin stories; mountain geology; weather and climate; snow, ice, and permafrost; water; hazards; ecosystems and biodiversity; and connections between mountains and lowland/coastal environments. Chapter 3, Mountains as Homelands, examines the diverse connections that people have with mountain places, including as sites of homes and Homelands, spiritual importance, recreation, and parks and protected areas, as well as tensions and transformations associated with settler-colonialism. Chapter 4, Gifts of the Mountains, examines the benefits that people receive from mountains, including values, relationships, and uses associated with gifts provided by mountains. Chapter 5, Mountains Under Pressure, evaluates processes, drivers, and trajectories of environmental and social change in mountain systems. Chapter 6, Desirable Mountain Futures, reflects on the other chapters and on the CMA's

knowledge co-creation process. It discusses cross-cutting themes that emerged from the project and concludes by calling attention to needs and opportunities for securing more desirable futures for mountain systems in Canada.

We hope that you enjoy, learn from, and are inspired by the Canadian Mountain Assessment.

Glossary

Canada: Canada is a country in North America composed of ten provinces and three territories. It is the world's second-largest country by total area globally. Confederated in 1867, Canada is a parliamentary democracy and a constitutional monarchy that is part of the British Commonwealth; it is premised on settler-colonial legal, economic, and political foundations. Now home to a highly diverse population of more than 40 million people, the state of Canada was imposed on the lands and territories of Indigenous Peoples, impacting but not erasing Indigenous governance systems and the stewardship, occupation, and use of lands under their care. Recognizing the complex meaning that the term "Canada" holds for different people, in the CMA we sometimes use phrases such as "the lands now referred to as Canada."

Canadian Mountain Network (CMN): The Canadian Mountain Network was established to support the resilience and health of mountain peoples and places in Canada through research partnerships based on Indigenous and Western ways of knowing that inform decision-making and action. It was funded by a five-year grant from the Government of Canada's Networks of Centres of Excellence (NCE) Program, and was operational between 2019-2024.

Elders: Elders are members of a community who hold important roles in sharing knowledge with future generations, gathered through their own experiences and knowledge often shared from their own Elders through ceremony, protocols, and land-based learning. In the context of the CMA, the term Elder is used as a respectful way to refer to Indigenous Knowledge Holders who play this role within their communities and who are acknowledged to be Elders in those contexts. The term Elder is capitalised to demonstrate respect and deference to the knowledge and authority held by these individuals.

Ethical space: Developed by Willie Ermine (2007), the term ethical space refers to a state of working across knowledge systems—in this case Western and Indigenous knowledges—that is characterised by "mutual respect, kindness, and generosity," and which involves ongoing conversation and active listening among actors with distinct worldviews and ethical norms. This process is rooted in relationship building and the development of trust, as well as a willingness to be adaptive and responsive to new information. Acknowledgement of each individual's positionality is a central step towards cultivating ethical space, because doing so requires recognizing power imbalances that shape access to and perceived legitimacy of knowledge. As Nikolakis and Hotte (2022) note, "ethical space has the potential to transform cross-cultural relations, from an asymmetrical social order to respectful partnerships between Indigenous and non-Indigenous peoples."

First Nations: First Nations is a collective term to refer to diverse Indigenous Peoples across what is now known as Canada who do not identify as Inuit or Métis. There are more than 630 federally recognized First Nations communities across Canada with distinct cultures and lifeways, who belong to more than 50 different Nations and speak more than 50 languages.

Grey literature: Information produced outside of traditional scholarly publishing and distribution channels, including policy literature, white papers, technical reports, government and community documents, newspaper, newsletters, and blogs, among other materials.

Indigenous Peoples: Indigenous Peoples are groups of culturally distinct people recognized as descendents of the earliest known human inhabitants of a particular region, who maintain enduring cultural and political connections to their ancestral lands and waters. There are thousands of distinct Indigenous Peoples worldwide who speak their own languages, have their own models of governance and law, and practise diverse ways of relating to and managing their surrounding environments. Note that the term "Indigenous Peoples" has no single agreed-upon definition and remains contested in many parts of the world. The United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP, 2007) does not define indigeneity or which groups constitute Indigenous Peoples, leaving it to these groups and Nations to identify themselves as such. In the context of present-day Canada, and North America more broadly, the term Indigenous Peoples often refers to First Nations, Métis, and Inuit Peoples in juxtaposition to settlers (European and non-European) and their descendants.

Indigenous knowledges: Indigenous knowledges are understood in the CMA as the bodies of knowledge generated by and belonging to Indigenous Peoples, both collectively and individually. The plural form "knowledges" reflects the diversity of Indigenous ways of knowing, rather than implying that Indigenous

Peoples hold one collective form of knowledge. Indigenous knowledges often derive from longstanding relationships with the lands and water of Indigenous territories. While such knowledges are sometimes referred to as Traditional Knowledge or Traditional Ecological Knowledge, in the CMA we have generally moved away from this usage because Indigenous knowledges can also refer to knowledge gathered by Indigenous persons using diverse tools and approaches, including Western scientific approaches. Where the term "knowledge traditions" is applied, we use this to convey an "understanding of where we come from to move forward and share all we have to offer for our future generations" (Gùdia Mary Jane Johnson, personal communication, 26 April 2023), and to reference longstanding practices and protocols associated with knowledge gathering, safekeeping, and transmission.

Intergovernmental Panel on Climate Change (IPCC): The Intergovernmental Panel on Climate Change is the United Nations body for assessing the science related to climate change. The IPCC was established in 1988 by the World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP) to provide policymakers with regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation.

International Network of Mountain Indigenous Peoples (INMIP): The International Network of Mountain Indigenous Peoples brings together mountain communities from 11 countries as they seek to revitalise biocultural heritage for climate-resilient and sustainable food systems. It was established in Bhutan in May 2014 at the 14th Congress of the International Society for Ethnobiology.

Inuit: Inuit are a group of culturally related Indigenous Peoples whose territories across Inuit Nunangat (homeland) extend across Arctic and subarctic regions of present-day Canada, and who share the common language, Inuktitut. Inuit are among the three federally recognized groups of Indigenous Peoples in Canada (along with First Nations and Métis Peoples). Inuit territories include Nunavut, an independently governed territory since 1999, Nunavik in the northern third of what is now known as Quebec, Nunatsiavut and NunatuKavut in present-day Labrador, and portions of the Northwest Territories.

Knowledge braiding: A process of bringing together multiple ways of knowing, articulated by Robin Wall Kimmerer (2020) to think through a respectful process of sharing knowledge across Western academic and Indigenous knowledges. The metaphor of the sweetgrass braid suggests an approach in which each "strand" of knowledge remains distinct while contributing to the whole braid to strengthen and enrich understanding. The process of braiding knowledges is rooted in respect for the diverse strengths of many ways of knowing and sees these knowledge systems as complementary rather than incorporating or integrating one knowledge system within or beneath another.

Knowledge co-creation: Knowledge co-creation refers to a collaborative process among two or more communities (e.g., disciplines, ethnic or cultural groups) actively participating on equal footing in efforts to generate and share information that is coherent with each of their respective worldviews, disciplines, or perspectives. Effective knowledge co-creation requires trust among collaborators and respect for diverse ways of thinking and can also be understood as a process of mutual learning.

Knowledge Holders: Knowledge Holders, also referred to as Knowledge Keepers, are individuals within an Indigenous community who are responsible for learning, caring for, and transmitting knowledge. This may include information about cultural practices and lifeways, environmental conditions, governance and protocols, family traditions, and more. Knowledge Holders are entrusted to safeguard and responsibly carry knowledge important to their communities, and often hold formal responsibilities associated with its use and transmission.

Métis: Métis People are one of three federally recognized groups of Indigenous Peoples in Canada (in addition to First Nations and Inuit). The term Métis refers collectively to a group of Peoples who consider themselves culturally and ethnically distinct, with mixed European and Indigenous ancestry, who developed and maintained distinct cultures, languages, and communities in the post-contact era.

Mountain systems: The phrase mountain systems is used in the CMA to connote the intrinsic connectedness of the physical, social, and more-than-human dimensions of mountainous places, and to call attention to the dynamism of mountain areas across space and time. While the phrase mountain systems is preferred, terms such as mountains, mountain areas, mountain regions, mountainous are also used in the CMA; these should be understood as connoting similar ideas, unless stated otherwise.

Mountain Research Initiative (MRI): The Mountain Research Initiative serves as a coordination network for research collaboration, bringing the global mountain research community together. Since the establishment of the MRI Coordination Office in 2001, the MRI has striven to promote basic and applied research to understand how drivers and processes of global change present challenges and opportunities in mountain social-ecological systems. The MRI is hosted by the Centre for Development and Environment at the University of Bern.

Multiple Evidence Base (MEB) approach: A Multiple Evidence Base approach emphasises the complementarity of knowledge systems and the values of letting each knowledge system speak for itself, within its own context, without assigning one dominant knowledge

system with the role of external validator. Complementary insights from different knowledge systems create an enriched picture of an issue of investigation. The approach acknowledges that there are power issues involved when connecting different knowledge systems, and that there are—despite similarities and overlaps—aspects of each knowledge system that cannot be fully translated into another. The MEB approach aims to promote and enable connections across knowledge systems in a respectful and equal manner. The approach stresses that the type of complementarity and co-production envisioned should be part of a collaborative process between those involved from the outset. The focus on the process may help to clarify the power dynamics, maintain integrity of knowledge systems, generate new questions, and thus enable assessments and knowledge generation activities that are salient, credible, and legitimate for a diversity of Knowledge Holders. Definition and text from Tengö et al. (2014).

Ongoing consent: In a research context, commitment to ongoing consent reflects an understanding that an initial process of obtaining informed consent (e.g., through an informed consent process guided by the Tri-Agency standards for ethical research conduct) is only the beginning of a continued consent process. Ongoing consent is an iterative process in which researchers maintain communication with research participants to provide updates and seek continued consent for participants' knowledge and data to be used and/or shared. The CMA enacts the principle of ongoing consent by maintaining dialogue throughout the CMA preparation process and ensuring through the publication contract that Learning Circle participants may—in perpetuity—withdraw knowledge shared into the assessment should they decide it is no longer appropriate to share.

Ownership, Access, Control, and Possession (OCAP®): OCAP® asserts that First Nations alone have control over data collection processes in their communities, and that they own and control how this information can be stored, interpreted, used, or shared. "Ownership" refers to the relationship of First Nations to their cultural knowledge, data, and information. This principle states that a community or group owns information collectively in the same way that an individual owns his or her personal information. "Control" affirms that First Nations, their communities, and representative bodies are within their rights to seek control over all aspects of research and information management processes that impact them. First Nations control of research can include all stages of a particular research project from start to finish. The principle extends to the control of resources and review processes, the planning process, management of the information and so on. "Access" refers to the fact that First Nations must have access to information and data about themselves and their communities regardless of where it is held. The principle of access also refers to

the right of First Nations' communities and organisations to manage and make decisions regarding access to their collective information. This may be achieved, in practice, through standardised, formal protocols. "Possession" While ownership identifies the relationship between a people and their information in principle, possession or stewardship is more concrete: it refers to the physical control of data. Possession is the mechanism by which ownership can be asserted and protected.

Peer-reviewed literature: Peer-reviewed literature has gone through an evaluation process in which expert scholars (peer reviewers) and journal editors critically assess the quality and scientific/academic merit of original research. Literature that passes this process is published in the academic journals (i.e., peer-reviewed articles) or scholarly presses (e.g. peer-reviewed books).

Systematic scoping review: Systematic scoping reviews use formal search procedures, inclusion/exclusion criteria, and classification protocols to provide an overview of the state of peer-review literature for a given topic. They prioritise transparency, traceability, and reproducibility, and aim to increase the credibility and thoroughness of literature-based assessment activities.

Traditional Territory: A legally defined term used in the modern-day treaties to refer to lands and waters historically used and occupied by First Nations, Métis, and Inuit Peoples.

Tri-Agency: Tri-Agency is the umbrella term used to describe the three Canadian Government research funding agencies: The Canadian Institutes of Health Research (CIHR), the Natural Sciences and Engineering Research Council (NSERC), and the Social Sciences and Humanities Research Council (SSHRC). The Tri-Agency is the primary mechanism through which the Government of Canada supports research and training at post-secondary institutions; it also provides guidance for the responsible and ethical conduct of research.

Truth and Reconciliation Commission of Canada (TRC): The Truth and Reconciliation Commission of Canada was created in 2008 as a result of the Indian Residential Schools Settlement Agreement. The purpose of the TRC was to document the history and lasting impacts of the Canadian Indian residential school system on Indigenous students and their families, including by providing residential school survivors opportunities to share their experiences during public and private meetings held across the country. The final report of the TRC, *Honouring the Truth, Reconciling for the Future* (2015), documents the tragic experiences of approximately 150,000 Canadian residential school students and outlines 94 "Calls to Action" regarding reconciliation between non-Indigenous Canadians and Indigenous Peoples.

United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP): The United Nations Declaration on the Rights of Indigenous Peoples is the most comprehensive international instrument on the

rights of Indigenous Peoples. It establishes a universal framework of minimum standards for the survival, dignity, and wellbeing of the Indigenous Peoples of the world and it elaborates on existing human rights standards and fundamental freedoms as they apply to the specific situation of Indigenous Peoples. It was adopted by the UN General Assembly on 13 September 2007 by a majority of member states. After initially opposing UNDRIP, the Government of Canada reversed its position and, as of 21 June 2021, now supports the implementation of the UNDRIP as a key step in renewing the Government's relationship with Indigenous Peoples.

Western academic knowledge: Western academic knowledge and ways of knowing have their intellectual roots in the Ancient Greek philosophers, including Socrates, Plato, and Aristotle, and extends through Roman philosophy, the European Renaissance, the Scientific Revolution, and the Age of Enlightenment. When we discuss Western academic knowledge or Western science, we do so to acknowledge the Western European knowledge traditions that underpin how universities understand, teach, and advance knowledge. Like Indigenous knowledges, Western academic knowledges are not monolithic and are informed by a wide range of assumptions, underpinning philosophies, approaches, methods, and contexts; often, though not always, Western academic practices aim to produce generalizable and reproducible insights based on analyses of observed phenomenon. These ways of producing knowledge are not static and reflect changing norms and principles for understanding what knowledge is legitimate.

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A bull moose on the move in Kananaskis Country, Canadian Rockies, during the autumn rutting season.
Photo courtesy of Abdulla Moussa, 2021.