

**ECOSYSTEM PRINCIPLES FOR BRITISH COLUMBIA PROTECTED AREAS:
STRATEGIC PLANNING AND DECISION-MAKING IN WELLS GRAY
PROVINCIAL PARK**

by

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ABSTRACT

Canada's commitment to conserving 30 percent of its lands and oceans by 2030 is an incredibly ambitious objective that involves immense political and strategic efforts. Despite initiatives by federal, provincial, and territorial authorities, this target remains distant. This research demonstrates that applying ecosystem principles, such as ecological integrity, connectivity, reconciliation, ecosystem-based approaches, adaptive management, and ecosystem services (ES), can contribute to new frameworks that support the current objectives of protected area (PA) conservation policy. To define these principles, I conducted semi-structured interviews with stakeholders experienced in PA management. This evidence was complemented with archival and policy analysis of government documents. In order to demonstrate how the ecosystem principles can be used to improve decision-making, I conducted ecosystem, land cover type, and Biogeoclimatic Ecosystem Classification (BEC) zone mapping within Wells Gray Provincial Park. This mapping was linked using GIS tools to implement an ecosystem-based approach and support the identification of ecosystems as key decision-making factors. Finally, the BEC zones were modelled against climate change scenarios to inform the interpretation of their potential impact on ecosystems. This analysis can be used to initiate a strategic thinking model to facilitate dialogue and collaborative planning with stakeholders.

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ABBREVIATIONS

BC	British Columbia
BEC	Biogeoclimatic Ecosystem Classification
CDF	Critical Decision Factors
CBD	Convention on Biological Diversity
ECCC	Environment and Climate Change Canada
ES	Ecosystem Services
OECM	Other effective area-based conservation measures
PA	Protected Areas
SEA	Strategic Environmental Assessment
TEK	Traditional Ecological Knowledge

CHAPTER 1

Introduction

In response to the global Aichi Biodiversity Targets adopted at the tenth meeting of the Conference of the Parties (COP10) to the Convention on Biological Diversity (CBD) in October 2010, Canada established a set of goals and targets to achieve its long-term biodiversity outcomes. The objective of Goal A was to use an ecosystem approach to effectively plan and manage Canada's lands and waters to promote biodiversity conservation at local, regional, and national levels. This goal included multiple targets. Target 1 specifically aimed to conserve a minimum of 17% of terrestrial areas and inland waters, as well as 10% of coastal and marine areas, through the establishment of protected areas (PA) and other effective conservation measures (OECM) (2020 Biodiversity Goals and Targets for Canada, 2016). In response to Target 3 of the Kunming-Montreal Global Biodiversity Framework, this target was updated by Canada at the fifteenth meeting of the Conference of the Parties (COP15) in December 2022 to protect at least 30% of land and oceans by 2030 (CBD, 2022).

To conserve the biodiversity and diverse ecosystems that characterize Canada's landscape, the Government of Canada has formed a representative network of PAs in all of Canada's ecological regions. Canada is divided into 31 different terrestrial and marine ecozones¹, each representing an area of the earth with a distinct climate and biodiversity. These ecozones are then categorized into 215 terrestrial ecoregions², which are characterized by specific regional attributes such as climate, landscape, vegetation, soils, flora, and fauna. According to Environment and Climate Change Canada (ECCC), Canada has implemented conservation measures for 94% of its ecoregions (ECCC, 2024). In addition, available ECCC data (Figure 1) indicates that by the end of 2023, 13.7% of

¹ An ecozone is a large area of land with similar natural features. Each ecozone has its own type of land, climate, plants, animals, and human activities. These areas help understand and manage Canada's different environments (Natural Resources Canada, 2025a).

² An ecoregion is a specific area within an ecozone that shares similar environmental features like climate, land, plants, and animals. It's a way to group places that have similar natural conditions (Data Basin & Conservation Biology Institute, 2020).

Canada's terrestrial territory and 14.7% of its marine territory were protected, which is 16.3% below the terrestrial target and 15.3% below the marine target set for 2030. ECCC also details that more than 65% of all terrestrial PAs are managed by provincial and territorial jurisdictions. This places the management of ecosystems and the conservation of their biodiversity in the hands of provincial governments. British Columbia (BC) contributes 19.7% of its land to Canada's PAs through provincial, regional, and recreational parks, conservancies, Indigenous protected areas, ecological reserves, wildlife areas, migratory bird sanctuaries, and other OECMs.

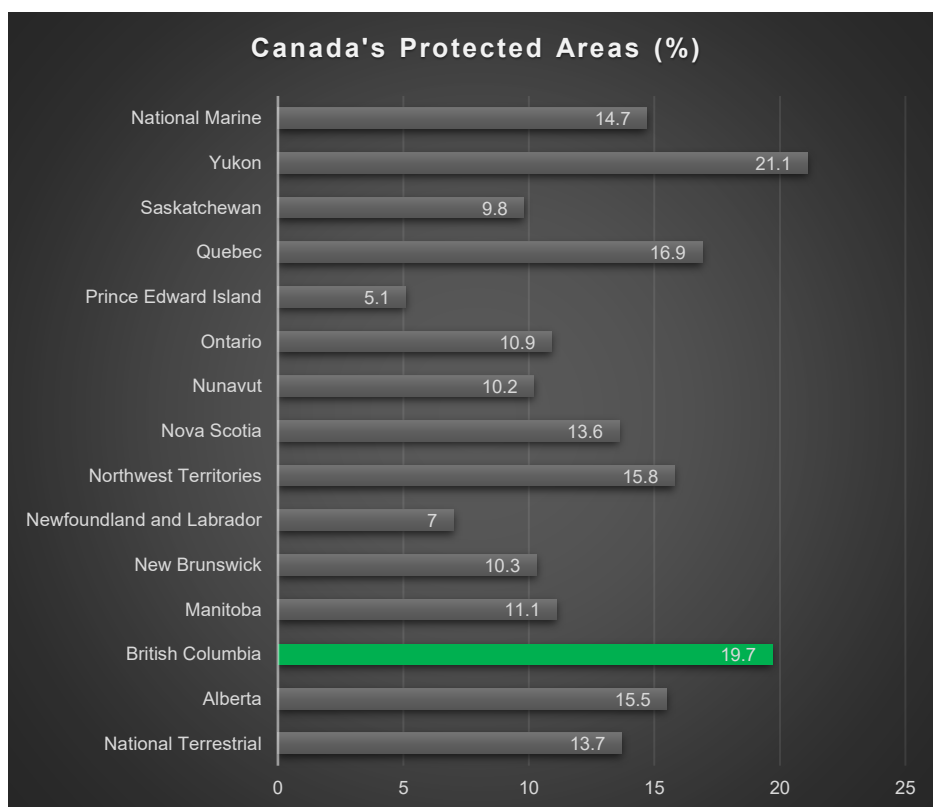


Figure 1 Canada's Protected Areas, based on the Proportion of Terrestrial Area Conserved by Province and Territory (ECCC, 2024)

Literature Review

Protected Areas and Other Effective Area-Based Conservation Measures

The different types of PAs were established in accordance with the International Union for Conservation of Nature (IUCN) Guidelines for Applying

Protected Area Management Categories, which defined a PA as a precise, legally recognized, and managed area for the long-term conservation of nature, ecosystem services (ES), and cultural values (Dudley, 2013). The OECM was adopted at the 14th meeting of the Conference of the Parties to the CBD (COP14) in 2018 and refers to a geographically distinct area, other than a PA, that is governed and managed to achieve positive and sustained long-term outcomes for biodiversity conservation, ecosystem functions and services, cultural, spiritual, socio-economic, and other locally relevant values (CBD, 2018)

It is important to emphasize that the conservation and biodiversity outcomes for OECMs are equivalent to those of a PA, but the main difference between them is the primary purpose of the area (Table 1). In the context of a PA, the primary objective is conservation. An OECM, on the other hand, is managed for a different purpose while achieving conservation and biodiversity outcomes (ECCC, 2022).

Protected Areas (PA)	Other Effective Area-based Conservation Measures (OECM)
National and Wildlife Areas, National Parks, Provincial and territorial parks and protected areas, Private protected areas, Indigenous-led conservation areas	Watershed protection zones, Research forests, Native prairie grasslands managed sustainably for beef production, Conservation set-asides in managed forests, Certain land use planning zones, Recreational areas, Parts of military bases

Table 1 Types of PA and OECM according to the Canadian government's conservation network (ECCC, 2022)

In compliance with IUCN guidelines and the COP15 target, the ECCC has implemented the Management Effectiveness Tracking Tool³. This tool helps to see how PAs are being managed, what actions are needed to get better results in their management, and to look at key ecological features and barriers for better decision-making. As a result of the use of this tool, ECCC reports different biodiversity indicators for PAs across Canada that include species status and trends, habitat quality and changes, ecological integrity, biological resource status and management (ECCC, 2025).

³ Framework for management effectiveness developed by the IUCN World Commission for Protected Areas [Explore the World's Protected Areas \(protectedplanet.net\)](https://protectedplanet.net/)

The ecological integrity indicator measure focuses on plant and animal populations and soil characteristics or the presence of invasive species to define the conditions of a PA. These reports, provided by provinces and territories, are often made without supporting research into the reasons for ineffectiveness in meeting key targets if they are not met (Olive et al., 2023). Conversely, indicators such as sustainable forest management prioritize biodiversity conservation as part of the ecological integrity measure. However, policy has failed to recognize the link between primary productivity and biodiversity and the role of tree diversity in various ecosystem functions such as carbon, water, and nutrient cycling (Mori et al., 2021). These are ecosystem functions that need to be balanced to maintain the quality of ecosystems and the services that people derive from nature.

BC Parks and Protected Areas Management

The history of provincial parks and PAs in BC can be traced back to 1911, when the intention of protecting wild areas from mining, logging, and other industrial activities was raised and Strathcona Provincial Park was established. However, it was not until 1965 that the first Park Act was passed by the legislature. This provided a detailed classification of provincial parks, management guidelines, and increased protection for the natural resources contained within them (BC Parks, 2024a).

Currently, BC Parks are governed by the Park Act (1996), Environmental and Land Use Act (1996), Ecological Reserve Act (1996), and Protected Areas of British Columbia Act (2000). According to this legislation, in BC there are 630 Class A parks, 2 Class B parks, 13 Class C parks, 2 Recreation Areas, 169 Conservancies, 86 Designations under the Environment and Land Use Act, and 148 Ecological Reserves (BC Parks, 2024b). In 2018, the Indigenous Circle of Experts released the report 'We Rise Together' to achieve the first of nineteen targets Canada committed to meet by 2020 in response to COP10 in Nagoya, Aichi Prefecture, Japan. The Indigenous Circle of Experts provided guidance on how to achieve Canada Target 1 (conserve at least 17% of terrestrial areas and

inland water and 10% of coastal and marine areas by 2020) by establishing Indigenous Protected and Conserved Areas (IPCA) (Parks Canada, 2018).

IPCAs are lands and waters where Indigenous communities, through their governments, take the lead to protect and conserve ecosystems using Indigenous laws and knowledge systems (Conservation through Reconciliation Partnership, 2023). Therefore, IPCAs can exist within and beyond established Crown PAs and can be set under three different models: Co-Governance, Tribal Parks, and Indigenous Governance. At present, in the context of achieving Target 1, less than 0.48% of Canada's terrestrial PAs network is under Indigenous-led conservation (Mansuy et al., 2023). The federal government has three Indigenous governance areas officially reported as IPCAs under the Protected Area Act that are in the Northwest Territories (ECCC, 2021). However, a great number of IPCAs were declared by First Nations across the country, and for the context of BC, there are currently 14 publicly declared. The Ministry of Water, Land and Resource Stewardship is developing a formal process and guidance to recognize them in regard to the values and vision of IPCAs, which they expect to release in 2025 (Outdoor Recreation Council of BC, 2024).

BC Parks has established a Strategic Management Planning Policy that defines the steps required to establish the vision and direction for these areas. The specific purposes of Management Plans are to: recognize a PA's relevance in the PA network to create a long-term vision; characterize the PA's ecological integrity, core values, and intended future state; encourage First Nations, the public, and interest groups involved in PAs management; provide a decision-making structure and priorities for implementation; and facilitate the efficient use of scarce resources by defining, characterizing, and prioritizing management measures to meet PAs goals. The main purpose of these management plans is to create a zoning plan that defines management zones based on crucial factors such as natural, cultural, environmental, and visitor experience criteria (BC Parks, 2013).

One of the objectives set by BC Parks for their conservation program is to maintain and restore ecosystems by allowing natural processes to proceed freely,

while acknowledging that sometimes ecosystems within PAs need assistance to reach a more resilient condition (BC Parks, 2020). Since 2018, BC Parks has committed to conducting the IUCN (Hockings & World Commission on Protected Areas, 2006) framework to assess the management effectiveness of PAs and study how well PAs are working. As a result of these evaluations, a lack of information on biodiversity outcomes seems to be the barrier to understand the current conditions (BC Parks, n.d.). Although management plans exist, they need to be updated to better address ecological values and the increasing levels of human use. The report explains that the management of everyday activities does not include explicit consideration of other ecological threats and longer-term conservation management. It is also limited to address urgent and developing issues connected with visitor usage. A lack of research and monitoring combined with funding constraints inhibits proactive planning and execution. The report also shows a lack of formal management plans, and the ones that exist have unclear purpose statements. Consequently, there are no specific goals for valuable ecological sites. It is lacking in knowledge of essential cultural and preservation assets, and there is very little active research or monitoring. Therefore, BC Parks stated that conservation values require careful decisions regarding where, when, and how people can continue to enjoy PAs. It also emphasizes the need for studying and monitoring natural conditions, as well as fostering a culture of conservation among visitors to protected places.

Furthermore, as seen in the Protected Planet website⁴, which offers PAs management effectiveness assessments and the worldwide database of protected places, Canada has 11,886 PAs. According to this website, Canada only has 62 PAs with an effective management evaluation. This means that only 3.11% of his total area dedicated to terrestrial and inland waters PAs and 0.15% of his marine PAs have been assessed (UNEP-WCMC, 2025). This clearly indicates that natural processes and the state of ecosystems have not been assessed properly, and strategies to help these PAs are still under development.

⁴ [Explore the World's Protected Areas](#)

A review of the BC Parks management plans in development and approved indicates that the process for approval of these plans is taking too long and that the actions needed to achieve the intended goals are not being delivered in the time required. These management plans encompass ecosystems and the services they provide to humans, extend beyond PAs, and establish a range of ecological attributes of ecosystems. The management objectives aim to preserve their composition, structure, and function. Unfortunately, they do not include variables related to decisions regarding implementable activities and their connection to ES, which could potentially support the maintenance and enhancement of their conditions.

It is essential to establish links between ES and decision variables for activities to be developed in PAs, as well as to identify how these can affect or improve existing ES. The purpose of developing physical ecosystem accounts is to quantify and communicate the significance of natural resources and services so decision-makers can improve the management and sustainability of these resources (Brander et al., 2022). It is therefore necessary to construct transition objectives that are coherent with the goals to be achieved for the conservation of the ecosystems that sustain the PAs and to integrate the visions of the different actors involved in this transition. This could improve the approval times for management plans and strengthen the ecosystems without depleting them.

Strategic Environmental Assessment

Strategic Environmental Assessment (SEA) is a tool intended to incorporate the environmental and social dimensions into the decision-making process of any plan, policy, program, or strategy (PPP)⁵. The use of this tool enhances the possibility of finding the source of the environmental and social impacts of a PPP before deciding about its implementation. The flexibility of the tool allows SEA to merge environmental, social, and economic concerns into the

⁵ Strategy regarding projects or activities that sets in a determinate region.

decision-making process and minimize adverse environmental effects regarding sustainability principles (Dalal-Clayton & Sadler, 2005).

In 2006, the Organisation for Economic Co-Operation and Development created a guideline document that outlined the use of SEA and established principles for its implementation. This procedure prioritizes the importance of making the tool flexible, iterative, and customized to the specific context, as well as providing clear justification to select preferred options and accept significant compensations. Additionally, it addresses the connections and trade-offs between environmental, social, and economic factors, involves key stakeholders, and promotes public participation (OECD, 2006). SEA can reduce plan formulation cost and time, improve resource management and decision-making, and identify collaboration and innovation across sectors and stakeholders. It may also encourage stakeholder collaboration and shared visions (Therivel, R., & González, A., 2020).

This tool uses many methods and combines diverse factors to achieve its objective. The main functions of SEA are to assess many possible scenarios, use a multi-stage iterative process with feedback loops, and prioritize a balanced approach to environmental, social, and economic goals (OECD, 2006). Buse et al. (2020) found that cumulative effects, agent-based modelling, the Drivers-Pressures-State-Impact-Responses framework, multi-criteria analysis, life cycle assessment, geospatial analysis, ES values, and trade-offs are the most common methods for PPP analysis. Given that SEA is a versatile tool that should consistently enable the utilization of appropriate mechanisms to accomplish a responsible and thorough strategic assessment, it is the responsibility of those who are implementing the tool to identify the most effective methods that can assist in the decision-making process to ensure the proper integration of social and environmental factors. Although the primary objective of SEA is to advance sustainability, it is crucial to comprehend the fundamental components or rules that should govern the application of this instrument (Unalan & Cowell, 2019).

In Canada, there are two approaches to the strategic assessment of the environmental dimension in the decision-making process. One is the SEA,

implemented under Cabinet Directive (Impact Assessment Agency of Canada, 2022), and the other is the Regional Strategic Environmental Assessment (RSEA), implemented under the Impact Assessment Act (Impact Assessment Agency of Canada, 2025). The decision of whether to implement SEA or RSEA involves various factors, with a focus on the assessments' capacity to fulfill federal objectives, comprehend the effects on different communities and regions, facilitate collaboration with other jurisdictions, and address public concerns regarding perceived or actual impacts (Buse et al., 2020).

In the context of national parks, Parks Canada conducted a SEA for Wood Buffalo National Park. The assessment had three goals for conserving outstanding universal values in the area: (i) improve the identification, recognition, and management of cumulative effects; (ii) inform the scope and effectiveness of project-level environmental assessment; and (iii) influence the development and implementation of an action plan for world heritage values (Parks Canada Agency, 2023). The report was submitted to the federal government in 2018, and an action plan was released in 2019 to preserve the park's world heritage status. No additional studies on the cumulative effects of Wood Buffalo National Park activities were conducted, limiting the SEA approach's assessment data. As a result, while the SEA offered an initial framework to address cumulative effects, its limited development and exclusion of ES highlight significant gaps in its application, undermining the long-term effectiveness of conservation efforts in the park (Noble et al., 2019).

A Cumulative Effects Framework was created by the Government of British Columbia (2015) to conduct RSEA for the Natural Resource Sector. This framework provides a strategic approach to evaluate the combined effects of various factors and determine management strategies to minimize negative effects on provincial principles. This framework includes rules, processes, and decision support technologies to improve cumulative effects assessments in BC natural resource management decision-making. BC's framework goals included forest biodiversity, old-growth forest preservation, aquatic ecosystem conservation, and grizzly bear and moose habitat preservation. The BC

government determined these values using legislation, land use plans, case law, or other management direction. They also considered values identified through strategic engagement and other agreements with First Nations, or values supporting Indigenous treaty rights, as well as mappable values (Government of British Columbia, 2015). The cumulative effects assessment employs data from the specific region of the planned activity to assess current conditions and identify potential future risks. This assessment considers information about the activity itself as well as other elements that influence the environment and its values, while also considering projected trends. The province of BC has developed other initiatives, like the Environmental Stewardship Initiative of 2014 and the Collaborative Stewardship Framework of 2018, which are co-responsibility actions developed with First Nations to support resource management and incorporate local and Indigenous knowledge in their territories.

These efforts are considered insufficient to address the significant gaps and needs that exist in many areas. An obstacle to the effectiveness of RSEA is its limited scope, as it tends to focus only on the specific issue or task at hand, rather than being integrated into an overall decision-making framework that is transparent and coherent in policy, planning, and development (Therivel, R., & González, A., 2020). According to a report made by West Coast (2016), there is a need to engage local stakeholders proactively and collaboratively in identifying and validating different current regional social, economic, and environmental values. It is essential to understand which values are relevant, why they matter, how they may be impacted by various development activities, and how future scenarios can be assessed to enhance and protect these values. There is a need to develop a framework for analysis and incorporation of positive and negative feedback, as current approaches do not allow for the correct interaction of values and socio-ecological conditions. Finally, current approaches to Cumulative Effects Assessment and RSEA tend to focus on past and present events without considering desired or possible future scenarios in the context of climate change models or what ecosystems can withstand.

Ecosystem Services and Ecosystem Services Valuation

Planning based on ecosystems and their services provides valuable information for decision-making, as it expresses the importance of environmental change in a common unit (i.e., monetary value), enabling direct comparison with other goods, services, investments, and impacts on the economy and society (Brander et al., 2022). In order to achieve this, the different beneficiaries' perceptions of the significance of ecosystems must be integrated into the same perspective before economic valuations of these and their services can be carried out. If an intrinsic value of ecosystems is not set on what is important for our well-being (because we cannot see ourselves independently from the ecosystem), it is impossible to define a way for a sustainable path for their management. Therefore, it is essential to use an ecosystem-based approach that incorporates the perspectives of different stakeholders from the outset of the planning process.

ES are all the benefits that human beings derive from the processes and functions that flow from natural resources (Liu et al., 2010). ES are divided into four main categories: provisioning (i.e., wood, water, food, fibre), supporting (i.e., habitat, water cycling), regulating (i.e., climate and water regulation, waste treatment, pollination), and cultural (i.e., recreation, aesthetic, cultural). It is essential to distinguish between the processes, functions, and services of ecosystems. Ecosystem processes and functions refer to the biophysical relationships that exist regardless of human benefits, and ES are those processes and functions that specifically benefit people but only exist if they contribute to human well-being, so they cannot be defined independently (Costanza et al., 2017).

The growing interest in valuing ES arises from its essential role in supporting human sustainability and the increasing scarcity of certain services. This scarcity poses a major challenge not only to societal development but also to effective environmental conservation. According to Liu et al. (2010), ES valuation is the process of estimating the contribution of ES to long-term development, fair distribution of resources, and efficient resource use. To carry

out this valuation, it is necessary to establish a method for measuring their value in economic terms. In this context, natural capital⁶ refers to the stock of natural resources that generate goods and services, commonly known as ES. It interacts with other forms of capital, such as built capital (or manufactured capital) and human capital, which together form social or cultural capital. These interconnected forms of capital generally contribute to the production of ES that support human well-being.

Since it is not possible to quantify all the benefits of ES, Therivel & González (2020) divide ES into two categories: monetizable use and non-monetizable use values. There are several methods to establish the value of ES that are considered monetizable, such as market methods, travel costs, hedonic methods, production approaches, contingent valuation, replacement costs, avoidance costs, and benefit transfer. Other methods are used for those that are defined as non-monetizable, such as measures of attitudes, preferences and intentions, civic valuation, decision science approaches, ecosystem benefit indicators, and biophysical ranking methods (Liu et al., 2010).

Despite various methods that exist to monetize ES, it is first fundamental to understand the different types of value these services represent for society. For example, a forest may hold economic value for those who count on it for timber extraction, while others may value it for its ecological functions, such as carbon sequestration, air purification, or water filtration. To consider these diverse perspectives, it is necessary to establish ecosystem principles that recognize both the benefits ecosystems provide to humans and their intrinsic ecological functions.

Land Use Management and Strategic Environmental Assessment

In terms of land use management and planning, integrating SEA principles with the ES framework offers an effective approach to support informed and sustainable decision-making. This integration can generate benefits for both

⁶ Natural capital refers to the planet's stocks of water, land, air, and renewable and non-renewable resources (such as plant and animal species, forests, and minerals) [What is natural capital? - David Suzuki Foundation](#)

ecosystems and human communities. The variety of developments occurring within a particular region can bring significant pressure on its natural resources, which directly influence land use decisions. Socio-economic factors, such as population growth, economic activity, and shifts in land use, are the main aspects behind changes in the provision and demand for ES (Partidário & Gomes, 2013). The valuation of ES can consider the strategic importance of biodiversity for specific regions and communities. The quality and availability of ES depend on land use policies and decisions, which in turn affect the value of ES derived from the natural resources of the region. Consequently, understanding the relationship between land use planning and the ES can manage the risks and costs of land use decisions (Nijhum et al., 2021).

According to De Groot et al. (2010), the main challenge in land use management is to determine the most efficient distribution and administration of the various land use options. To include ES in land use planning, management, and decision-making, it is imperative to understand and measure the services ecosystems provide; assess their value; incorporate ES into trade-off analyses; apply them in planning and management; and develop mechanisms to support their long-term use.

Future predictions based only on past trends and the current global context are uncertain and inadequate to address today's complex challenges. Instead, it is essential to consider disruptive futures that rethink ecosystem use, respect ecological carrying capacities, and maintain or enhance ecosystem functions while delivering benefits within their limits. Territorial planning frameworks must integrate key ecosystem principles to guide the assessment of actions and activities across a region. To achieve a desired vision, these principles must be defined by the region's most relevant ecosystem factors. A balanced approach to ecosystem use is critical, and applying strategic thinking, where ES are recognized as Critical Decision Factors (CDFs), can lead to more effective and sustainable land management and planning.

Design for Sustainability Transitions

Design for sustainability transitions is an area within sustainable design that focuses on reshaping socio-technical systems to facilitate transformative⁷ change in society (Ceschin & Gaziulusoy, 2020). Transition and transformation can occur simultaneously, as both provide perspectives on how to describe, interpret, and support the fundamental and non-linear social changes needed to achieve sustainable societies (Hölscher et al., 2018). These transformations must address contemporary challenges and barriers (Gaziulusoy & Erdoğan Öztekin, 2019). The Stockholm Resilience Centre (2023) states that we must respect nine planetary boundaries to preserve the earth's balance, foster the development of our current societies, and guarantee the well-being of future generations. The goal of this framework is to define the environmental limits within which human beings and societies could safely operate without altering the earth's ecosystems (European Commission, 2016). Alterations in the functioning ecosystems of the earth have begun to expose our societies and economies to substantial risk (Richardson et al., 2023). One of the main boundaries that has been crossed is land system change, where land use conversion and fires are causing rapid changes in forest cover.

As Von Flittner et al. (2022) stated, governments and organizations are gradually engaging in sustainability transition processes. This growing interest is principally guided by the urgent need to respond to the crises associated with exceeding planetary boundaries. However, most practices primarily focus on reducing impacts in the short term and aligning with national reduction targets. Achieving transformations requires significant changes in the fundamental structures of the societal systems. The interconnections between these systems indicate that intrinsic transitions require the development of new conceptions inside the systems, reshaping how systems are conceived and operated, to enable alternative and more sustainable futures (Gaziulusoy & Ryan, 2017).

⁷ Transformation implies a more radical and profound change, often involving a fundamental shift in the nature, structure, or character of something. Therefore, we use the term "transformative" here to describe something that either causes a transformation or has the potential to cause one.

The multi-level perspective is the framework that Gaziulusoy & Ryan (2017) use to explain and analyze the role of design for sustainability transition processes. This perspective is based on studies of transitions in areas such as energy and transportation, and it is very useful for understanding complex interactions in contexts where changes are generated at different levels. According to this, the three main activities that operate at the different levels that interact in this context of transitions are:

- **Strategic Activities/Landscape (macro-level):** This level is interested in creating long-term plans and goals that will transform the culture and structure of a socio-technical system. These changes are gradual and influenced by factors that either do not change or change very slowly, as well as by rapid external shocks.
- **Tactical Activities/Regimens (meso-level):** It describes how changes can be made to achieve certain goals and how different people can collaborate to turn new ideas into reality. It supports current social and technological systems by demonstrating the actions that can create obstacles to change.
- **Operational Activities/Noches (micro-levels):** This explores new learning by doing, with a focus on big and disruptive ideas. This considers the extent to which people experiment with new technologies, business models, social and cultural practices, and institutional changes.

Design for sustainability transitions has the potential to enable collaborative co-creation between different stakeholders at different levels of the social structure by helping them to identify desirable futures. Furthermore, it is imperative that all activities in the transition process operate according to the level where the actions are required and consequently enable the achievement of the desired goals. It is not enough to just use new technologies during these times of change; policies, manager habits, cultural meanings, infrastructure, and business models all need to be changed as well. These are long-term processes that happen over decades. They are driven by the need to use systemic

innovation to solve long-lasting problems in society (Sustainability Directory, 2025). Without alignment, it is difficult to get transitions, but it is essential to start the process at some level, in hope that it permeates other levels if we want to change our societal structures and models to further develop our current societies and future generations.

Thesis Statement and Research Questions

The purpose of this research is to establish ecosystem principles that will facilitate the planning and management of protected areas (PAs) in BC. It includes an assessment of current policies and guidelines for developing management plans in BC's PAs, along with an evaluation of conservation outcomes compared to the goals set by the Government of Canada. To achieve this, an analysis of federal, provincial, and territorial legislation was conducted. In addition, interviews with stakeholders with expertise in PAs in Canada helped identify management directions and ecosystem principles that could contribute to management strategies for PAs in BC. Also, Wells Gray Provincial Park was used as a case study to demonstrate how the ecosystem principles can be integrated for planning purposes. The critical research questions that guided this project were:

1. What management strategies have been applied to PAs in BC?
2. To what extent are the current and future impacts of climate change considered in PAs management strategies?
3. How will an ecosystem-based strategy influence PAs management policies, planning, and resources?
4. Can the identification of land cover ES, as perceived by stakeholders involved in the decision-making process, improve PAs management strategies to achieve sustainability transitions?

I argue that the use of ecosystem principles, such as ecological integrity, connectivity, reconciliation, ecosystem-based approach, adaptive management,

and ES, can produce new frameworks that strengthen the current objectives of PA conservation policies. Consequently, to improve management directions in Wells Gray Provincial Park, it is essential to incorporate and align these principles with the park's values and the mission of its master plan. Linking ecosystems, ES, land cover, and the Biogeoclimatic Ecosystem Classification (BEC) zones can support an ecosystem-based approach that sets ecosystems and their services as CDFs to initiate a strategic thinking model for stakeholder dialogue and improve decision-making in the park's planning processes.

Methodological Approach

Wells Gray Provincial Park has been used as a case study for the development of this project. The research methods for this project can be divided into five parts:

1. Archival research of federal legislation and other Canadian provincial and territorial legislation. This included a review and analysis of the ECCC databases that report on the types of PAs and OECMs and their status in relation to the monitoring indicators established by the Government of Canada.
2. Conducting semi-structured interviews with a group of stakeholders with expertise in PAs management. These identified the perceived gaps and risks at the legal and management levels and the actions or measures that should be considered to improve current practices. Future directions were also recognized and used to build the ecosystem principles to support current objectives of PA conservation policies.
3. Definition of CDFs for territory management and planning, based on the SEA strategic thinking model defined by Partidario & Gomes (2013). These were developed by mapping the ecosystems, land covers, and BEC defined for Wells Gray Provincial Park. The land covers were obtained from Natural Resources Canada (2025b), and the BEC zones were acquired from the BC Data Catalogue (Government of British

Columbia, 2025). The ecosystems and services were defined based on the classification of the Ecosystem Services Valuation Database (SEEA EA) (United Nations, 2021a) and the open-source modelling platform for environmental sustainability ARIES (ARIES, 2021; United Nations, 2021b).

4. Ecosystem-based approach for Wells Gray Provincial Park. This approach is one of the key ecosystem principles identified through the research. It was used to illustrate how decisions related to land cover types and BEC zones of Wells Gray Provincial Park interact with ecosystems and the ES they provide. The development of this approach involved integrating and spatially interconnecting ecosystems, land cover types, and BEC zones within Wells Gray Provincial Park.
5. BEC classification changes due to climate change. A model of future scenarios for Wells Gray Provincial Park was created using the interactive data visualization and access platform ClimateBC_Map (University of British Columbia & Centre for Forest Conservation Genetics, 2023) based on how the BEC zones would change in response to the Intergovernmental Panel on Climate Change projections (Hausfather, 2018).

The results of these models can be integrated with the ecosystem principles defined in this research to determine future directions to improve the Wells Gray Provincial Park Master Plan. With the goal of achieving sustainability transitions, these principles could also serve as a first step in formulating a framework for policy and management guidance plans for BC PAs.

Research Methods

Archival Research

The main objective was to understand the existing legislation and practices established by the federal, provincial, and territorial governments for the management of PAs. The information to conduct the legal analysis was

obtained from Parks Canada Agency, Justice Laws Website⁸, the Canadian Legal Information Institute (CanLII)⁹ and the different provincial and territorial legal web pages for PA management. This archival analysis also considered the ECCC database¹⁰, which reports on the different types of PAs and OECMs in Canada, as well as the environmental indicators that help to verify compliance with the principle of environmental integrity. This information was used to produce graphs showing Canada's network of PAs and tables showing the different policies and guidelines for their management at federal, provincial, and territorial levels.

Semi-Structured Interviews and Reflexive Thematic Analysis

Design for sustainability transitions¹¹ can be applied to any initiative aimed at contributing to long-term systemic change, and it essentially asks what societal transformations are necessary to achieve sustainability (Gaziulusoy & Erdoğan Öztekin, 2019). Research in this field often uses scenario planning processes and participatory methods to explore potential futures. These processes are participatory events in which the intention may be to produce future-related knowledge, strengthen participants' thinking, create collaborative networks, enhance social appreciation and learning, communicate research findings, or resolve a conflict (Nygrén, 2019). When incorporated into broader planning efforts, scenario planning provides a foundation for structured engagement and reflection. In this research, only semi-structured interviews were conducted as a first step to inform the development of ecosystem principles that could later guide decision-making within planning scenarios for PAs.

Qualitative research is the study of phenomena, usually in depth and holistically, through the collection of narrative material using a flexible research

⁸ Online source of the consolidated Acts and regulations of Canada. This website provides access to federal Acts and regulations. [Justice Laws Website](#)

⁹ A not-for-profit organization that provides efficient and open online access to judicial decisions and legislative documents from all Canadian jurisdictions. [Canadian Legal Information Institute | CanLII](#)

¹⁰ The Environment and Climate Change Canada (ECCC) Data Catalogue is a platform that provides environmental and scientific data on Canada's protected and conservation areas. [ECCC Data Catalogue](#)

¹¹ For the purpose of this research, the sustainability transitions concept is understood as the idea of maintaining and improving natural resources and ecosystems within ecological systems and strengthening their stability while recreational, conservation values, and other human activities are developed.

design (Polit & Beck, 2017). According to Adeoye-Olatunde & Olenik (2021), there are various methods for collecting data in qualitative research, including observation, semi-structured interviews, and focus groups. Since the goal of this research is to recognize the individual perspectives on policies, guidelines, and management strategies of stakeholders with expertise in PAs, semi-structured interviews were the most effective method. Interviews can foster a deeper comprehension of the unique perspective of the participants, rather than a generalized understanding of a phenomenon (McGrath et al., 2019).

According to Braun & Clarke (2012), reflexive thematic analysis is an interpretative method for qualitative data that allows for the identification and analysis of themes in a data set. By using a reflexive approach to thematic analysis, themes are not set in advance to look for codes; rather, themes naturally come up as codes are arranged around a main idea, which is the researcher's awareness of the data (Braun & Clarke, 2019). This approach helps highlight the interviewees' opinions and the interpretations of the researcher within the theoretical framework (Byrne, 2022). For these reasons, I considered the use of reflexive thematic analysis as a method to analyze my qualitative data from semi-structured interviews.

I conducted 21 semi-structured interviews with a group of stakeholders with expertise in PAs management who were chosen to ensure a variety of aspects relevant to PA planning in BC. Their opinions were used to define critical issues in the management of PAs, as well as possible outcomes to overcome pressing challenges. General interview questions can be found in Appendix A. Each interview was audio-recorded with the consent of the interviewee, then transcribed and sent to the interviewee for approval. All participants were offered anonymity. Some chose to remain anonymous so that their names would not be associated with their contributions, and pseudonyms were used. A copy of the consent form given to each interviewee can be found in Appendix B.

The interviewees were recruited by contacting organizations that were related to parks and protected areas management. These interviewees represent sectors such as provincial park management, Indigenous tourism, NGOs,

regional tourism, and community-based initiatives. By including observations from these different experts, the research aimed to incorporate institutional, Indigenous, local, and environmental viewpoints into the development of ecosystem principles for PAs planning. Then, by network sampling, some participants connected me with other future interviewees that had the knowledge and interests in this topic (Statistics Canada, 2021). It is important to note here that 78% of the interviewees were affiliated with organizations or government entities based in BC. This reflects both the initial focus of the research and the accessibility of contacts through existing networks.

All the interviews were conducted in person and virtually and were led with the following stakeholders to include different perspectives in the research analysis:

No.	Date	Name	Organization	Interview Method
1	2024-08-21	Trevor Goward	Lichenologist, Department of Botany, UBC Wells Gray World Heritage Committee	In-Person
2	2024-09-10	Jason W. Johnston	Indigenous Tourism Association of Canada (ITAC)	In-Person
3	2024-09-12	Ian Barnett	Nature Conservancy Canada (NCC) Grasslands Conservation Council (GCC) Wildlife Habitat Canada	In-Person
4	2024-09-19	Tom Dickinson	Wells Gray World Heritage Committee	In-Person
5	2024-09-23	Catherine Hickson	Chief operating officer for Dajin Resources Corp President Tuya Terra Geo Corp	Virtual
6	2024-09-24	Nancy Flood	Wells Gray World Heritage Committee Kamloops Naturalists Club	In-Person
7	2024-10-02	Hillary Page	Nature Conservancy Canada (NCC)	Virtual
8	2024-10-08	Roland Neave	Wells Gray Tours	In-Person
9	2024-10-09	Stephanie Russell	BC Parks	In-Person
10	2024-10-09	Tod Haughton	BC Parks	In-Person
11	2024-10-09	Peter Weilandt	BC Parks	In-Person
12	2024-10-22	Don Carruthers Den Hoed	PARKS+ Collective	Virtual
13	2024-10-23	Tay Briggs	Wells Gray Adventures	In-Person

No.	Date	Name	Organization	Interview Method
14	2024-10-28	Sasha Morton ¹²	Ducks Unlimited Canada BC	Virtual
15	2024-10-28	Sarah Clem ¹³	BC Parks Foundation	Virtual
16	2034-10-30	Herb Hammond	Silva Forest Foundation	Virtual
17	2024-10-31	Danielle Toperczer	Thompson Nicola Conservation Collaborative (TNCC)	Virtual
18	2024-11-06	Claire Matthews ¹⁴	BC Parks	Virtual
19	2024-11-28	Julia Howe ¹⁵	Ministry of Environment and Parks	Virtual
20	2024-11-29	Peter Garrett ¹⁶	Environmental and Climate Change Canada (ECCC)	Virtual
21	2024-12-06	Mike Dedels	Grasslands Conservation Council (GCC)	In-Person

Table 2 Overview of participants, organization and dates

All the interview transcripts were analyzed using reflective thematic analysis and an inductive coding process was applied. This allowed themes to emerge directly from the data rather than being predetermined by the interview guide. While the interview questions provided a clear structure for discussion, codes and themes were generated through close reading and reflection on the participants' answers. All transcripts were reviewed multiple times to identify recurring themes. These themes were then coded and categorized to ensure that the contributions aligned with and supported various sections of this research. Several of the identified themes informed the analysis of policies and guidelines in Chapter 2. Similarly, the management issues mentioned by the interviewees, along with future directions for PA management, contributed to the development of Chapter 3. Furthermore, the reflexive thematic analysis of the interviews played a significant role in the identification of the ecosystem principles discussed in Chapter 3, which can be used to guide decision-making processes within different planning scenarios.

¹² Anonymous Participant

¹³ Anonymous Participant

¹⁴ Anonymous Participant

¹⁵ Anonymous Participant

¹⁶ Anonymous Participant

Ecosystem Mapping for Wells Gray Provincial Park

Partidario & Gomes (2013) propose that the CDF framework is the most effective approach to incorporate ES into the context of SEA. The strategic thinking model described by Partidário (2012) is a tool used to analyze development contexts, identify and solve problems, and find environmentally sustainable options to achieve strategic objectives. SEA strategic thinking is about creating principles for stakeholder dialogue and facilitating decision-making. The SEA strategic-thinking model is structured into three fundamental stages that follow a cyclical pattern. The three main components of this initiative are: 1) SEA context and strategic focus, 2) Pathways for sustainability and guidelines, and 3) A continuous stage of follow-up, process linkages, and engagement (Partidário MR, 2012). As recognized by Geneletti (2015), using an ecosystem services approach in SEA helps communicate more effectively with stakeholders and decision makers by offering a more comprehensive assessment of the socio-ecological system.

An ES approach in SEA enables the identification of the services and benefits provided by ecosystems, as well as the design of measures to improve or support them. Identifying key ES in relation to important management and planning variables, as CDFs, enhances engagement with stakeholders involved in the planning or use of the region. From this point, it becomes possible to develop scenarios that will help achieve the desired goals and principles for the area of interest.

The System of Environmental and Economic Accounting—Ecosystem Accounting (SEEA EA) statistically integrate biophysical data on ecosystems to measure the services they provide. This framework monitors changes in ecosystems and assesses the value of their services in response to economic and human activities (United Nations, 2021b). The SEEA has also developed a reference list of ecosystem services for each type of ecosystem on Earth (United Nations, 2021a). For this research, to identify the ecosystems and services present in Wells Gray Provincial Park, the Artificial Intelligence for Environment and Sustainability (ARIES, 2021) tool, developed for SEEA by k.LAB (2021), was

used. This list of ecosystems and ES represents the CDFs that will guide management decisions in future scenarios generated by ClimateBC_MAP. This will enable future adaptation strategies to be planned in line with the ecosystem principles developed in this research.

Ecosystem-Based Approach for Wells Gray Provincial Park

The classification of land covers and their assigned use in a region represent the complexity and dynamism of a territory. However, the changes that occur in these do not follow linear patterns, generating complex and emergent hierarchies (Xiao et al., 2022). Planning a territory and managing its ecosystems becomes challenging due to this complexity. Linking ecosystems to land cover classifications can aid planning decision-making processes. However, because ecosystems extend beyond the visible boundaries of land cover features, the use of complex ecosystem-based approaches is needed. For this research, I established links between ecosystems and land cover types, as well as between ecosystems and BEC zones, to incorporate ecosystem functions into land use decisions. To protect and restore ecosystems and limit the development of land uses that affect and deteriorate them, land use goals must be aligned with the functions of the ecosystems that are to be preserved.

Once the ecosystems and ES were identified, and the land cover data (Canada Centre for Remote Sensing, 2022) and BEC data (Government of British Columbia, 2025) for Wells Gray Provincial Park were mapped, GIS¹⁷ software (ESRI, 2024a) was used to establish spatial interconnections between ecosystems, land covers, and BEC zones. To create these interconnections, the Intersect tool was used to calculate the geometric intersection between input layers (e.g., Ecosystems vs. Land Covers and Ecosystems vs. BEC zones). This step generated a new output feature class representing only the overlapping areas, which was useful to find shared spatial extents between datasets (ESRI,

¹⁷ A Geographic Information System (GIS) is a tool designed to store, retrieve, manage, display, and analyze all types of geographic and spatial data. GIS software allows the production of maps and other graphic displays of geographic information for analysis and presentation.

2024b). Finally, the Dissolve tool was used to aggregate these intersected features based on specified attributes (ESRI, 2025).

This method enabled the grouping of all land cover types and BEC zones associated with specific ecosystem types. As a result, it becomes possible to assess which ecosystems and ES may be enhanced or affected by a given decision. With this information, decisions regarding the management of a land cover type or BEC zone within Wells Gray Provincial Park can be analyzed by considering the ecosystems they encompass and their interactions. These insights can then be defined as CDFs, setting up a foundation to start strategic thinking models, encourage stakeholder dialogue, and improve decision-making processes within the park's planning context.

BEC Classification Changes due to Climate Change Scenarios for Wells Gray Provincial Park

The ClimateBC_Map (University of British Columbia & Centre for Forest Conservation Genetics, 2023) was used to visualize the changes in the BEC of Wells Gray Provincial Park. ClimateBC_MAP allows visualization of the iterations performed by the Climate_BC software, which produces high-resolution spatial estimates of temperature and precipitation, as well as a range of other related climate variables, for BC's historical and future climate (Centre of Forest Genetic Conservation, 2024). The software then allows the projection of changes in the province's BEC classification in response to different climate scenarios, such as those projected by the Intergovernmental Panel on Climate Change (IPCC).

In its Sixth Assessment Report (AR6), the IPCC developed a set of pathways that examine how global society, demographics, and the economy might change (Table 3). These pathways are commonly known as the Shared Socio-economic Pathways (SSP) (IPCC, 2023).

SHARED SOCIO-ECONOMIC PATHWAYS	DESCRIPTION
SSP1: Sustainability – Taking the Green Road (Low challenges to mitigation and adaptation)	A world of sustainability-focused growth and equality
SSP2: Middle of the Road (Medium challenges to mitigation and adaptation)	A “middle of the road” world where trends broadly follow their historical patterns
SSP3: Regional Rivalry – A Rocky Road (High challenges to mitigation and adaptation)	A fragmented world of “resurgent nationalism”

SSP4: Inequality – A Road Divided (Low challenges to mitigation, high challenges to adaptation)	A world of ever-increasing inequality
SSP5: Fossil-fueled Development – Taking the Highway (High challenges to mitigation, low challenges to adaptation)	A world of rapid and unconstrained growth in economic output and energy use

Table 3 Shared Socio-economic Pathways (Hausfather, 2018; Riahi et al., 2017)

There are also four Representative Concentration Pathways (RCP) that describe different levels of greenhouse gases that could occur in the future (Table 4).

REPRESENTATIVE CONCENTRATION PATHWAYS	DESCRIPTION	RADIATIVE FORCING ¹⁸	TEMP ANOMALY (°C)
RCP2.6	Mitigation scenario that aims to limit the global average temperature increase to 2°C. This scenario represents a medium development scenario for population, income, energy use, and land use.	Radiative forcing peaks at approximately 3 W/m ² before 2100 and then declines	1.5
RCP4.5	Mitigation scenario that addresses long-term GHG emissions, short-lived species, and land use and cover within a global economic framework. Achieving this scenario will require changes in the energy system, including a transition to electricity, lower-emission energy technologies, and the adoption of carbon capture and geological storage technology.	Radiative forcing is stabilized at approximately 4.5 W/m ² after 2100	2.4
RCP6	Mitigation scenario that considers long-term trends in GHG emissions, short-lived species, and changes in land use and land cover. This scenario assumes that emissions	Radiative forcing is stabilized at approximately 6 W/m ²	3

¹⁸ Radiative forcing is the difference between incoming and outgoing energy in the Earth's climate. When increased GHG result in incoming energy being greater than outgoing energy, the planet will warm due to increased radiative forcing. Some forcings are positive while others, such as those from volcanoes or human-emitted aerosols, are negative (Hausfather, 2018).

REPRESENTATIVE CONCENTRATION PATHWAYS	DESCRIPTION	RADIATIVE FORCING ¹⁸	TEMP ANOMALY (°C)
	are reduced cost-effectively in each period through a global emissions trading market.		
RCP8.5	Scenario based on assumptions of high population and relatively slow income growth with modest rates of technological change and improvements in energy intensity, leading to high energy demand and GHG emissions in the long term in the absence of climate change policies.	Radiative forcing reaches >8.5 W/m ² by 2100 and continues to rise for some amount of time	4.9

Table 4 Representative Concentration Pathways (Van Vuuren et al., 2011; Thomson et al., 2011; Masui et al., 2011; Riahi et al., 2011)

The RCPs did not initially include socio-economic narratives. In response, the AR6 incorporate climate scenario model developed five Shared Socio-economic Pathways (SSPs), which were combined with the RCPs (Hausfather, 2018). These SSPs outline five potential scenarios for the evolution of the world in the absence of climate policy, as well as the varying levels of climate change mitigation that could be achieved by aligning the RCPs' mitigation targets with the SSPs (Riahi et al., 2017). According to Hausfather (2018), the SSP and RCP pathways were designed to be complementary. While the RCPs define scenarios for greenhouse gas concentrations and potential warming by the end of the century, the SSPs focus on whether emission reductions will be achieved under different socio-economic conditions. The SSP reference scenarios represent a range of potential outcomes in the absence of additional climate policies, so it was crucial to examine how different levels of mitigation and adaptation would align with the future described by each SSP. Mitigation targets are defined by levels of radiative forcing (measured in watts per square meter), consistent with the RCPs, which establish target greenhouse gas concentrations and corresponding radiative forcing levels for 2100 (Hausfather, 2018). To address

this, models were run for each SSP in relation to the RCPs, producing the emission scenarios named by the IPCC in AR6. The new set of emission scenarios in AR6 are SSP126, SSP245, SSP370, SSP460, and SSP585.

For this research, the SSP245 scenario was selected to visualize changes in the BEC zones of Wells Gray Provincial Park. This scenario was chosen because it represents a world where social, economic, and technological trends do not significantly deviate from historical patterns, but where governments and institutions are working towards sustainable development goals. In this context, COP15 targets will persist, but progress into achieving them will be slow. The scenario also reflects the degradation of environmental systems, with some improvements observed in the various global environmental monitoring indicators. It generally suggests a decrease in resource and energy intensity, possibly due to the energy transitions in several countries. Additionally, it estimates moderate and stabilized population growth in the second half of the century but highlights continued challenges in reducing vulnerability to social and environmental changes (Riahi et al., 2017).

The models obtained from this process set the basis for planning scenarios through which the Wells Gray Master Plan can develop strategies that prioritize the maintenance of ecosystems and ES. And if combined with the CDFs identified through the ecosystem mapping process and the insights obtained from the ecosystem-based approach, these results can guide future management strategies for the park in a better-informed and sustainable manner.

Research Positionality

I was born and raised in Colombia, a South American country with diverse landscapes, ecosystems, and cultures. My entire professional life, I have been involved in the development of infrastructure projects in different regions of the country where planning strategies were a critical issue. However, it was always a challenge to create precise actions when information was scarce, or regional areas did not have clear goals for how they wanted to develop their territories. Inserting a development idea when ecological and social systems are unknown

can foster uncertainty. Consequently, actions arose only to manage temporary problems instead of contemplating long-term ones for the benefit of nature and communities.

The goal of pursuing my master's evolved with the idea of studying how environmental and social data could be better integrated into planning processes, especially when different interests are established for a region. Considering that environmental data in Canada is well documented and, most importantly, available for public use, understanding how nature and biodiversity were managed in Canada was the first step to fully comprehend how planning processes worked. However, as I advanced my research, it became quite obvious that, despite Canada's commitment to achieve the conservation goals proposed by COP15, economic pressures (related to resource extraction) and shifting political contexts have created challenges and gaps that need to be addressed. For this reason, the idea to establish ecosystem principles for the management of a territory emerged as an opportunity to connect both worlds, because it is not possible to have a prosperous society without healthy ecological systems. Planning ecosystems for their maintenance and improvement is the only way we can balance our needs within the economy of the living world.

Thesis Overview

This thesis is divided into five chapters. Chapter 1 provides an overview of the commitments made by the Canadian government to meet the goals of the Convention on Biological Diversity. It also presents the literature review, outlines the purpose of the research, and describes the methodological approach and methods used to develop the project.

Chapter 2 provides a general overview of the various federal, provincial, and territorial policies and guidelines for the establishment and management of PAs in Canada. It discusses some of the barriers that stakeholders consider limit the achievement of conservation goals from a legal perspective. The chapter also suggests actions to overcome these barriers.

Chapter 3 presents the most pressing risks facing PAs, as named by various stakeholders. It also features stakeholder perspectives on the connections between land cover and ecosystems to emphasize how these relationships can support decision-making in spatial planning. The chapter includes an analysis of the role of PAs in conservation, recreation, and climate resilience. Additionally, it outlines stakeholder suggestions for rethinking management decision-making processes and explores future directions for PA governance. Finally, the chapter introduces the ecosystem principles that should guide PAs management to address the challenges discussed here and in Chapter 2.

Chapter 4 presents Wells Gray Provincial Park as a case study to demonstrate how ecosystem principles, such as an ecosystem-based approach, can be incorporated into planning processes. It illustrates how the interconnection between land cover types, BEC zones, ecosystems, and ES can help clarify how decisions made within a specific feature interact with ecological systems. Additionally, the chapter provides a climate change analysis of BEC zones, highlighting how projected changes may affect their associated ecosystems and ES.

To conclude, Chapter 5 overviews the significance of the research findings, its limitations, and future research directions or opportunities.

References

- 2020 *Biodiversity Goals and Targets for Canada*. (2016). Minister of Environment and Climate Change Canada. <https://www.biodivcanada.ca/national-biodiversity-strategy-and-action-plan/2020-biodiversity-goals-and-targets-for-canada>
- Adeoye-Olatunde, O. A., & Olenik, N. L. (2021). Research and scholarly methods: Semi-structured interviews. *JACCP: JOURNAL OF THE AMERICAN COLLEGE OF CLINICAL PHARMACY*, 4(10), 1358–1367. <https://doi.org/10.1002/jac5.1441>
- Artificial Intelligence for Environment and Sustainability (ARIES). (2021). *Making science matter in policy where nature counts*. ARIES Project. <https://aries.integratedmodelling.org/>
- BC Parks. (n.d.). *Long-Term Ecological Monitoring Program - Province of British Columbia*. BC Parks. <https://bcparks.ca/conservation/long-term-ecological-monitoring-program/>
- BC Parks. (2013). *Management planning process - For Ecological Reserves, Parks Conservancies, Protected Areas and Recreation Areas*. BC Parks. <https://bcparks.ca/about/management-plans/planning-process/>
- BC Parks. (2024a). *History of BC Parks - Province of British Columbia | BC Parks*. BC Parks. <https://bcparks.ca/about/our-mission-responsibilities/history/>
- BC Parks. (2024b). *Types of parks and protected areas - Province of British Columbia*. BC Parks. <https://bcparks.ca/about/our-mission-responsibilities/types-parks-protected-areas/>
- Brander, L., Schägner, J. P., & De Groot, R. (2022). On the potential use of the Ecosystem Services Valuation Database for valuation in the System of Environmental Economic Accounting. *One Ecosystem*, 7, e85085. <https://doi.org/10.3897/oneeco.7.e85085>
- Braun, V., & Clarke, V. (2012). Thematic analysis. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), *APA handbook of research methods in psychology, Vol 2: Research designs: Quantitative, qualitative, neuropsychological, and biological*. (pp. 57–71). American Psychological Association. <https://doi.org/10.1037/13620-004>
- Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, 11(4), 589–597. <https://doi.org/10.1080/2159676X.2019.1628806>

- Buse, C., Friberg, R., Arnold, L., & Hanna, K. (2020). Unlocking the promise of 'integrated' regional and strategic environmental assessments based on a realist review of the scholarly literature. https://www.echonetwork-reseaecho.ca/s/CEAR_SC_20_1_SSHRC-RSEA-Final-Report.pdf
- Byrne, D. (2022). A worked example of Braun and Clarke's approach to reflexive thematic analysis. *Quality & Quantity*, 56(3), 1391–1412. <https://doi.org/10.1007/s11135-021-01182-y>
- Canada Centre for Remote Sensing. (2022). *2020 Land Cover of Canada - Open Government Portal*. Open.canada.ca; Natural Resources Canada. <https://open.canada.ca/data/en/dataset/ee1580ab-a23d-4f86-a09b-79763677eb47>
- Centre of Forest Genetic Conservation. (2024). *ClimateBC* (University of British Columbia, Ed.). Climatebc.ca. <https://climatebc.ca/>
- Ceschin, F., & Gaziulusoy, I. (2020). *Design for sustainability: a multi-level framework from products to socio-technical systems*. Routledge/Taylor & Francis Group.
- Conservation through Reconciliation Partnership. (2023). *About IPCAs*. CRP Website. <https://conservation-reconciliation.ca/about-ipcas>
- Costanza, R., De Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutton, P., Farber, S., & Grasso, M. (2017). Twenty years of ecosystem services: How far have we come and how far do we still need to go? *Ecosystem Services*, 28, 1–16.
- Convention on Biological Diversity. (2018). *COP 14: Fourteenth meeting of the Conference of the Parties to the Convention on Biological Diversity*. Convention on Biological Diversity. <https://www.cbd.int/meetings/COP-14>
- Convention on Biological Diversity. (2022). *COP15: Final text of Kunming-Montreal Global Biodiversity Framework available in all UN languages*. Convention on Biological Diversity. <https://www.cbd.int/article/cop15-final-text-kunming-montreal-qbf-221222>
- Dalal-Clayton, D. B., & Sadler, B. (2005). *Strategic environmental assessment: a sourcebook and reference guide to international experience*. Earthscan.
- Data Basin, & Conservation Biology Institute. (2020). *Canada Ecoregions | Data Basin*. Databasin.org. <https://databasin.org/datasets/6dfe01568b844a5c84549670552221b2/>

- De Groot, R. S., Alkemade, R., Braat, L., Hein, L., & Willemen, L. (2010). Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. *Ecological Complexity*, 7(3), 260–272. <https://doi.org/10.1016/j.ecocom.2009.10.006>
- Dudley, N. (Ed.). (2013). *Guidelines for applying protected area management categories*. IUCN. <https://portals.iucn.org/library/node/9243>
- Environment and Climate Change Canada. (2021). *Canada Target 1 Challenge*. [Www.canada.ca. https://www.canada.ca/en/environment-climate-change/services/nature-legacy/canada-target-one-challenge.html](https://www.canada.ca/en/environment-climate-change/services/nature-legacy/canada-target-one-challenge.html)
- Environment and Climate Change Canada. (2022). *Other Effective area-based Conservation Measures*. [Www.canada.ca. https://www.canada.ca/en/environment-climate-change/services/nature-legacy/other-effective-area-based-measures.html](https://www.canada.ca/en/environment-climate-change/services/nature-legacy/other-effective-area-based-measures.html)
- Environment and Climate Change Canada. (2024). *Canada's conserved areas*. [Www.canada.ca. https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/conserved-areas.html](https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/conserved-areas.html)
- Environment and Climate Change Canada. (2025). *Biodiversity indicators*. [Www.canada.ca. https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/biodiversity.html](https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/biodiversity.html)
- ESRI. (2024a). *What is GIS? | Geographic Information System Mapping Technology*. [Esri.com. https://www.esri.com/en-us/what-is-gis/overview](https://www.esri.com/en-us/what-is-gis/overview)
- ESRI. (2024b). *How Intersect works—ArcGIS Pro | Documentation*. [Pro.arcgis.com. https://pro.arcgis.com/en/pro-app/latest/tool-reference/analysis/how-intersect-analysis-works.htm](https://pro.arcgis.com/en/pro-app/latest/tool-reference/analysis/how-intersect-analysis-works.htm)
- ESRI. (2025). *How Dissolve (Data Management) works—ArcGIS Pro | Documentation*. [Arcgis.com. https://pro.arcgis.com/en/pro-app/latest/tool-reference/data-management/h-how-dissolve-data-management-works.htm](https://pro.arcgis.com/en/pro-app/latest/tool-reference/data-management/h-how-dissolve-data-management-works.htm)
- European Commission. (2016). Interview: Will Steffen and Katherine Richardson discuss making Planetary Boundaries relevant to policy makers. *The beyond GDP Newsletter*, 2518-3427. <https://ec.europa.eu/newsroom/env/newsletter-archives/1380>
- Gaziulusoy, A. İ., & Ryan, C. (2017). Roles of design in sustainability transitions projects: A case study of Visions and Pathways 2040 project from Australia. *Journal of Cleaner Production*, 162, 1297–1307. <https://doi.org/10.1016/j.jclepro.2017.06.122>

- Gaziulusoy, İ., & Erdoğan Öztekin, E. (2019). Design for Sustainability Transitions: Origins, Attitudes and Future Directions. *Sustainability*, 11(13), 3601. <https://doi.org/10.3390/su11133601>
- Geneletti, D. (2015). A Conceptual Approach to Promote the Integration of Ecosystem Services in Strategic Environmental Assessment. *Journal of Environmental Assessment Policy and Management*, 17(04), 1550035. <https://doi.org/10.1142/S1464333215500350>
- Government of British Columbia. (2015). *Cumulative Effects Framework - Province of British Columbia*. Gov.bc.ca. <https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/cumulative-effects-framework>
- Government of British Columbia. (2025). *Data Catalogue: BEC Map*. Catalogue.data.gov.bc.ca. <https://catalogue.data.gov.bc.ca/dataset/bec-map/resource/46ceb84a-3f6d-436c-b4c1-c89beb72d11a>
- Hausfather, Z. (2018). *Explainer: How “Shared Socioeconomic Pathways” explore future climate change*. Carbon Brief. <https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change/>
- Hockings, M., & World Commission on Protected Areas (Eds.). (2006). *Evaluating effectiveness: a framework for assessing the management of protected areas* (2nd. ed). IUCN.
- Hölscher, K., Wittmayer, J. M., & Loorbach, D. (2018). Transition versus transformation: What’s the difference? *Environmental Innovation and Societal Transitions*, 27, 1–3. <https://doi.org/10.1016/j.eist.2017.10.007>
- Impact Assessment Agency of Canada. (2022). *Policy Framework for Strategic Assessment under the Impact Assessment Act*. Www.canada.ca. <https://www.canada.ca/en/impact-assessment-agency/services/policy-guidance/policy-framework-strategic-assessment.html>
- Impact Assessment Agency of Canada. (2025). Policy and guidance. *Canada*. <https://www.canada.ca/en/impact-assessment-agency/services/policy-guidance.html>
- IPCC. (2023). *AR6 Synthesis Report: Climate Change 2023*. Www.ipcc.ch. <https://www.ipcc.ch/report/ar6/syr/>
- k.LAB. (2021). *k.Hub*. Integratedmodelling.org; The SEEA Ecosystem Accounting standard on the ARIES platform. A collaboration between UNSD, UNEP and BC3. <https://integratedmodelling.org/hub/#/home>

- Liu, S., Costanza, R., Farber, S., & Troy, A. (2010). Valuing ecosystem services: Theory, practice, and the need for a transdisciplinary synthesis. *Annals of the New York Academy of Sciences*, 1185(1), 54–78. <https://doi.org/10.1111/j.1749-6632.2009.05167.x>
- McGrath, C., Palmgren, P. J., & Liljedahl, M. (2019). Twelve tips for conducting qualitative research interviews. *Medical Teacher*, 41(9), 1002–1006. <https://doi.org/10.1080/0142159X.2018.1497149>
- Mansuy, N., Staley, D., Alook, S., Parlee, B., Thomson, A., Littlechild, D. B., Munson, M., & Didzena, F. (2023). Indigenous protected and conserved areas (IPCAs): Canada's new path forward for biological and cultural conservation and Indigenous well-being. *FACETS*, 8, 1–16. <https://doi.org/10.1139/facets-2022-0118>
- Masui, T., Matsumoto, K., Hijioka, Y., Kinoshita, T., Nozawa, T., Ishiwatari, S., Kato, E., Shukla, P. R., Yamagata, Y., & Kainuma, M. (2011). An emission pathway for stabilization at 6 Wm⁻² radiative forcing. *Climatic Change*, 109(1–2), 59–76. <https://doi.org/10.1007/s10584-011-0150-5>
- Mori, A. S., Dee, L. E., Gonzalez, A., Ohashi, H., Cowles, J., Wright, A. J., Loreau, M., Hautier, Y., Newbold, T., Reich, P. B., Matsui, T., Takeuchi, W., Okada, K., Seidl, R., & Isbell, F. (2021). Biodiversity–productivity relationships are key to nature-based climate solutions. *Nature Climate Change*, 11(6), 543–550. <https://doi.org/10.1038/s41558-021-01062-1>
- Natural Resources Canada. (2025a). *Forest classification - Natural Resources Canada*. Canada.ca. <https://natural-resources.canada.ca/forest-forestry/sustainable-forest-management/forest-classification>
- Natural Resources Canada. (2025b). *Land Cover - Natural Resources Canada*. Canada.ca. <https://natural-resources.canada.ca/maps-tools-publications/satellite-elevation-air-photos/satellite-imagery/land-cover>
- Nijhum, F., Westbrook, C., Noble, B., Belcher, K., & Lloyd-Smith, P. (2021). Evaluation of alternative land-use scenarios using an ecosystem services-based strategic environmental assessment approach. *Land Use Policy*, 108, 105540. <https://doi.org/10.1016/j.landusepol.2021.105540>
- Noble, B., Gibson, R., White, L., Blakley, J., Croal, P., Nwanekezie, K., & Doelle, M. (2019). Effectiveness of strategic environmental assessment in Canada under directive-based and informal practice. *Impact Assessment and Project Appraisal*, 37(3–4), 344–355. <https://doi.org/10.1080/14615517.2019.1565708>

- Nygrén, N. A. (2019). Scenario workshops as a tool for participatory planning in a case of lake management. *Futures*, 107, 29–44. <https://doi.org/10.1016/j.futures.2018.10.004>
- Olive, A., Finegan, C., & Beazley, K. (Eds.). (2023). *Transformative politics of nature: overcoming barriers to conservation in Canada*. University of Toronto Press.
- Organisation for Economic Co-operation and Development (OECD) (Ed.). (2006). *Applying Strategic Environmental Assessment: good practice guidance for development co-operation*. Organisation for Economic Co-operation and Development.
- Outdoor Recreation Council of BC. (2024). *IPCA 101: What you need to know about Indigenous Protected and Conserved Areas*. Outdoor Recreation Council of BC. <https://www.orcbc.ca/blog/ipca-101>
- Parks Canada. (2018). We rise together: achieving pathway to Canada target 1 through the creation of Indigenous protected and conserved areas in the spirit and practice of reconciliation: the Indigenous Circle of Experts' report and recommendations. Parks Canada. <https://publications.gc.ca/site/eng/9.852966/publication.html>
- Parks Canada Agency. (2023). *Wood Buffalo National Park World Heritage Site Action Plan*. Parks.canada.ca. <https://parks.canada.ca/pn-np/nt/woodbuffalo/info/action>
- Partidário MR. (2012). *Strategic Environmental Assessment Better Practice Guide Methodological guidance for strategic thinking in SEA*. Portuguese Environment Agency and Redes Energéticas Nacionais (REN), SA. <https://www.iaia.org/pdf/special-publications/SEA%20Guidance%20Portugal.pdf>
- Partidario, M. R., & Gomes, R. C. (2013). Ecosystem services inclusive strategic environmental assessment. *Environmental Impact Assessment Review*, 40, 36–46. <https://doi.org/10.1016/j.eiar.2013.01.001>
- Polit, D. F., & Beck, C. T. (2017). *Nursing research: generating and assessing evidence for nursing practice* (10th edition, international edition). Wolters Kluwer.
- Riahi, K., Rao, S., Krey, V., Cho, C., Chirkov, V., Fischer, G., Kindermann, G., Nakicenovic, N., & Rafaj, P. (2011). RCP 8.5—A scenario of comparatively high greenhouse gas emissions. *Climatic Change*, 109(1–2), 33–57. <https://doi.org/10.1007/s10584-011-0149-y>

- Riahi, K., Van Vuuren, D. P., Kriegler, E., Edmonds, J., O'Neill, B. C., Fujimori, S., Bauer, N., Calvin, K., Dellink, R., Fricko, O., Lutz, W., Popp, A., Cuaresma, J. C., Kc, S., Leimbach, M., Jiang, L., Kram, T., Rao, S., Emmerling, J., ... Tavoni, M. (2017). The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview. *Global Environmental Change*, 42, 153–168. <https://doi.org/10.1016/j.gloenvcha.2016.05.009>
- Richardson, K., Steffen, W., Lucht, W., Bendtsen, J., Cornell, S. E., Donges, J. F., Drüke, M., Fetzer, I., Bala, G., Von Bloh, W., Feulner, G., Fiedler, S., Gerten, D., Gleeson, T., Hofmann, M., Huiskamp, W., Kummu, M., Mohan, C., Nogués-Bravo, D., ... Rockström, J. (2023). Earth beyond six of nine planetary boundaries. *Science Advances*, 9(37), eadh2458. <https://doi.org/10.1126/sciadv.adh2458>
- Statistics Canada. (2021). *Non-probability sampling*. Statcan.gc.ca. <https://www150.statcan.gc.ca/n1/edu/power-pouvoir/ch13/nonprob/5214898-eng.htm>
- Stockholm Resilience Centre. (2023). *Planetary boundaries - Stockholm Resilience Centre*. Stockholmresilience.org. <https://www.stockholmresilience.org/research/planetary-boundaries.html>
- Sustainability Directory. (2025). *Sociotechnical Transitions*. Prism Sustainability Directory. <https://prism.sustainability-directory.com/term/sociotechnical-transitions/>
- Therivel, R., & González, A. (2020). Is SEA worth it? Short-term costs v. long-term benefits of strategic environmental assessment. *Environmental Impact Assessment Review*, 83, 106411. <https://doi.org/10.1016/j.eiar.2020.106411>
- Thomson, A. M., Calvin, K. V., Smith, S. J., Kyle, G. P., Volke, A., Patel, P., Delgado-Arias, S., Bond-Lamberty, B., Wise, M. A., Clarke, L. E., & Edmonds, J. A. (2011). RCP4.5: a pathway for stabilization of radiative forcing by 2100. *Climatic Change*, 109(1–2), 77–94. <https://doi.org/10.1007/s10584-011-0151-4>
- Unalan, D., & Cowell, R. (2019). Strategy, context and strategic environmental assessment. *Environmental Impact Assessment Review*, 79, 106305. <https://doi.org/10.1016/j.eiar.2019.106305>
- UNEP-WCMC. (2025). *Protected Area Profile for Canada from the World Database on Protected Areas*. Protected Planet. <https://www.protectedplanet.net/country/CAN>

- United Nations. (2021a). *Ecosystem Accounting | System of Environmental Economic Accounting*. Seea.un.org. <https://seea.un.org/ecosystem-accounting>
- United Nations. (2021b). *ARIES for SEEA | System of Environmental Economic Accounting*. Seea.un.org. <https://seea.un.org/content/aries-for-seea>
- University of British Columbia, & Centre for Forest Conservation Genetics. (2023). *ClimateBC_Map*. Climatebc.ca. <https://climatebc.ca/mapVersion>
- Van Vuuren, D. P., Stehfest, E., Den Elzen, M. G. J., Kram, T., Van Vliet, J., Deetman, S., Isaac, M., Klein Goldewijk, K., Hof, A., Mendoza Beltran, A., Oostenrijk, R., & Van Ruijven, B. (2011). RCP2.6: exploring the possibility to keep global mean temperature increase below 2°C. *Climatic Change*, 109(1–2), 95–116. <https://doi.org/10.1007/s10584-011-0152-3>
- Von Flittner, Z. F., Gaziulusoy, I., Nielsen, S., & Marttila, S. (2022). Design for Sustainability Transitions: Reflections on Practice. *Cuadernos Del Centro de Estudios de Diseño y Comunicación*, 157. <https://doi.org/10.18682/cdc.vi157.6850>
- West Coast Environmental Law. (2016). Regional Strategic Environmental Assessment for Northern British Columbia: The Case and the Opportunity | West Coast Environmental Law. Wcel.org. <https://www.wcel.org/publication/regional-strategic-environmental-assessment-northern-british-columbia-case-and>
- Xiao, Y., Huang, M., Xie, G., & Zhen, L. (2022). Evaluating the impacts of land use change on ecosystem service values under multiple scenarios in the Hunshandake region of China. *Science of The Total Environment*, 850, 158067. <https://doi.org/10.1016/j.scitotenv.2022.158067>

CHAPTER 2

The Politics of Nature: Legislative Gaps and the Management of Protected Areas

This chapter examines the network of protected areas (PAs) and other effective area-based conservation measures (OECMs) in Canada and explains how they are established and monitored. It also provides a general description of the federal, provincial, and territorial laws and policies that govern PAs, with a particular focus on the policies, guidelines, and measures that BC has in place for the management of PAs. The Canadian Protected and Conserved Areas Database, managed by Environment and Climate Change Canada (ECCC) and the Canadian Council on Ecological Areas, reports that PAs represent 13.7% and 14.7% of Canada's national marine and terrestrial area (Figure 2), respectively (ECCC, 2024a).

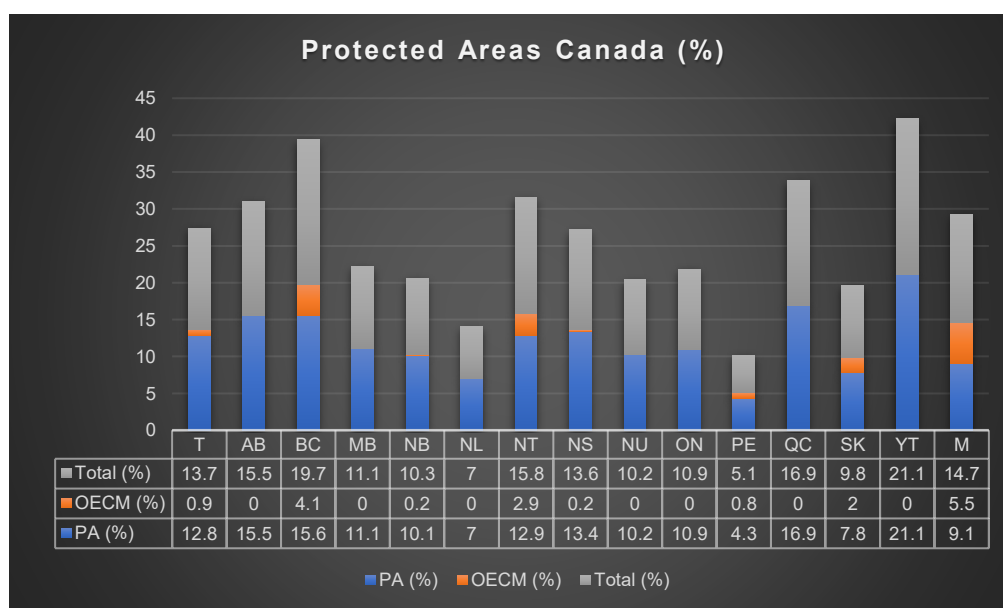


Figure 2 Percentage of Canada's Protected Areas by National Terrestrial and Marine Designations, by Provinces and Territories (ECCC, 2024a)¹⁹

¹⁹ T: National Terrestrial, AB: Alberta, BC: British Columbia, MB: Manitoba, NB: New Brunswick, NL: Newfoundland and Labrador, NT: Northwest Territories, NS: Nova Scotia, NU: Nunavut, ON: Ontario, PE: Prince Edward Island, QC: Quebec, SK: Saskatchewan, YT: Yukon, M: National Marine

The database also includes all conserved areas in Canada's provinces and territories (Figure 3) and presents them in two main categories: Protected Areas (PA) and Other Effective Area-based Conservation Measures (OECM).

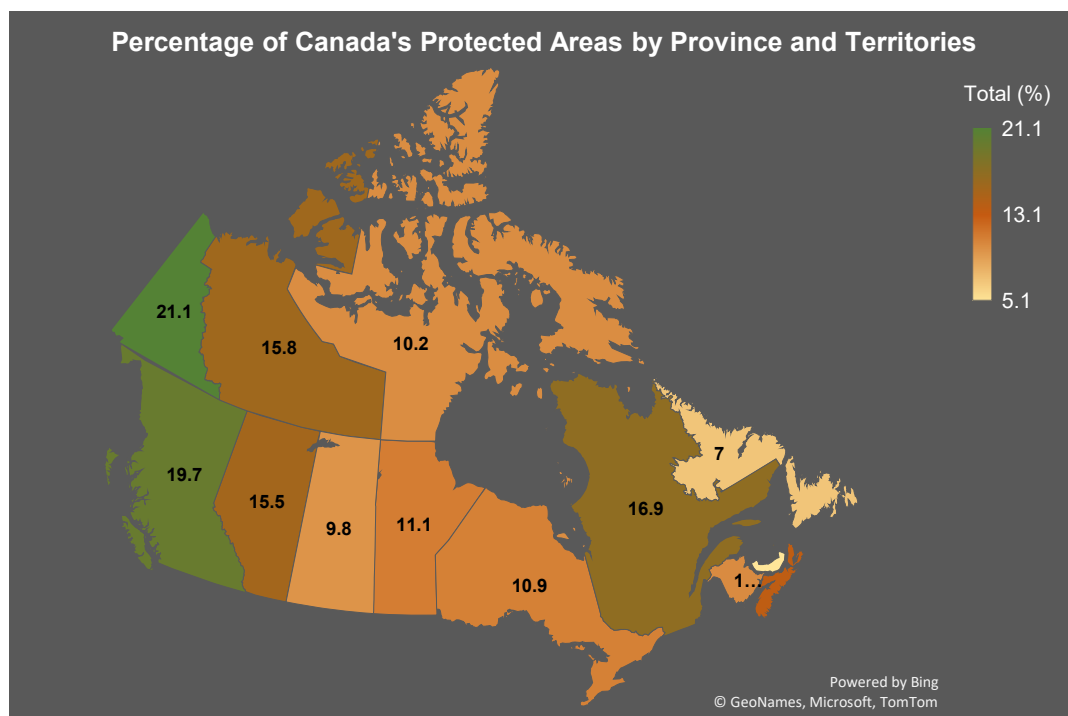


Figure 3 Percentage of Canada's Protected Areas by Provinces and Territories (ECCC, 2024a)

This section also presents an overview of the perspectives shared by interviewees with experience in PAs management and shows key barriers within the current political framework that interfere with progress toward the 30-by-30 conservation target. It also explores proposed solutions, including the integration of Indigenous rights and traditional ecological knowledge (TEK) and the recognition of ecosystem services (ES). Other approaches include the adoption of adaptive and resilient management strategies in response to climate change and the inclusion of diverse stakeholders in decision-making processes to overcome these gaps.

Federal

Canada's vast landscape encompasses a wide variety of natural areas and ecological features. The federal government's guiding purpose for the management of PAs emphasizes the importance of preserving and supporting these features through its primary goal of meeting national and international obligations in the areas of heritage recognition and preservation. This includes the identification, protection, and enjoyment of places that serve as notable examples of Canada's cultural and natural heritage. According to Parks Canada Agency (2008), its goal is to promote public knowledge, appreciation, and enjoyment of these areas while ensuring their long-term ecological integrity.

From the archival research base (Parks Canada Agency, Justice Laws Website²⁰, and the Canadian Legal Information Institute – CanLII²¹), there are 20 specific acts at the federal level to ensure the creation and management of Canada's PAs, as well as historic and heritage places (Appendix C). However, for the purpose of this research, the focus will be set on those that are related to the establishment, management, and protection of various types of PAs, ensuring the conservation of natural heritage.

The acts highlighted in Appendix C are federal laws that mainly govern areas under federal jurisdiction, but they often require collaboration with provincial and territorial governments to ensure effective conservation and management of PAs across Canada. Each province and territory also have its own set of laws and regulations to manage their specific PAs, which follow the principles and purposes of these federal legislations.

From the acts listed in Appendix C, special attention should be given to the Nature Accountability Act (Bill C-73), introduced by the ECCC in 2024. This act emerges from the goals set by the Kunming-Montréal Global Biodiversity Framework (COP15)²². The objective of the Bill is to establish effective

²⁰ Online source of the consolidated Acts and regulations of Canada. This website provides access to federal Acts and regulations. [Justice Laws Website](#)

²¹ A not-for-profit organization that provides efficient and open online access to judicial decisions and legislative documents from all Canadian jurisdictions. [Canadian Legal Information Institute | CanLII](#)

²² COP15: Final text of Kunming-Montreal Global Biodiversity Framework (CBD, 2022)

stewardship of Canada's natural environments that require action by all levels of government. The key elements of the Act include (ECCC, 2024b):

- Protecting biodiversity by aiming to conserve 30% of Canada's lands and waters by 2030.
- Restoring ecosystems, with a target to rehabilitate at least 30% of degraded ecosystems by 2030.
- Strengthening Indigenous conservation leadership by emphasizing the role of Indigenous knowledge and governance in conservation efforts.
- Integrating nature-based solutions to mitigate the impacts of climate change on biodiversity.

The Nature Accountability Act mandates the creation of national biodiversity strategies, like Canada's 2030 National Biodiversity Strategy (Government of Canada, 2024), and action plans to ensure the government reports on progress and follows international biodiversity commitments. The federal government has determined 23 specific targets to implement Canada's 2030 Nature Strategy. The targets include the following: a statement of the goal, the current status, the challenges and opportunities that need to be addressed, the actions that are being held, and other actions that are required to move forward. The targets of Canada's 2030 Nature Strategy can be summarised in three categories: i) *Reducing threats to biodiversity*, which includes addressing the drivers of biodiversity loss, protecting and conserving land and water ecosystems, restoring degraded ecosystems, and recovering species; ii) *Meeting people's needs*, which includes actions to value ES, sustainably manage biological resources, and share the benefits from the use of genetic resources; and iii) *Providing tools and solutions*, by supporting inclusive decision-making, mobilising resources, and sharing tools that improve guidance and track progress on the actions set out to achieve the 30-by-30 goal. To ensure that targets are met, Canada's 2030 Nature Strategy establishes the Domestic Biodiversity Monitoring Framework, which incorporates indicators set by the COP15. This framework is designed to measure biodiversity status, assess the implementation

of planned interventions, and evaluate the effectiveness of these efforts (Government of Canada, 2024). However, a significant number of these indicators lack updated methodologies and, according to the strategy document, continue under development. At the time of this research, the Nature Accountability Act was at second reading in the House of Commons.

National Parks, Reserves and National Marine Conservation Areas

The Parks Canada Agency indicates that there are 37 national parks, 10 national park reserves, and one national urban park. BC is the province with the highest number of national parks, followed by Ontario (Figure 4). Also, there are 5 national marine conservation areas distributed in the provinces of Ontario, BC, Quebec and the territory of Nunavut (Figure 5).



Figure 4 Canada's National Parks and Reserves by Provinces and Territories (Parks Canada Agency, 2022)

wetland ecosystems remained stable. While 100% of glaciers were melting, 29% of forests were shrinking, and 21% of freshwater habitats were deteriorating. Improvements were only observed in 17% of wetlands, 15% of freshwater environments, and 13% of forest ecosystems (ECCC, 2024c).

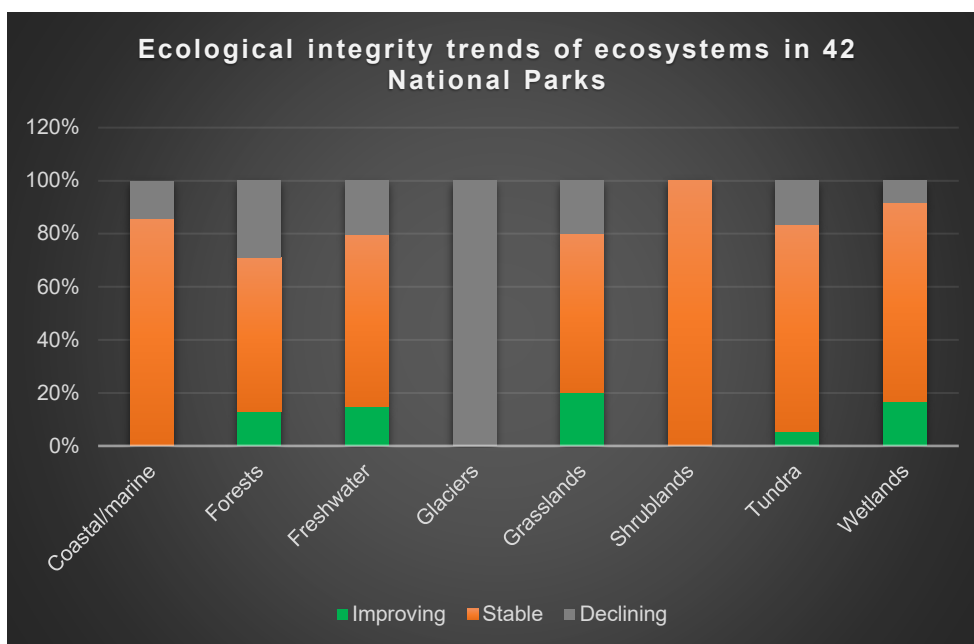


Figure 6 Ecological integrity trends of ecosystems in 42 National Parks (ECCC, 2024c)

Parks Canada Agency (2021), in the State of Canada's Natural and Cultural Heritage Places report, establishes that the Government of Canada is committed to preserve and protect the natural environment through the expansion of the national park system. This goal addresses the two most pressing environmental challenges: biodiversity loss and climate change. In this context, PAs offer numerous benefits by playing a central role in biodiversity conservation, ES maintenance, landscape connectivity, carbon storage, and sequestration. In addition, PAs support research and education, helping to raise public awareness among those who visit and enjoy these natural spaces.

Parks Canada uses a variety of strategies and actions to protect and restore PAs to enhance their ecological integrity. It is recognized that each ecosystem responds in a unique way to the factors that affect it and to management interventions. To maintain and improve ecological integrity and to

validate the ecological benefits of management actions, a considerable amount of time is required to demonstrate the ecological benefits of management actions. However, understanding the trends of the different types of ecosystems that exist in PAs is a key step, not only to analyze the condition of these areas but also to define the most effective ways to manage them (ECCC, 2024c). It is critically valuable for Parks Canada to define how PAs will be planned, established, managed, and connected to respond to the challenges associated with climate change.

The national parks established today are facing significant environmental changes, meaning their current ecological state may not exist in the future. This situation raises essential questions about how these areas should be defined. Should these areas be planned and managed according to their current ecological characteristics or according to the changes they will experience in the future? Aspects such as size and boundaries must also be considered in order to address the impacts of rapid ecological change due to climate change (Parks Canada Agency, 2021).

National Wildlife Areas and Migratory Bird Sanctuaries

According to ECCC, the country has a total of 58 National Wildlife Areas and 92 Migratory Bird Sanctuaries. As shown in Figure 7 and Figure 8, Ontario has the highest number of National Wildlife Areas, while Newfoundland and Labrador, as well as Prince Edward Island, have none. For Migratory Bird Sanctuaries, Quebec leads with the most, while Manitoba and Yukon have none (ECCC, 2021). These protected areas play a critical and distinctive role in Canada's national network of PAs. Their primary purpose is to safeguard habitats essential for migratory birds and species of national importance, particularly those at risk of extinction (ECCC, 2023).

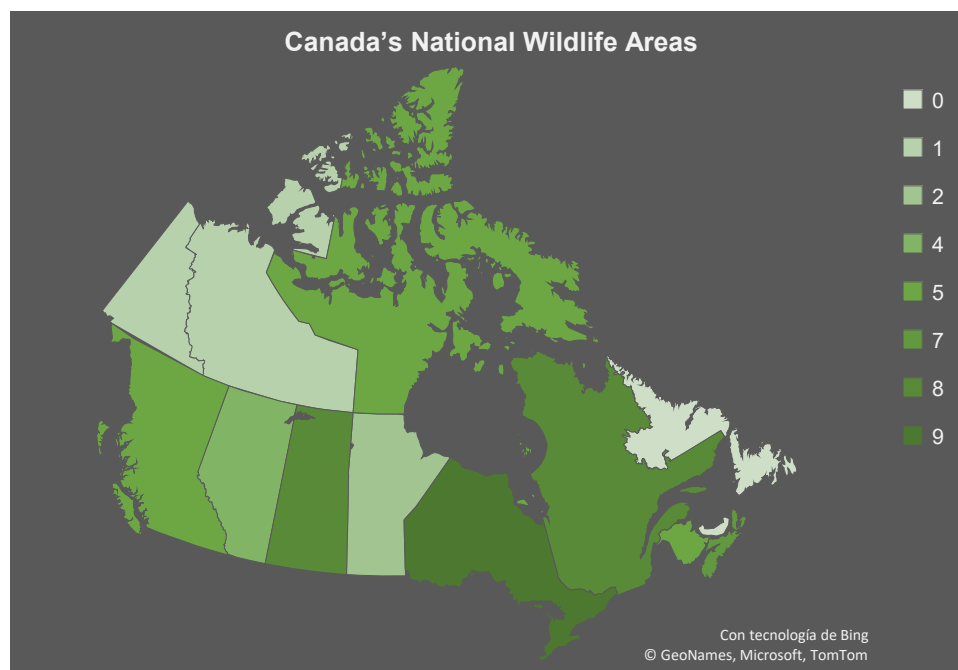


Figure 7 Canada's National Wildlife Areas by Provinces and Territories (ECCC, 2021)

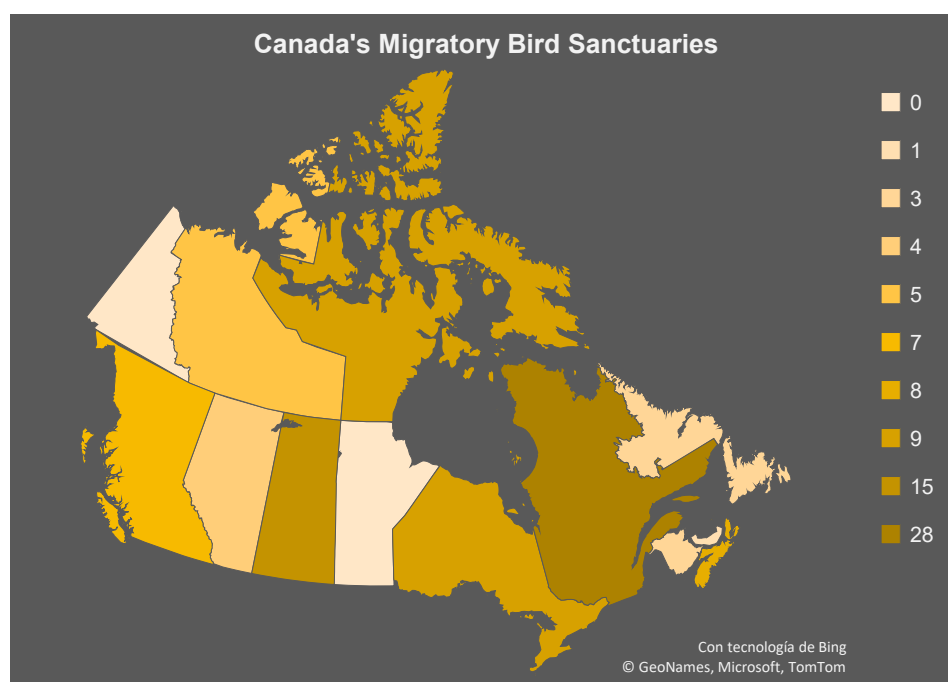


Figure 8 Canada's Migratory Bird Sanctuaries by Provinces and Territories (ECCC, 2021)

For these wildlife and bird sanctuary areas, the ECCC's Protected Areas Program has established a Strategic Program Plan and Vision to 2030. Its primary goals are to protect, maintain, and monitor existing PAs to achieve

conservation objectives; expand Canada's network of PAs to conserve habitat for migratory birds, endangered species, and other wildlife; and increase Canadians' awareness and acknowledge of the values and benefits of the PAs system (ECCC, 2023). The plan's guiding principles are to put conservation first, to evaluate PAs to determine if they are being managed effectively by standardizing systematic biological monitoring across the network, and to address specific challenges that arise in different provinces. To achieve these goals, the plan recognizes the significance of identifying key biodiversity areas, critical habitats, and strategies for bird conservation regions and to measure various biodiversity indicators (ECCC, 2024c). This includes management opportunities with Indigenous peoples and local communities for new areas proposed for protection and other conservation programs.

Provinces and Territories

Canada is divided into 10 provinces and three territories (the Northwest Territories, Yukon, and Nunavut). Each of them has established a set of acts and regulations to fulfill the main purpose that the federal government has defined, which is to preserve and maintain the country's natural heritage. The number of acts per province or territory varies, with some having two and others having up to eight to manage their natural spaces (Figure 9).

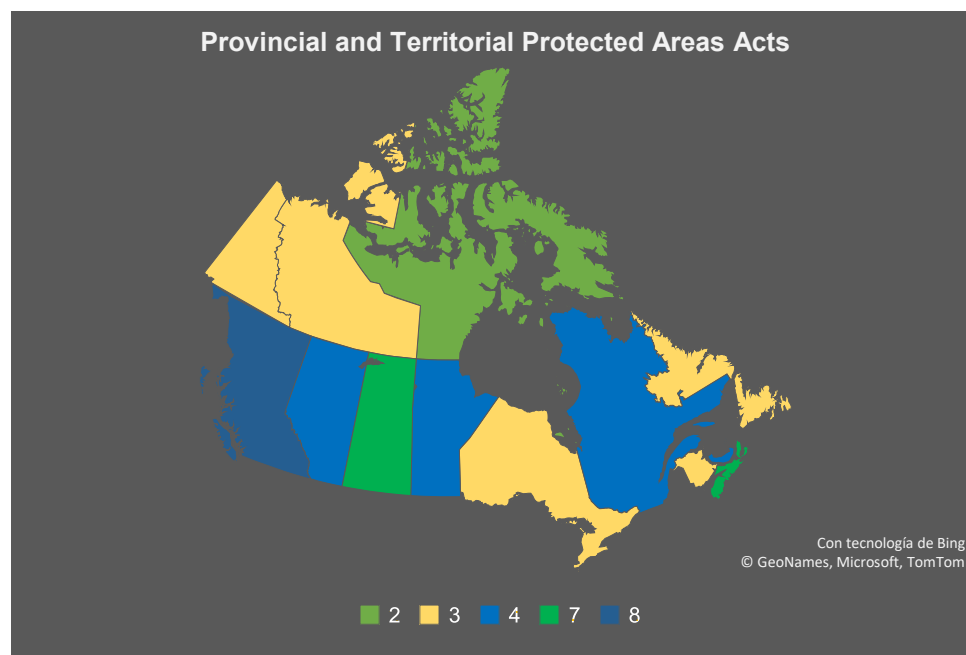


Figure 9 Protected Areas Acts by Provinces and Territories

Maintaining the ecological integrity of natural spaces is the main objective of the federal legislation and guides how these areas are defined and what their purpose is. According to the different provincial web pages and CanLII, the main in-force acts that establish the diverse PAs in each province and territory follow this objective (Appendix D).

In addition to federal legislation, all of Canada's ecozones²⁴ have some level of protection under the various laws that govern how each province or territory protects its land. As shown in Figure 10, nine terrestrial and marine ecozones (Tundra Cordillera, Arctic Basin, Offshore Pacific, Taiga Cordillera, Pacific Maritime, Montane Cordillera, Arctic Cordillera, Eastern Arctic, and Southern Arctic) have more than 20% of their area protected, 13 have between 10 and 20%, and 9 have between less than 1 and 10% (ECCC, 2024a).

²⁴ An ecozone is a large area of land with similar natural features. Each ecozone has its own type of land, climate, plants, animals, and human activities. These areas help understand and manage Canada's different environments (Natural Resources Canada, 2025).

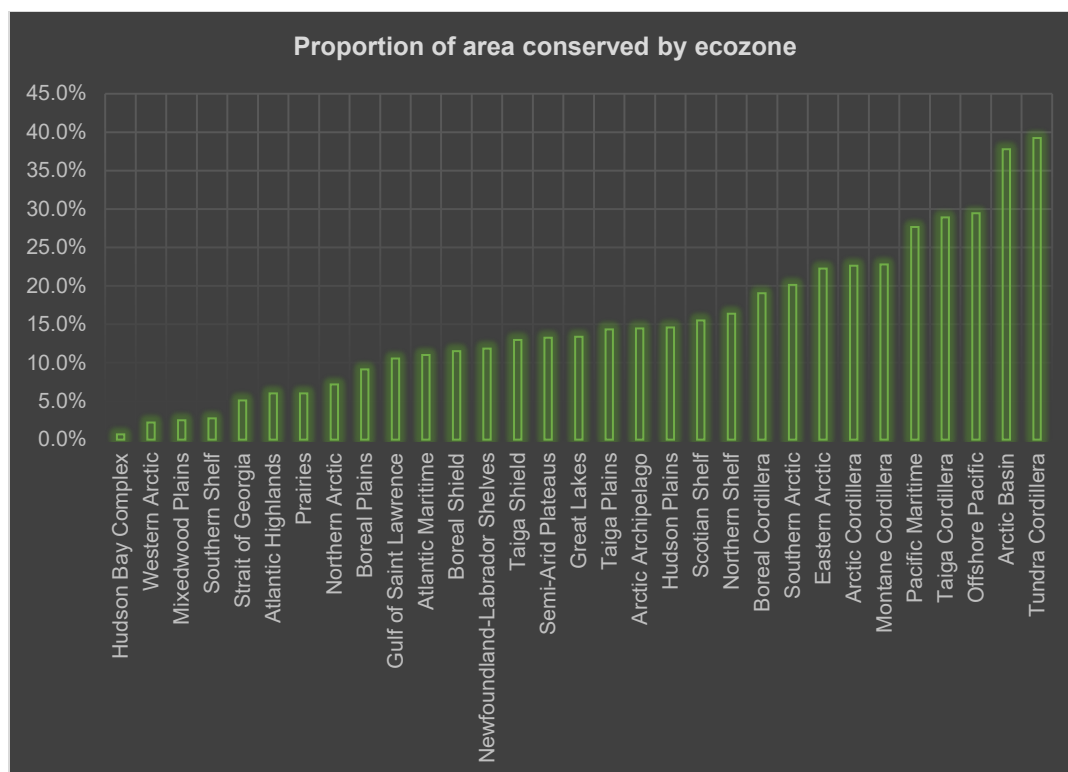


Figure 10 Proportion of area conserved by ecozone (ECCC, 2024a)

Complementary to the various acts and regulations that define the implementation of these PAs, some provinces and territories have developed guidelines and programs to effectively manage and protect the different types of PAs. The guidelines and policies highlighted in Appendix E are those that incorporate the concept of ecological integrity in their objectives and purposes as part of the approach to plan and manage the different types of PAs. In this context, PAs should then respond with the classification of ecozones and ecoregions²⁵ of the provinces or territories, as these play a key role in defining these significant areas.

²⁵ An ecoregion is a specific area within an ecozone that shares similar environmental features like climate, land, plants, and animals. It's a way to group places that have similar natural conditions (Data Basin & Conservation Biology Institute, 2020).

British Columbia

As shown in Appendix D and Appendix E, BC has eight key legislative acts and policies that guide the creation and development of management plans for protected and wilderness areas. However, other actions that indirectly support the 30-by-30 target of the Kunming-Montréal Global Biodiversity Framework (COP15) have also been implemented. For example, the Cumulative Effects Framework measures the effects of natural resource activities on some specific values (Government of British Columbia, 2015). Another relevant initiative is the Climate Preparedness and Adaptation Strategy 2022–2025, which outlines the actions and directions BC is taking to improve both understanding of, and adaptation to, the impacts of climate change (Ministry of Environment and Climate Change Strategy, 2021).

According to the Canadian Protected and Conserved Areas Database, BC has a total of 2407 PAs. These areas include National and Provincial Parks, Conservancies, Ecological Reserves, Protected Areas, Recreational Areas and Wildlife Areas (Figure 11).

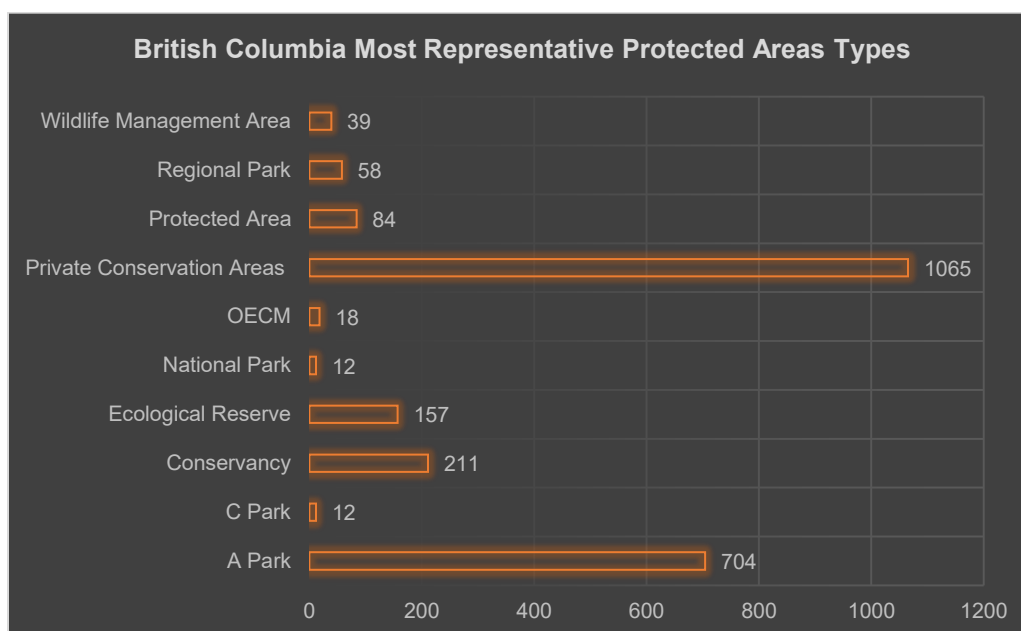


Figure 11 British Columbia's most representative protected area types (ECCC, 2024a)

Although private conservation areas make up nearly half of the different types of PAs (Figure 12), they represent less than 1% of the total land in BC that is protected or conserved under any official land protection status (Figure 13).

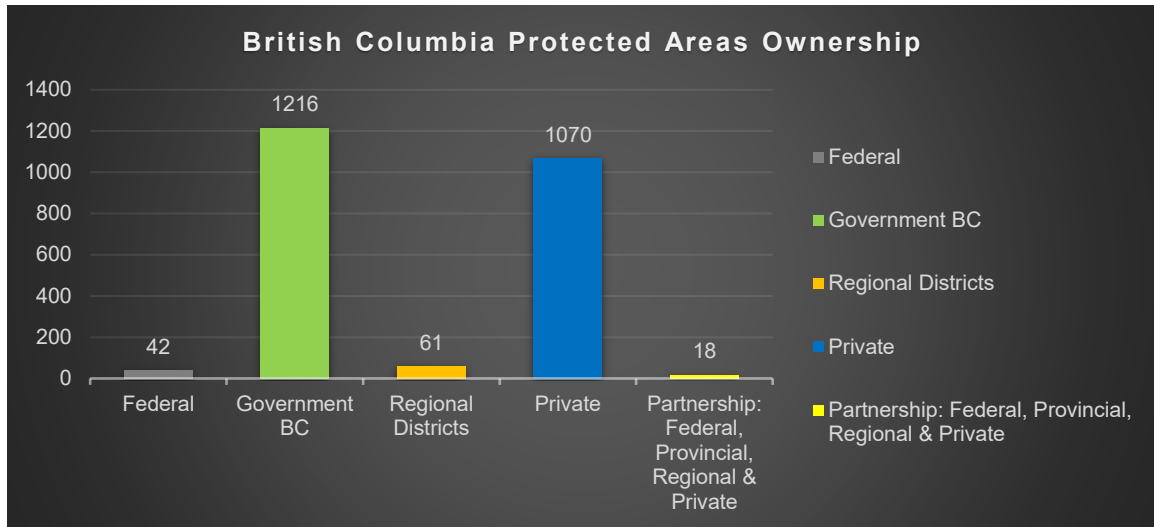


Figure 12 British Columbia Protected Areas Ownership (ECCC, 2024a)

The Protected Areas of British Columbia Act sets aside about 55% of the land for this purpose, and almost 40% is protected under other types of acts and agreements, including federal legislation such as the Wildlife Act and the National Parks Act (Figure 13).

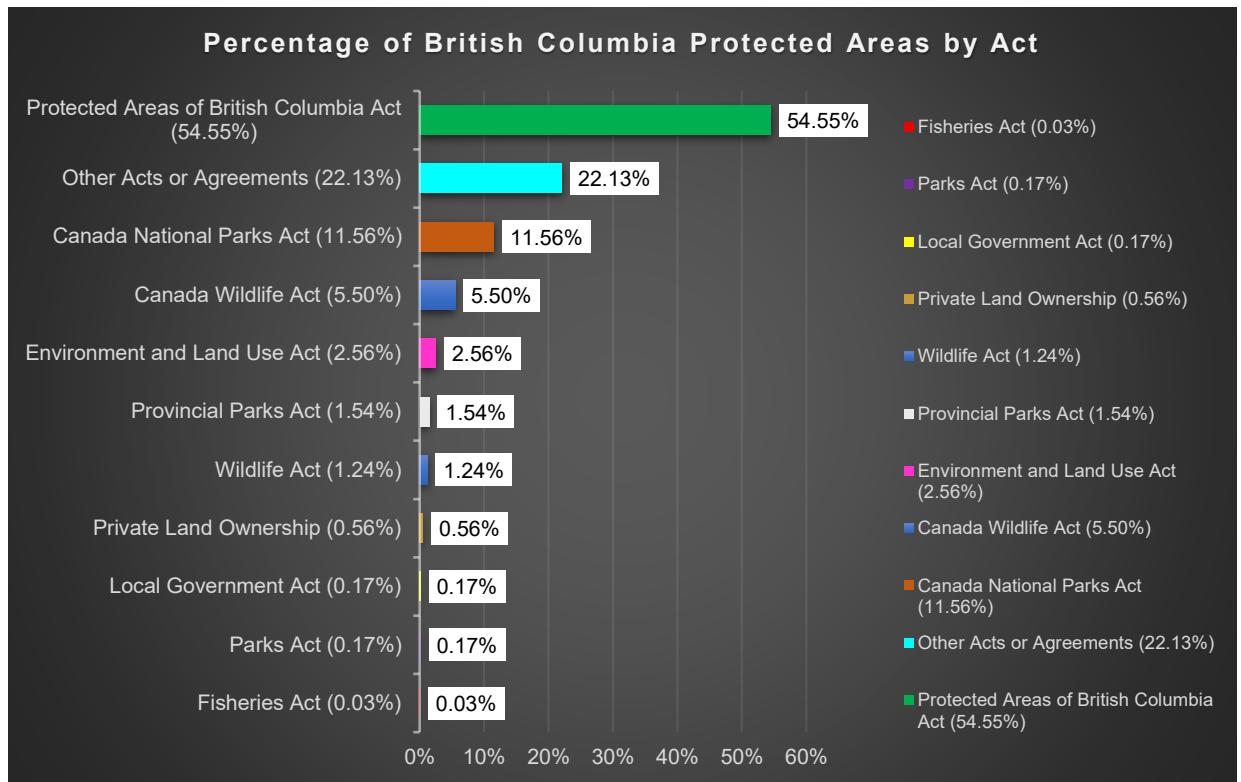


Figure 13 Percentage of British Columbia's area protected by the Act (ECCC, 2024a)

In this context, most of the land dedicated to conservation and protection is managed and was established under federal, provincial, and regional legislation, in response to acts that were enacted to define its ecological value and significance (Figure 14).

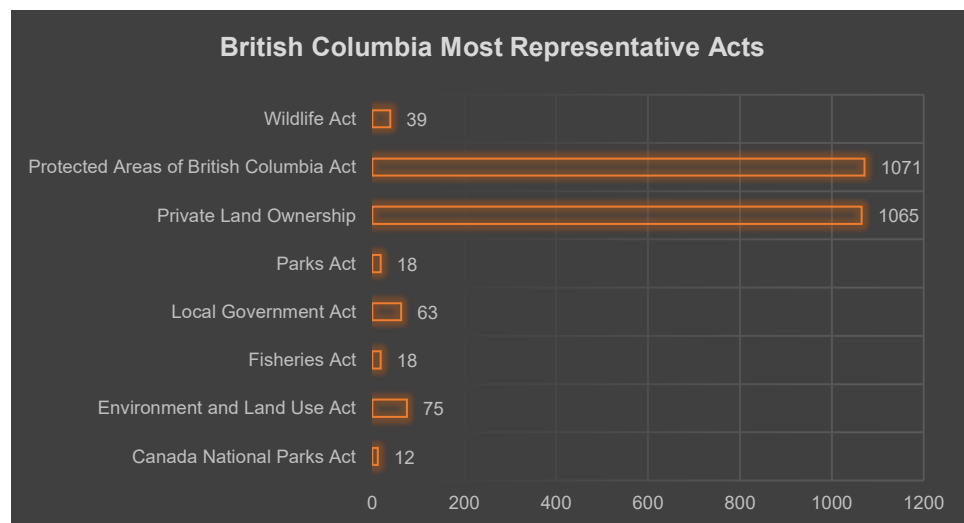


Figure 14 British Columbia's most representative Acts for Protected Areas (ECCC, 2024a)

British Columbia Contribution to the Canada's 2030 Nature Strategy

The BC government is partly committed to the conservation of biodiversity and to maintain the ecosystem health that encompass the province. The province has developed a range of actions, strategies, and frameworks to improve, maintain, and expand the network of PAs. Some of the main guidelines and strategies that incorporate the concept of ecological integrity into their objectives are presented in Appendix E. However, it is imperative to highlight the BC Draft Biodiversity and Ecosystem Health Framework as its main objective is to provide strategic directions to develop the steps necessary to deliver the legislation, policies, and actions needed to facilitate the transition to transformational change in the short term. According to the framework this would be achieved in partnership with First Nations to move from a land management system that somehow privileges resource extraction to a future that prioritises the conservation and management of ecosystem health and biodiversity (Water and Resource Stewardship Ministry of Land, 2023). However, the framework is not clear on how the priority of biodiversity and ecosystem health will be legally prioritised. There is no clear path on how ecosystem-based planning will be implemented, and there are no clear pillars or principles on how ecosystem-based management, adaptive management, and other key actions needed to achieve the shift will be addressed (West Coast, 2024).

To address these gaps, West Coast Environmental Law (2024) has established several recommendations: i) The framework should explicitly state that keeping 30% of the land area free from resource extraction, through a contiguous and representative network of effective and legal PAs, is an essential element of maintaining the proposed ecosystem approach; ii) BC should fully support the Indigenous Protected and Conserved Areas (IPCAs) declared by First Nations as one of the most direct ways to advance the 30-by-30 commitments; iii) A new Biodiversity and Ecosystem Health Act is essential to provide legal support for the framework; iv) BC laws, policies, and practices should be aligned with First Nations conservation priorities, including the governance of IPCAs, both in the Framework and in a new Biodiversity and

Ecosystem Health Act. The BC Draft Biodiversity and Ecosystem Health Framework is currently under development. It is expected to be released in 2025, hopefully with key actions for implementation and integration of some of the recommendations set up by West Coast Environmental Law.

Stakeholder Perspectives on Protected Areas Legislation

In Canada, there are numerous laws, policies, and guidelines at the federal, provincial, and territorial levels. However, when different stakeholders with expertise in PAs across Canada and BC were interviewed, some of their opinions demonstrated that the country may not be able to fully achieve its conservation goals in both the short and long term. Although efforts by the federal and provincial governments to protect and conserve natural areas and the ecosystems within them, governments fail to consider how biodiversity loss driven by climate change and land use changes alters ecosystem function.

Policies and actions defining PAs in Canada remain focused primarily on expanding these areas to conserve specific ecozones, ecoregions, and native species diversity. Indicators monitoring the status of PAs across various regions in Canada show a decline and loss of biodiversity, suggesting that the country is not responding effectively to biodiversity loss within its borders, despite the presence of several laws established to stop it (Whitehorn et al., 2019; Olive et al., 2023). Some of the main aspects noted by the interviewees, are related to the necessity of updating policies and legislation. Don Carruthers Den Hoed Research Associate at UBC and Senior Fellow of PARKS+ Collective, explained:

There's a good basis of policies, legislation, and guidelines that serve as tools to achieve the goals set out by our society and governments. In that regard, our legislation and guidelines are okay. There's room for improvement for aspects that are out of date, or they can be consolidated [October 22, 2024].

Peter Garrett²⁶ from Environmental and Climate Change Canada ECCC, expanded further:

Parks Canada has a very robust policy framework for their work. BC parks do, but invariably, issues arise where they need to have policy innovations or

²⁶ Anonymous participant

changes to respond. Fisheries and Oceans Canada also has protected areas. They've not been in the game for as long, so I think they've got a little bit more to go in terms of developing a solid policy framework. And then ourselves (ECCC), I think we're probably a little light in a number of policy areas that we could make some improvements. As issues arise, we kind of slowly move towards getting policies. But generally speaking, we've got a good policy framework as well. We've been in the business for about 100 years, so institutional memory and policy is in reasonable shape for us as well. As protected areas institutions adapt to emerging concepts like Indigenous Protected Areas, there's work to be done there [November 29, 2024].

And Claire Matthews²⁷ from BC Parks, mentioned:

Within BC Parks there are program areas devoted to both conservation and planning. There are some strong policies, some that are ready to be updated and some gaps [November 6, 2024].

Besides the need for improved and updated policies, there is also a need to revise legislation to better reflect reconciliation efforts with Indigenous peoples and communities. This includes incorporating TEK and supporting the creation of IPCAs. Sasha Morton²⁸ from Ducks Unlimited Canada BC, said:

I think there's a lot of Crown land, like 94% of British Columbia is not privately held land. All of that is contested by multiple overlapping claims by Indigenous governments. What's lacking, and perhaps there's an understandable reason for, is guidance for how. This is something that the province does, it certainly appears to be trying to figure out, how we work with First Nations, or how the province is going to work government to government with First Nations to set designations. You need to have some sort of flexible process that provides enough flexibility for nations that want unique things. But there's definitely something that needs to be done there, because it needs to be well communicated and engage, perhaps non-Indigenous folks as well in what conservation designations mean and what's being accomplished, and how their private land is not going to be affected by it in a very clear way. That's probably the biggest gap right now [October 28, 2024].

In line with this, there was also an awareness of the colonial nature of the policies, like Carruthers Den Hoed, expressed:

when it comes to conservation and protected areas and parks, the legislation and guidelines are still colonial, and they have a colonizing impact. They're still imposing systems that haven't been resolved or reconciled with either Indigenous peoples or nature itself. And they serve such complex needs that there's a point at which they're ineffective because they're part of a system that's doing something that is maybe counter to the goals of protected areas [October 22, 2024].

²⁷ Anonymous participant

²⁸ Anonymous participant

Additionally, Herb Hammond, Founder and President of Silva Forest Foundation, stated:

One of the Nations that I work with refer to Ecological and Cultural Protected Areas, instead of calling them Indigenous Protected and Conserved Areas. From my perspective, this change reflects the colonial use of 'Indigenous land', as opposed to 'crown land'. All the land in BC is Indigenous land and by changing the terminology, Indigenous Nations are reminding us that they have been conserving and protecting their land for millennia. Organizations like the Indigenous Law Research Unit at the University of Victoria are working with Indigenous Nations to codify their laws and use them as the foundation to assert, establish and manage ecological and cultural protected areas [October 30, 2024].

Following these concerns, some interviewees also mentioned a lack of political will from provincial or federal governments to enforce existing protective legislation, particularly when such enforcement conflicts with resource extraction interests. Jason Johnston, executive board member from the Indigenous Tourism Association of Canada (ITAC), explained:

Managing the natural processes that we rely on is an important thing that parks, and protected areas should be focused on. I do think they need to expand that protection and, I don't think there's a lack of realization, I think it's more of a political will. Protecting part of the mountain range or the wetlands, is not enough to keep the processes healthy, because we have so many other places that are being paved over and dug up and cut down. Nationally, we have protective legislation around endangered species, ecosystems, and a lot of those are not as strong as they should be. When we talk about bird migration, about the navigable waterways with fisheries, we see that there is seemingly a lack of will from provinces or the federal government to put in the resources to protect those places. The province should be responsible, or Canada should be responsible. When we see the creation of protected areas, it seems more often than not, that resource extraction industries overpower any kind of protective legislation [September 10, 2024].

This perspective was reinforced by other interviewees, who pointed to the lack of political will among governments to enforce environmental protections when faced with pressures from resource extraction and expressed strong concerns about the political and institutional challenges that threaten the effectiveness of PAs. Tom Dickinson, Wells Gray World Heritage Committee member, identified political decision-making as the most significant risk, particularly when short-term economic values are prioritized over long-term ecological integrity:

The biggest threat is the political one. The biggest threat is when people see values in things other than the natural values that are within a park or a protected

area. If they see cows as more important than the grass that's protected in a park, then they'll put more cows on it, and the grass will be forfeited. If they see the timber as more valuable than the forest, then they'll make an argument and say, 'trees are infected with a pine beetle here, we should be able to go in and harvest them'. And yet, the natural process is for the pine beetle to kill itself. I think that's the biggest threat, the politics is too responsive to short term interests in a system where parks are meant to protect the long-term natural ecosystems [September 19, 2024].

Moreover, Hammond noted the fragmented nature of legislation and planning processes, emphasizing how PAs are often considered responsive measures instead of proactive tools in land-use planning:

The legislation and guidelines for protected areas are a fragmented system. Establishment of protected areas occur in different ways in different ministries. Most of it is an approach focused on protecting small areas that are already part of major developments. In this way, protected areas are an afterthought, rather than being the starting point for planning the use of land. Identification and establishment of protected areas doesn't really occur in most cases until development proposals are on the table. Aside from this process, the significant protected areas that have been developed through the years are not the result of government policy and procedure, but the result of activists who identify these areas and create a public campaign to protect them [October 30, 2024].

While some interviewees expressed concern over the political prioritization of short-term economic interests and the fragmented nature of PAs legislation, others highlighted the need to balance environmental protection with the realities of economic need in natural resource industries. Catherine Hickson, Chief operating officer for Dajin Resources Corp. and President Tuya Terra Geo Corp., stated:

I'm in favor of the protection that is given to the Class A provincial parks, as well as bringing more areas under the Protected Area status. And I'm supportive of the provinces' attempts to bring more areas either giving them Park status or protected area status. However, I am a geologist, and very aware of the use of metals in our society, and I think that it's very important for our society that mining and mineral exploration, as well as hydrocarbons, continue because this is the basis of our standard of living here in British Columbia. Mineral deposits are only in one place. It's not like, they're everywhere. And if we exclude that specific mineral deposit from exploitation, then we are shutting the door for expansion of our revenues related to mineral exploration, as well as making this much more reliant on bringing in commodities from other jurisdictions which may not have the same kind of environmental laws that we do here in British Columbia. I think people need to realize that mining in British Columbia and in Canada, is much more environmentally sensitive and conscientious, than mining in many other parts of the world [September 23, 2024].

However, Johnston, expressed that there is a big difference between the value that people and government place on resource extraction and the value that natural resources place on natural spaces and well-being:

I don't think that there's enough power and authority behind the legislation when it comes to wildlife protection. We have a lot of endangered species in Canada. We have a lot of protected species in Canada. But the use of natural resource, the extraction of natural resources, seems to be valued much, much higher [September 10, 2024].

These perspectives acknowledge a persistent tension in BC's land management. While there is good support for expanding PAs, the prioritization of resource extraction, often reinforced by political and economic interests, continues to limit the authority and effectiveness of conservation policies.

According to the opinions expressed by the interviewees, the main policy gaps that pose barriers to achieve the conservation objectives set by the Government of Canada are related to the fact that the legislation is outdated, does not adequately reflect reconciliation efforts, and still responds to a colonial structure. There is a need to integrate conservation (ecosystem-based approaches) with biodiversity strategy plans and policies and sustainable development strategies that incorporate biodiversity elements.

Some interviewees also commented on the existence of gaps in the applicability of policies and guidelines, as people may not always know how to implement them effectively. This aspect may be related to the need to update and consolidate legislation to align policies and laws with the objectives of the Kunming-Montréal Global Biodiversity Framework (COP 15). This could also be addressed through the implementation of Canada's Nature Strategy 2030 or the BC Draft Biodiversity and Ecosystem Health Framework. Federal, provincial, and territorial governments work within a fragmented system. Conservation and biodiversity objectives are the responsibility of specific ministries or agencies instead of being an integral part of the planning and decision-making process of different political sectors, such as those responsible for natural resource management (Ray et al., 2021).

Interviewees noted that there is a clear lack of articulated conservation and biodiversity objectives in the context of PAs. In many cases, policies and guidelines set management standards for recreational activities, and conservation is based more on maintaining some areas with restricted access for certain activities. Although the legal framework is comprehensive, it fails to establish restrictions on activities that are incompatible with the objectives of conserving ecosystems and their biodiversity. Consequently, current governmental frameworks do not provide clear objectives on how these management strategies should incorporate biodiversity and ecosystems to address the root causes of biodiversity loss (Sarkki et al., 2016).

It is important to note that many of the interviewees (78%) were located in or were affiliated with organizations based in BC. Although the perspectives mentioned here highlight significant issues and tensions in the management of PAs, this geographical concentration may introduce a regional bias. The shared perspectives may indicate specific challenges, particularly related to the political and governance dynamics of BC and may not fully represent the experiences of other stakeholders in other provinces and territories of Canada.

Overcoming the Barriers in the Policy of Protected Areas

During the interviews, some of the participants provided insight into how to tackle the barriers and existing gaps in the political framework. One of the most commented aspects was related to the incorporation of Indigenous rights, responsibilities and TEK into PAs policies. Some of them established that there is a trend towards greater Indigenous involvement in co-management and establishment of IPCAs. Hammond explained:

Governments are willing to talk about and support protected areas. But, when it comes down to really applying both the science of ecology and conservation biology and facilitating principled reconciliation with Indigenous peoples, governments are less enthusiastic about protected areas. The way that governments are treating reconciliation is like another chapter of assimilation for Indigenous peoples. If Indigenous peoples follow the economic models that governments support, they will be rewarded with social and economic benefits. However, if they don't, reconciliation is an empty basket. That situation is changing with the establishment of IPCAs because they're Indigenous led. Some

Indigenous Nations follow a conventional approach in their IPCAs. However, many Nations are establishing them according to their own laws and customs. That is a bright light for progressive ways to protect and conserve ecosystems [October 30, 2024].

Despite the disposition of the government to expand PAs, as well as the willingness of Indigenous communities to establish IPCAs, this perspective shows the disconnect between government discourse and action. This viewpoint is particularly true as reconciliation efforts clearly remain conditioned by governmental economic models. However, the emergence and recognition of IPCAs offer a transformative path to move forward. IPCAs not only empower Indigenous governance but also introduce a holistic and culturally grounded approach to conservation.

The value of recognizing ES provided by PAs to strengthen conservation goals, was also mentioned by interviewees. Some stated that policies should better account for and protect ES provided by PAs, such as carbon sequestration, water filtration, and biodiversity conservation. Assigning economic values to these services will aid in policy decisions. Mike Dedels, Executive Director of Grasslands Conservation Council (GCC), emphasized:

the quantitative part is interesting, because we had some studies done a few years ago where the grasslands were part of the ecosystem services and then the values of them. And, trying to put dollars on those, is challenging. If we just put the qualitative, we want for grasslands, because they're pretty and people like to play on them, and they're good for wildlife, doesn't quite cut it as much as if you actually put a value on it, because if you put values on it, then you'll know a bit more about what you're protecting [December 6, 2024].

This perspective sets the need to integrate ES valuation methods into policy formulation. Quantifying ES not only strengthens conservation goals but also provides a clearer justification for protecting areas that might otherwise be overlooked economically and prioritized for other economic activities.

Some interviewees stated the need to incorporate climate change considerations into the management of PAs, especially regarding fire regimes and species conservation. Tay Briggs, Owner of Wells Gray Adventures, specified that the increase of wildfires, due to climate change, requires proactive strategies to support the survival of vulnerable species like the caribou:

climate change is going to increase fire. But if you are going to protect an endangered species like the caribou, then you might have to look at areas where we have an increased susceptibility to fire because of climate change, and do some active management due to that, or you will not have caribou. Because what we have right now is a window of opportunity to make management decisions that will ensure the caribou survival in time for the other habitat to become suitable. There needs to be strategies set aside for climate change that involve more than just letting those lands sit and manage themselves [October 23, 2024].

Dedels argued that ecosystems are dynamic, noting that natural disturbances such as fire and insect outbreaks are essential components of long-term ecological processes:

we're starting to learn a lot more about the role of fire especially in the interior. So, my reflection will be mostly on interior parks, [...] the fact that these aren't static ecosystems. When you protect large 100-year-old lodgepole pine, it's not going to be old growth 500-year-old lodgepole pine, it dies, and it's either going to be bugs or fire. So, there's no one pristine system that is going to look like it forever. Even at the coast, there are changes, but they're slower [...] you got 500, 600-year-old trees there, so they do last longer, but they don't last forever [December 6, 2024].

These insights show that conservation efforts can no longer be supported just on preserving current conditions. Instead, adaptive management strategies are needed for maintaining the resilience and ecological integrity of PAs.

Other perspectives identified the need for policies that balance human use and access with conservation objectives, including the management of tourism and resource extraction near PAs. Interviewees also point out the importance of having greater restrictions on commercial activities within PAs and, to better align conservation goals with resource extraction demands, the need to strengthen the authority of wildlife protection legislation. Additionally, policies that consider ecological connectivity between PAs and surrounding landscapes were mentioned, such as the implementation of buffer zones and wildlife corridors.

Developing policies that allow for the protection of ecosystems that transcend multiple jurisdictions, potentially through better inter-provincial collaboration was discussed. Johnston, explains:

BC has a huge extraction industry. There's lots of mining, forestry and commercial fishing. Alberta is known for oil extraction, mining, forestry, hunting and, fishing as well. I guess BC has been projecting itself as a more environmentally conscious province. Having nations along the border where there are overlapping territories between the provinces, I think that can open the

door for better planning between provinces to say, 'these places definitely have different priorities. It doesn't mean that the ecosystem stops at the border, that we have water systems that flow from the mountains into BC or the mountains into Alberta. When we talk about the protection policies around wildlife. They're not just going to stay in one area. You can have a protected area where you have wildlife that can't be hunted, but then you have hunters waiting on the outskirts as soon as they cross the border. And there are some policies around buffer zones you can't hunt within. And I think there needs to be more of that relation between provinces to come to an understanding that this is a bigger picture. This is a longer-term vision [September 10, 2024].

This observation highlights the need for collaboration between provinces, especially in areas where ecosystems and species cross borders. Environmental protection cannot stop at provincial borders. There is a need for a long-term shared vision if federal and provincial governments want conservation policies to have a real impact on the territory.

Finally, creating a more inclusive process for policy development that involves a wider range of stakeholders, including the public, in decision-making about PAs was emphasized. Trevor Goward, Lichenologist from the Department of Botany at UBC, recognized:

if they're going to manage parks well, they should be consulting with people who actually know the park., but they don't consult with local people. They make poor decisions. They could ask for some advice, but they don't do it. It's just not within their little hierarchy, it's all self contained, it's all top secret and so forth. One of the improvements that could be made is not to go and ask the people to vote on this. Most people don't know things about parks and what they're good at, what they're there for, what they contain. But to make a special effort to reach out to people who do have special knowledge about the area, about the areas concerned [August 21, 2024].

This reflection is a reminder that good decisions about PAs need to be made with the help of knowledgeable stakeholders. Listening to the people who know these places best. Making the effort to involve local voices, especially those with real, lived knowledge of the land. This could lead to creating policies that actually work on the ground.

Preventing the further loss of biodiversity requires a radical change in legislative structures that takes a long-term view and addresses fundamental issues. This change will imply a review and update of current policies, as well as the ES that ecosystems provide, both for human benefit and for ecosystem

functioning. Critically, this includes the integration of species of special concern into economic and development decision-making processes (Ray et al., 2021).

To achieve real restoration and conservation goals in PAs, knowledge from multiple sectors must be integrated into decision-making processes. Likewise, adaptation strategies must be developed not only to maintain and enhance biodiversity characteristics, but also to preserve the ES that humans derive from nature. Therefore, TEK, federal, provincial and territorial priorities, and Western science must work together to mobilize expertise and achieve real policies and legislation that truly enable the so-called ecological integrity of the vast PAs that exist in Canada (Braiding Knowledges Canada, 2024; Nadeau & Doyon, 2024).

Conclusion

This chapter focuses on delivering an overview of the policies and guidelines that exist to create and manage PAs across Canada. It profiles the perspectives of different stakeholders on the barriers that conservation faces in the context of legislation and what actions might be taken by the government and institutions to overcome these issues. Despite efforts by the federal and provincial governments to protect and conserve natural areas and the ecosystems within them, they fail to consider how biodiversity loss driven by climate change and land use changes may alter ecosystem function. Policies and actions defining PAs in Canada remain focused primarily on expanding these areas to conserve specific ecozones, ecoregions, and native species diversity. The goals lack specific actions to conserve biodiversity in general, which contributes to the functions of ecosystems and their quality (Jacobs et al., 2018).

Other issues that emerged from the interviews were the need to balance conservation goals with other land uses, particularly with resource extraction. For example, the lack of willingness by the provinces or the federal government to enforce existing conservation legislation was noted, especially when it conflicts with resource extraction interests. Provincial and territorial control over natural resources and the economic benefits derived from them has been the primary consideration in decisions defining economic development and land use change

(Olive, 2016; Natural Resources Canada, 2018). Considering the colonial mindset that persisted for years in Canada regarding resource extraction and development, the rules governing the use of natural resources were shaped to facilitate these resource extraction activities. This was based on the assumption that the extent and availability of Canada's natural resources would not be adversely affected as a result of their extraction (Olive et al., 2023). However, this perspective evolved into the idea that impacts could be effectively mitigated through independent processes set out in the management plans of the various land use activities that impact the environment (Hughes et al., 2016). With biodiversity and other environmental and social considerations excluded from planning and decision-making processes, economic benefits have traditionally been the driving force behind land use decisions (Bond et al., 2020).

Another important aspect noted in the interviews is that the laws enacted by each province or territory are also not consistent across borders. Provincial laws are established according to what each territory defines as a priority based on its economic development or major natural resources but do not take into account the ecological integrity of the entire ecosystem as a whole. Canada has always faced the challenge of jurisdictional fragmentation, as 89% of natural assets (ecosystem goods and natural resources) fall under provincial authority. This naturally leads to differences in policies and priorities between governments, particularly with respect to natural resource extraction and its impacts on biodiversity (Ray et al., 2021). In order for federal legislation to have a positive impact on ecosystems, the provinces must support it and commit to managing ecosystem issues according to principles that represent the needs of the entire nation, not just specific provinces or territories.

References

- Bond, A., Pope, J., Fundingsland, M., Morrison-Saunders, A., Retief, F., & Hauptfleisch, M. (2020). Explaining the political nature of environmental impact assessment (EIA): A neo-Gramscian perspective. *Journal of Cleaner Production*, 244, 118694. <https://doi.org/10.1016/j.jclepro.2019.118694>
- Braiding Knowledges Canada. (2024). STRATEGIC PLAN 2024-2029: Reconciliation through Research. In *Braiding Knowledges Canada* (p. 38). https://braidingknowledgescanada.ca/wp-content/uploads/2024/07/BKC-Strategic-Plan_July2024.pdf
- CanLII. (2025). *CanLII - Canadian Legal Information Institute*. Canlii.org. <https://www.canlii.org/en/>
- Convention on Biological Diversity. (2022). *COP15: Final text of Kunming-Montreal Global Biodiversity Framework available in all UN languages*. Convention on Biological Diversity. <https://www.cbd.int/article/cop15-final-text-kunming-montreal-gbf-221222>
- Data Basin, & Conservation Biology Institute. (2020). *Canada Ecoregions | Data Basin*. Databasin.org. <https://databasin.org/datasets/6dfe01568b844a5c84549670552221b2/>
- Environment and Climate Change Canada. (2021). *Map: National Wildlife Areas and Migratory Bird Sanctuaries*. Wwww.canada.ca. <https://www.canada.ca/en/environment-climate-change/services/national-wildlife-areas/map.html>
- Environment and Climate Change Canada. (2023). *Protected Areas Program: Strategic Program Plan and Vision to 2030 - Canada.ca*. Canada.ca. <https://www.canada.ca/en/environment-climate-change/services/protected-areas-program/publications/protected-areas-program-strategic-plan-vision-to-2030.html>
- Environment and Climate Change Canada. (2024a). *ECCC Data Catalogue*. Ec.gc.ca. <https://donnees.ec.gc.ca/data/species/protectrestore/canadian-protected-conserved-areas-database/Databases>
- Environment and Climate Change Canada. (2024b). *2030 Nature Strategy and Nature Accountability Bill*. Wwww.canada.ca. <https://www.canada.ca/en/environment-climate-change/news/2024/06/2030-nature-strategy-and-nature-accountability-bill.html>

- Environment and Climate Change Canada. (2024c). *Ecological integrity of national parks*. Www.canada.ca. <https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/ecological-integrity-national-parks.html>
- Environment and Climate Change Canada. (2025). *Biodiversity indicators*. Www.canada.ca. <https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/biodiversity.html>
- Government of British Columbia. (2015). *Cumulative Effects Framework - Province of British Columbia*. Gov.bc.ca. <https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/cumulative-effects-framework>
- Government of Canada. (2024). *Canada's 2030 Nature Strategy: Halting and Reversing Biodiversity Loss in Canada - Canada.ca*. Canada.ca. <https://www.canada.ca/en/environment-climate-change/services/biodiversity/canada-2030-nature-strategy.html>
- Hughes, E. L., Kwasniak, A. J., & Lucas, A. R. (2016). *Public Lands and Resources Law in Canada*. Irwin Law.
- Jacobs, B., Boronyak, L., Mitchell, P., Vandenberg, M., & Batten, B. (2018). Towards a climate change adaptation strategy for national parks: Adaptive management pathways under dynamic risk. *Environmental Science & Policy*, 89, 206–215. <https://doi.org/10.1016/j.envsci.2018.08.001>
- Justice Law Website. (2019). *Canada National Parks Act*. Laws-Lois.justice.gc.ca; Government of Canada. <https://laws-lois.justice.gc.ca/eng/acts/n-14.01/page-1.html>
- Ministry of Environment and Climate Change Strategy. (2021). *Climate Preparedness and Adaptation Strategy - Province of British Columbia*. Www2.Gov.bc.ca. <https://www2.gov.bc.ca/gov/content/environment/climate-change/adaptation/cpas>
- Nadeau, M., & Doyon, A. (2024). Exploring ethical space in land use planning. *Critical Policy Studies*, 18(4), 660–681. <https://doi.org/10.1080/19460171.2024.2305920>
- Natural Resources Canada. (2018). *10 Key facts on Canada's natural resources*. Natural-Resources.canada.ca. https://natural-resources.canada.ca/sites/www.nrcan.gc.ca/files/files/pdf/10_key_facts_NatResources_2018_e.pdf

- Natural Resources Canada. (2025). *Forest classification - Natural Resources Canada*. Canada.ca. <https://natural-resources.canada.ca/forest-forestry/sustainable-forest-management/forest-classification>
- Olive, A. (2016). *The Canadian environment in political context*. University of Toronto Press.
- Olive, A., Finegan, C., & Beazley, K. (Eds.). (2023). *Transformative politics of nature: overcoming barriers to conservation in Canada*. University of Toronto Press.
- Parks Canada Agency. (2008). *Guiding Principles and Operational Policies - Policy Context*. Parks.canada.ca. <https://parks.canada.ca/agence-agency/bib-lib/politiques-policies/gestion-management/princip/sec1/part1c>
- Parks Canada Agency. (2014). *Acts*. Parks.canada.ca. <https://parks.canada.ca/agence-agency/lr-ar/lr-ar1>
- Parks Canada Agency. (2021). *State of Canada's natural and cultural heritage places, 2021*. Parks.canada.ca. <https://parks.canada.ca/agence-agency/bib-lib/rapports-reports/elnhc-scnhp/2021#section-5-2>
- Parks Canada Agency. (2022). *National parks - Parks Canada - National parks*. Parks.canada.ca. <https://parks.canada.ca/pn-np>
- Parks Canada Agency. (2023). *National marine conservation areas and marine park network - National Marine Conservation Areas System Plan*. Parks.canada.ca. <https://parks.canada.ca/amnc-nmca/plan#map>
- Ray, J. C., Grimm, J., & Olive, A. (2021). The biodiversity crisis in Canada: failures and challenges of federal and sub-national strategic and legal frameworks. *FACETS*, 6, 1044–1068. <https://doi.org/10.1139/facets-2020-0075>
- Sarkki, S., Niemelä, J., Tinch, R., Jäppinen, J.-P., Nummelin, M., Toivonen, H., & Von Weissenberg, M. (2016). Are national biodiversity strategies and action plans appropriate for building responsibilities for mainstreaming biodiversity across policy sectors? The case of Finland. *Journal of Environmental Planning and Management*, 59(8), 1377–1396. <https://doi.org/10.1080/09640568.2015.1076384>
- Schüle, M., Heinken, T., & Fartmann, T. (2023). Long-term effects of environmental alterations in protected grasslands – Land-use history determines changes in plant species composition. *Ecological Engineering*, 188, 106878. <https://doi.org/10.1016/j.ecoleng.2022.106878>

- Water and Resource Stewardship Ministry of Land. (2023). *B.C.'s draft Biodiversity and Ecosystem Health Framework - Province of British Columbia*. Www2.Gov.bc.ca.
<https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/biodiversity/bc-s-draft-biodiversity-and-ecosystem-health-framework>
- West Coast Environmental Law. (2024). *WCEL Submissions on the Draft BC Biodiversity and Ecosystem Health Framework | West Coast Environmental Law*. Wcel.org. https://www.wcel.org/publication/wcel-submissions-draft-bc-biodiversity-and-ecosystem-health-framework?gad_source=1&gclid=Cj0KCQiA-aK8BhCDARIsAL-H9nkYsJiZYWdfVQ_oF6fJ2fLHf497eHePhZ4NU8ZhjZIGJgiMiO0wKYaAhfmEALw_wcB
- Whitehorn, P. R., Navarro, L. M., Schröter, M., Fernandez, M., Rotllan-Puig, X., & Marques, A. (2019). Mainstreaming biodiversity: A review of national strategies. *Biological Conservation*, 235, 157–163.
<https://doi.org/10.1016/j.biocon.2019.04.016>

CHAPTER 3

Rethinking Protected Areas Management: Ecosystem Principles for Sustainability Transitions

The aim of this chapter is to present the most pressing risks facing protected areas (PAs), as identified by different stakeholders with expertise in PAs management. It includes an analysis of the role of PAs in conservation, recreation, and climate resilience and explores how the links between land cover and ecosystems can serve as a decision-making tool in spatial planning. The chapter also describes stakeholder perspectives on rethinking management decision-making processes and outlines future directions for PAs.

While existing legislation protects many ecological values, such as rare species and priority habitats, it is primarily focused on meeting international obligations and often fails to assess how ecosystems function (Quine et al. 2013). Integrating an ecosystem approach into decision-making is vital for managing land use and maintaining the ecosystem services (ES) that support human well-being. A clear understanding of ecosystem functions within landscape features helps identify the most appropriate planning principles for any area.

PAs are intact ecosystem fragments where multiple land uses can cause biodiversity loss, including the cumulative effects of surrounding activities such as nutrient enrichment or resource extraction. Similarly, the invasion of exotic species, intense recreational activities, and climate change can also cause biodiversity loss in PAs. Existing ES models often implicitly assume that undisturbed fragments of forests will continue to provide the same level of benefits for the same area in the future, despite the potential loss of multiple species within these fragments (Isbell et al., 2015). These human drivers can affect an area's ES, ecosystem functions, and human well-being by disrupting biomass production, soil and sediment retention, water flow regulation, precipitation patterns, pollination, and global climate regulation.

To make informed decisions about the conservation of biodiversity and the maintenance of ES, it is necessary to have knowledge of which ecosystems are most vulnerable to collapse, and which ecosystems provide benefits for humans (Keith et al., 2022). Below, the ecosystem principles on which management should be based to overcome these challenges are introduced. These principles integrate core management concepts, such as ecological health and integrity, climate change resilience and protection, ethical and precautionary approaches, reconciliation, and adaptive ecosystem-based management.

The Assessment of Risks to Protected Areas

According to Schulze et al. (2018), the threats that pose a risk to PAs are all activities or human processes that result in the destruction and/or degradation of biodiversity. Through 21 semi-structured interviews, stakeholders identified key risks. As shown in Figure 15, the most frequently mentioned risks were resource extraction industries (57%), followed by human activities and overuse (52%), fragmentation (48%), and political-economic pressures (48%).

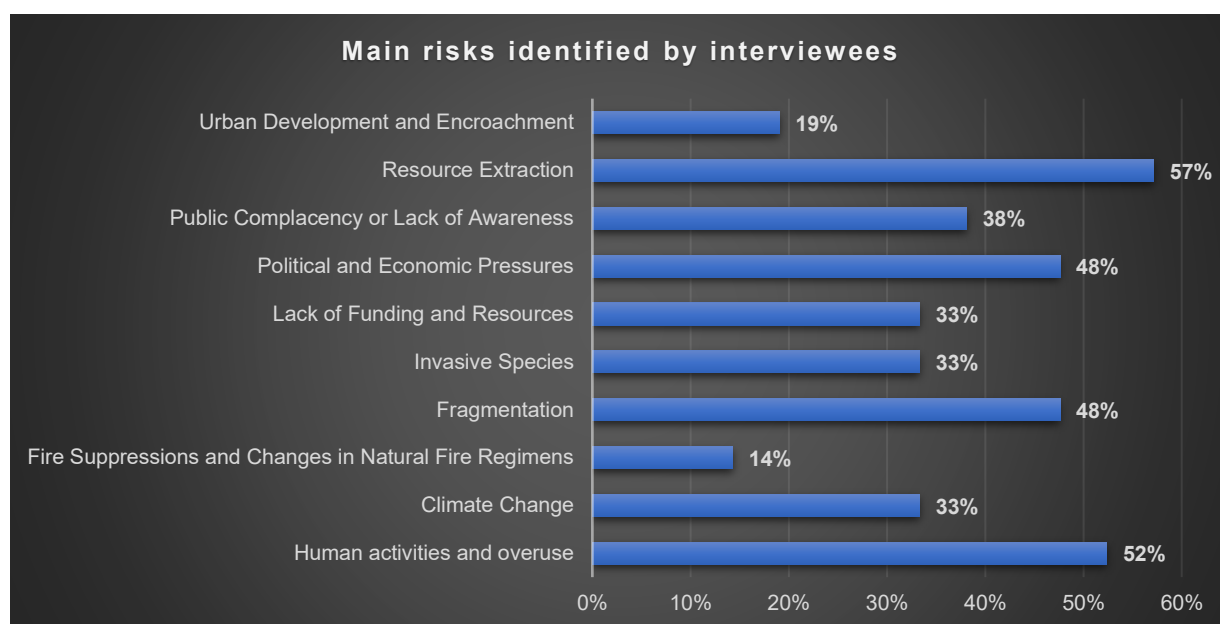


Figure 15 Main risks identified by interviewees.

Resource extraction is seen by interviewees as one of the greatest hazards to the integrity of PAs. Activities such as logging, mining, and oil/gas extraction were mentioned. Ian Barnett, former VP of Nature Conservancy Canada (NCC), member of the Grasslands Conservation Council (GCC) and Wildlife Habitat Canada, mentioned:

I think if you look at the landscape, you say, what's there from the species richness and rarity? And then be able to say, what are these other activities? There's logging, ranching, hunting. Where can they fit in? So, the question is, at what point and when we're going to take some benchmark areas and put a fence around them and test them and see how they compare? An important thing to do is to be able to evaluate. Once you've understood your conservation richness and rarity, we can say, allow these uses [September 12, 2024].

Despite the existence of environmental legislation, current practices often fail to achieve sustainability, particularly when ecosystem functions are missed in land use decisions. Tay Briggs, Owner of Wells Gray Adventures, said:

In many areas, we are continuing to use it until it's gone. I have this argument with my forestry friends all the time because I don't believe what we're doing is sustainable. I know because when I was a kid in my area, we had seven log Mills, and now we have none. So, tell me what's sustainable about that? [October 23, 2024].

These observations reflect a growing awareness among stakeholders of the urgent need to evaluate land uses within the broader ecological context. The importance of identifying species richness and rarity before allowing activities such as logging or ranching calls for assessing ecological integrity over time. The absence of this practice reveals how unsustainable standards have already depleted landscapes and ecosystems. These insights show the necessity of integrating ecosystem principles into land management, not only to protect biodiversity but also to ensure long-term social and economic sustainability.

Human activities, including tourism, recreation, and overuse of PAs, were also among the most frequently cited risks. Tom Dickinson, member of the Wells Gray World Heritage Committee, explained:

Many people plan for today and ignore the fact that today is not going to be what tomorrow is in terms of either climate or people. My biggest perception is that many of the environmental problems we face today are because we have too many people using too many resources and polluting too much of the atmosphere in the world that we're in. It's a cumulative effect of all the people that

are there. And we know there's going to be more people demanding the same spaces that we have today [September 19, 2024].

Jason Johnston, executive board member from the Indigenous Tourism Association of Canada (ITAC), expanded:

What I've seen is a negative trend in overuse of areas to meet tourism demand, which takes away from the conservation focus of some of these areas. Because of tourist demand and increased visitor numbers, there's been an increase in parking lot sizes, trails, and facilities. Every single park that I've worked at has expanded parking lots to meet the demand. People are parking outside the roads, on the grass. Let's make a bigger parking area so it won't happen. The only thing that happens is now you have more people, and they are still parking on the grass and on the road. You just have twice as many people now, and that is being sold as we're alleviating pressure [September 10, 2024].

And Tod Haughton Area Supervisor for Thompson-Northern Forests with BC Parks, also mentioned:

On the ground uses just gone up exponentially, recreational use. And impacts have gone up, specifically invasive species [October 9, 2024].

These statements demonstrate the tension between present demands and long-term sustainability goals. Future environmental and demographic changes must be considered, as ecological challenges arise from cumulative human pressures. Despite emerging solutions to manage growing tourism pressure, some strategies end up having the opposite effect to that intended. To preserve PAs, a system that recognizes the limits of growth and ecological integrity values in the long term should be implemented.

The fragmentation of contiguous habitat by human development and infrastructure was also identified as a risk to ecosystem connectivity. Stephanie Russell, Conservation Specialist with BC Parks, declared:

We have a couple of parks within the region where we need to protect old growth forest, land cover for caribou and sparrow owl [northern pigmy-owl], and they're also at that age where you would expect wildfire to come through. And so, we're always struggling with that, how to manage natural fire but also protect a species whose habitat has shrunk so significantly over time? what's happening outside of the park and how that's impacting the park? what is removing connectivity? it's just a cut block right up to the edge? [October 9, 2024].

And Danielle Toperczer, Manager of the Thompson Nicola Conservation Collaborative, also commented:

urbanization and the pressure to build new housing can lead to the loss of important areas outside city centers. Instead of expanding into natural areas, we should focus on infill development within urban areas to minimize habitat fragmentation and protect water quality [October 31, 2024].

These observations emphasize the importance of managing the internal dynamics of PAs as well as the external pressures that affect their ecological integrity. Those who manage these PAs face difficult decisions, such as allowing natural processes like fire and protecting vulnerable species whose habitats have already been drastically reduced. Decisions about land use beyond the boundaries of PAs, such as logging or urban expansion, affect the connectivity of ecosystems and isolate them. To ensure the long-term resilience of PAs, planning must extend beyond their borders, integrating regional landscape characteristics to reduce fragmentation, preserve ecological corridors, and align development with conservation goals.

The risk of reduced protection or funding for PAs due to changing political attitudes or economic priorities was also an important risk mentioned by interviewees. Hillary Page, Senior Director for BC of Nature Conservancy Canada (NCC), explained:

politics have a huge impact on management and creation of new protected areas. So just looking at changes in governments that could be coming federally and provincially, that will have a big impact on our work and how we work into the future [October 2, 2024].

Also, Herb Hammond, Founder and President of Silva Forest Foundation, established:

Community-based economies are the only economies that have ever been sustainable in the long term. Today's global economy is a corporate controlled economy, where corporate entities control both government decision-making and allocation of land. In this situation, the global economy preys on community economies, so community economies pay the price of the global economy, which is about concentrating wealth in the hands of a few, not in maintaining community integrity. I've had a lot of individuals who have come to talks that I've given and/or read some of the materials I have produced. The feedback I get from individuals about Nature-directed Stewardship is very positive. They want to see this kind of approach used to design protected areas, and community-based economies. However, this often does not occur, because the decision-makers tend to be controlled by corporate objectives to maximize profits. This type of decision-making is often associated with 'green washing'. Corporate controlled decision-makers are experts at redefining terminology to mean what they want it to mean, not what it really means. This reality makes change difficult [October 30, 2024].

Political changes and corporate goals influence and shape the creation and management of PAs. Although communities support PAs management and sustainable local economies, reaching a significant change is difficult when decision-making is governed by short-term profit targets instead of long-term ecological and social integrity. Moreover, conservation is not only challenged by corporate profit-seeking but also by governments' desire for revenue and jobs. Stumpage fees and royalties from timber and mining influence government policy and priorities.

The IUCN-CMP Threat Classification provides a list of threats that pose a risk to biodiversity (Table 5). These are categorised by risks that represent direct impacts on biodiversity and activities that create pressures on these direct impacts. Direct risks are associated with sources of stress and emerging pressures. These risks can be historical (either unlikely to return or likely to return), ongoing, or likely to occur in the future (IUCN Red List, 2022).

LEVEL 1 RISK	DEFINITION
Residential & Commercial Development	Risks from human settlements or other non-agricultural land uses with a significant footprint, such as residential and urban areas or tourism and recreation areas.
Agriculture & Aquaculture	Risks from agriculture and livestock as a result of agricultural expansion and intensification, including silviculture, mariculture, and aquaculture (comprising the effects of any fencing around farmed areas), such as timber and pulp plantations, livestock farming and ranching.
Energy Production & Mining	Risks from non-biological resource extraction, such as oil and gas drilling, mining, renewable energy, etc.
Transportation & Service Corridors	Risks from long, narrow transport corridors and the vehicles that use them, including associated wildlife mortality, such as roads, utility and service lines.
Biological Resource Use	Risks from the use of 'wild' biological resources, including both intentional and unintentional effects of harvesting; also, persecution or control of specific species, such as hunting and gathering, logging and timber harvesting.
Human Intrusions & Disturbance	Risks from human activities that alter, destroy and disturb habitats and species associated with non-consumptive uses of biological resources, such as recreational activities.
Natural System Modifications	Risks from actions that convert or degrade habitat in the service of "managing" natural or semi-natural systems, often to improve human welfare, such as fire and fire suppression, dams, and water management/use.

LEVEL 1 RISK	DEFINITION
Invasive & Other Problematic Species, Genes & Diseases	Risks from alien and native plants, animals, pathogens/microbes, or genetic material that have or are predicted to have adverse effects on biodiversity following their introduction, spread, and/or increase in abundance.
Pollution	Risks from the introduction of exotic and/or excess materials or energy from point and non-point sources such as domestic, urban, and industrial wastewater, garbage and solid waste, and air pollutants.
Geological Events	Risks from catastrophic geological events, such as volcanoes, earthquakes, and landslides.
Climate Change & Severe Weather	Risks from long-term climatic changes that may be linked to global warming and other severe climatic/weather events that are outside the natural range of variation or that can potentially bring a vulnerable species or habitat to extinction, such as habitat alteration, droughts, extreme temperatures, and floods.

Table 5 Adapted from IUCN-CMP Threats Classification (IUCN Red List, 2022)

Schulze et al. (2018) used this list to identify the types of risks faced by 1,961 PAs across 60 realm biomes in 149 countries. They found that the main risks associated with PAs are Natural System Modification (31%), followed by Biological Resource Use (28%), Agriculture & Aquaculture (22%), Climate Change & Severe Weather (20%), Residential & Commercial Development (19%), Invasive & Other Problematic Species, Genes & Diseases (14%) and Human Intrusion & Disturbance (12%). In this study, the main risks associated with biomes representative of the Canadian landscape are highlighted in Table 5. The risks identified by stakeholders with an expertise in the management of PA fall within the categories listed by IUCN and are consistent with the research conducted by Schulze et al. (2018). This shows the relevance of establishing practices and policies to manage and mitigate the risk posed by these threats.

It is crucial to recognize that three risks identified during the interviews, political-economic pressures, lack of funding and resources, and public complacency or lack of awareness, do not appear in the risk list developed by the IUCN or in the assessment by Schulze et al. (2018). These risks could be understood as indirect risks rather than direct threats to PAs. While the Level 1 risks in Table 5 describe immediate and observable pressures on ecosystems (invasive species, climate change, land use change), these risks identified in the

interviews refer to institutional, financial, and socio-political conditions that intensify those direct risks.

However, these risks pose a significant danger to the management of PAs as they are linked to legislation and strategies implemented by federal, provincial, and territorial governments to set economic priorities. This may ultimately result in lower conservation targets and less funding for required improvements to the PA network.

Rethinking Management

It is no secret that fundamental sustainability challenges persist across various sectors, and PAs are no exception. Established practices are interconnected with organizational structures, policies, institutional frameworks, and even political structures. To change these practices, it is necessary to engage in transformations that bring fundamental changes to socio-technical systems (Markard et al., 2012). Consequently, ecosystems and their services are fundamental to sustainability transitions because they provide the natural resources and processes that support human well-being and societal development. Understanding the relationship between ecosystems, ES and sustainability transitions is essential for achieving a sustainable future, as healthy ecosystems are crucial for providing the resources and regulating processes needed for human persistence and prosperity (Fisher et al., 2014; Xu & Peng, 2024). Rethinking how we plan and organize PAs requires analyzing the key aspects that support the roles these areas are meant to fulfill. This involves considering existing gaps, identifying activities that pose risks to current systems, and improving existing strategies to achieve the proposed objectives. It also involves rethinking the objectives and actions to prioritize aspects that need more attention in the current context.

The structured questions for the interviews aimed to identify key issues that would define which aspects need to be reconsidered in relation to the planning and management of PAs. Similarly, the aim was to identify possible

solutions or actions to mitigate existing obstacles that would help improve what is currently in place.

The Roles of Recreation and Conservation

As identified by the thematic analysis made from the interviews, the recreational role of PAs is a significant aspect. However, it should be managed in a way that supports and enhances conservation goals rather than compromising them, as Peter Weilandt, Regional Planning Section Head at BC Parks, expressed:

where you're talking about recreation versus conservation, a lot of people want to put an activity in that may or may not be compatible with the ecosystem. There's always this idea that you have to compromise no matter what. So, you could have a park that's set aside completely for conservation, and someone will pick up their hand in a meeting and say, you have to compromise. So, your big park that you had planned is getting shrunk down to smaller, but now we have to make it more conservation oriented. You can't just have conservation. You want to get these other activities in there. So that's the system. There is always pressure to do that. I go through management planning processes for parks, and we just throw everyone together in the same room, and we work at. I think overall, everyone seems to understand what we're doing. The only thing is there's some people who believe that we should always be compromising, no matter if there's an impact or not, or if some ecosystem or some species is in a bad state. They still say, we should compromise. You can't just leave us out of there [October 9, 2024].

This quote highlights the ongoing challenge in park management of balancing conservation efforts with demands for recreational or other land uses, often resulting in compromises that may overlook ecological concerns. While conservation is generally considered as the primary objective of PAs, recreation remains a secondary yet significant consideration. Achieving a balance between the two is essential to maintaining ecological integrity while still allowing for public access and enjoyment. The ecological health of the ecosystem is therefore fundamental to the success of a PA, as Trevor Goward, Lichenologist from the Department of Botany at UBC, recognized:

The reason that we even talk about protected areas, is because somehow, underneath the idea of protected area is the idea that there's an area worth protecting. What is the protection? The protection is to allow it to be what it has become. How did it get to become what it is? And the answer is, on landscape

scale, it was allowed to just respond to whatever it was that was happening in a way that worked. You know, both with physics and with life [August 21, 2024].

The different ecosystems within a PA provide a variety of significant ES, not only for human well-being, but also for the proper functioning of ecosystems and the maintenance of biodiversity. ES such as carbon sequestration, flood protection, and water regulation are often linked to conservation efforts, making the balance between recreation and conservation objectives relevant.

A growing focus on managing recreational activities to minimize their impact on conservation values was also noted by interviewees. This includes the introduction of visitor caps, reservation systems, and designated areas for certain activities. Roland Neave, President of Wells Gray Tours, explained:

by putting in or maintaining trails that go further away, then you still are protecting the environment, so the people aren't just trampling over the meadows, everywhere, at least you can find them to a trail. I'm a great supporter of trails, so if you have to make a bit of an effort to get into some of these places it's ok. But building roads everywhere probably not a good idea [October 8, 2024].

Also, Briggs indicated the importance of prioritizing conservation while recognizing the potential for well-managed recreation:

there needs to be an emphasis on conservation obviously. How to increase recreation use without impacting conservation values? There's lots of ways to do that. You just have to manage your recreation more closely and have the guts to say what recreation uses are appropriate for what places [October 23, 2024].

These insights reflect the importance of cautious management in balancing conservation with recreational access. The value of maintaining trails to direct recreational use while protecting sensitive ecosystems emphasizes that planned access can prevent environmental degradation. Prioritizing conservation while still enabling recreational activities stressed the need for strategic management and decision-making regarding what types of recreation are appropriate in specific areas.

Recreation in PAs plays a significant role to educate visitors about conservation and to create a bond between people and nature. The more visitors know and appreciate the value of these areas, the more public support will be generated for conservation efforts. Nancy Flood, member of Wells Gray World Heritage Committee, and President of the Kamloops Naturalists Club, expressed:

A lot of the people aren't learning about the importance of parks and what parks can be and do, and what nature is and can do and how important nature is. They're not taking care of those parks. They're just using them to stay in there. They are not saying, this is a park. I'm so lucky to be here. Look at all the amazing things around me [September 24, 2024].

This perspective shows the need for better education and awareness in fostering a deeper connection between people and nature. Without a strong awareness of the value of PAs, visitors may fail to appreciate their role in conservation, blocking efforts to protect these vital ecosystems. Recreation, especially through tourism, also provides economic benefits that can support conservation efforts. However, as mentioned above, it is relevant to ensure that tourism does not compromise the ecological integrity of PAs. In addition, both recreation and conservation strategies need to adapt to the impacts of climate change. This includes managing fire risks, adapting infrastructure, and protecting species migration corridors. Don Carruthers Den Hoed, Research Associate at UBC and Senior Fellow of the PARKS+ Collective, explained:

with climate change and the impact of climate change, the impact of fires and floods on parks themselves and protected area sites, your agency is now a disaster response unit, a rebuilding organization. BC Parks has educated people, and they try to make decisions with evidence. How do we respond? How do we rebuild? And even if there isn't a disaster or disruption, they know the impacts of climate change that could happen. They know modeling wise what changes might happen in an ecosystem, in a land cover, in a species. So, they can preventatively manage for what's coming or do they just ride the wave and wait for the next thing to happen? So, this agency that has this clear sense of purpose and this cohesive set of shared values, now has this extra layer on top of it that is incredibly acute and incredibly overwhelming [October 22, 2024].

Climate change is profoundly transforming the role of PAs, adding new layers of responsibility and urgency. PAs managers must now not only protect ecological values but also anticipate, respond to, and recover from increasingly frequent climate-related disruptions.

In this context, the need for strong policies that prioritize conservation while allowing for appropriate recreational use emerges as a critical issue for federal, provincial, and territorial governments to address. Similarly, continued monitoring and research are essential to understanding the impacts of climate change and recreation on conservation values, informing management decisions,

and supporting the experience of visitors who enjoy these areas. Finally, the growing emphasis on incorporating Traditional Ecological Knowledge (TEK) and its management practices into both conservation and recreation is essential to balance the roles of conservation and recreation in PAs (Houde, 2007).

The Connections Between Ecosystems and Land Cover

In the context of climate change, the frequent and accelerated alteration of land cover and land use results in its degradation and consequently in the loss of biodiversity. This reinforces the understanding that climate–land-use interactions cause significant declines in biodiversity-related ecosystem services (He et al., 2019). Desertification, water scarcity, and other negative consequences, such as the decrease in carbon storage in soil and trees, are also outcomes that are altered by climate change. These aspects have become the greatest concern that governments and agencies face when planning an area or territory (Xiao et al., 2022). While land cover classifications provide a useful framework to understand and manage PAs, it is mandatory to consider the complex ecosystems that exist within and across these classifications to avoid misrepresenting ecological realities (Kuemmerle, 2024). The link between ecosystems and land cover offers a practical approach to PAs management while recognizing the need for a more complex, ecosystem-based perspective (Gohr et al., 2022).

Different land cover types provide specific ES. For example, interviewees associated wetlands with water filtration and flood mitigation, forests with air purification and carbon sequestration, and grasslands with agriculture support and carbon storage. Sasha Morton²⁹, Ducks Unlimited Canada BC, said:

a lot of these different ecosystem types will provide a lot of the same services, but in different ways or at different levels. A forest sequesters carbon, but so does a salt marsh, and a salt marsh buffers flooding, but actually so does a forest, but in a different way. A forest will stabilize a landscape, the trees will pull up water, and same with drought. Trees and vegetation provide shade for water, which prevents it from evaporating. The whole thing is very interconnected. I would say that it would make more sense to talk about the linkages between those

²⁹ Anonymous participant

ecosystems as well. I think being explicit about the interconnectedness between these different systems is important to really have a robust understanding of the ecosystem services [October 28, 2024].

Land cover classifications can serve as a more accessible way to communicate about ecosystems to different stakeholders, especially those who may not have in-depth ecological knowledge. As noted above, a single land cover type may contain multiple ecosystems, and an interconnection between them may aid in a more complete appreciation of the ecological process. This situation highlights the need to consider ecological complexity beyond broad land cover categories.

Considering that the stock of services delivered from a forest, such as timber, carbon sequestration, soil protection, and recreational use, are under pressure from wicked problems³⁰ (Kramer et al., 2022), the different types of land cover require specific management approaches. For example, grasslands that are close to urban areas may require more controlled access due to their sensitivity to human use, as argued by Briggs:

the interesting thing about land covers is that some of them are more popular with human beings for building. For instance, grassland are endangered ecosystems because they're warm, dry and they're in valleys with rivers where it is very easy to build on. If you were to look at a grassland ecosystem, I would hope that you would recognize a couple things. First is that it's endangered. The second is they're very proximal to larger population centers. They have more ability to provide recreation value because they're closer and they're very sensitive to some uses. You need to be cognizant of the fact that the use has to be controlled. I think you can take a land cover, and you can make very good generalizations about how to manage it from what you know from that point of view [October 23, 2024].

The statements quoted here from stakeholders indicate that acknowledging the relationship between land cover and ecosystems is essential for effective restoration and conservation planning. Land cover can be used as an indicator of ecosystem health and change over time, informing adaptive management strategies. For example, mountain ecosystems like the Rocky Mountains in Canada provide ES that have local and global importance. Due to the population pressure in these areas from land cover and land use changes to give more space for food production and forestry, there has been a decrease of

³⁰ Like climate change, land cover and land use changes, biodiversity loss, and invasive species.

these ES. Supply is lower than demand for some ES, such as timber, water and mineral provision, carbon sequestration, and recreation (Grêt-Regamey & Weibel, 2020). It is also imperative to consider that climate change is causing changes in land cover, and since these and their interactions are critical to the general health of ecosystems and their biodiversity, knowing this relationship should not be overlooked when planning for the long term.

As mentioned above, linking ecosystems and ES to land cover classifications can aid planning decision-making processes. However, it is relevant to consider that ecosystems extend beyond the visible boundaries of land cover types. The elements of the landscape and ecological processes often extend across adjacent land cover units. Ignoring these transboundary connections puts at risk the ecosystem's function and can mislead management decisions regarding existing land covers (Field & Parrott, 2022). As Gordon et al. (2023) state, TEK provides sound ecological principles for land management because its foundations are based on environmental justice. Rather than TEK being considered as supplementary evidence on the periphery of Western science, it is more accurate to understand TEK as a distinct system of knowledge based on Indigenous worldviews and responsibilities towards the place being planned. Although there may be moments where TEK can be complemented with Western science, it is not simply a source of data; rather, it represents a comprehensive framework for understanding, relating to, and managing ecosystems (Grenz, 2024). In the management of PAs, this means going beyond integration, to endorse a respectful coexistence of these two distinct knowledge systems (Battiste & Henderson, 2000; Bartlett et al., 2012).

Integrating TEK as a planning tool provides valuable knowledge for the management of PAs, as this traditional knowledge has a comprehensive understanding of the function of ecosystems within land covers. TEK is based on millennia of interactions between Indigenous communities and the environment, but it has not been incorporated into land management policies and practices in many settler colonial nations (Walker, 2013). This exclusion from management conflicts with the principles of environmental justice, which require the

participation of affected communities in land-use decision-making. It is therefore emphasized that the use of the term 'traditional' does not mean that the knowledge is historical and no longer in use, but rather that it is based on observations over time and is subsequently living and evolving knowledge (Gordon et al., 2023).

The Role of Protected Areas in Climate Change and Resilience

An intact forest landscape is defined as a contiguous network of forest ecosystems and natural areas, such as wetlands or grasslands, which show no signs of human activity over an area of at least 500 km² (Potapov et al., 2017). Conserving these landscapes is essential for stabilizing carbon storage, supporting biodiversity, and maintaining other ecosystem services (ES), such as water regulation, that are necessary for their proper functioning. For example, the carbon sequestration potential of an ecosystem is connected to its biodiversity, as natural ecosystems have the capacity to store large amounts of carbon in structures such as tree bark or root systems (Weiskopf et al., 2024). With increased levels of alteration due to climate change, there is a greater potential for biodiversity loss, which results in increased carbon emissions and consequently more climate change. PAs have a crucial role to play both in mitigating the effects of climate change and in helping ecosystems and species to adapt to changing conditions. Some of the key roles of PAs that were identified by respondents are shown in Figure 16.

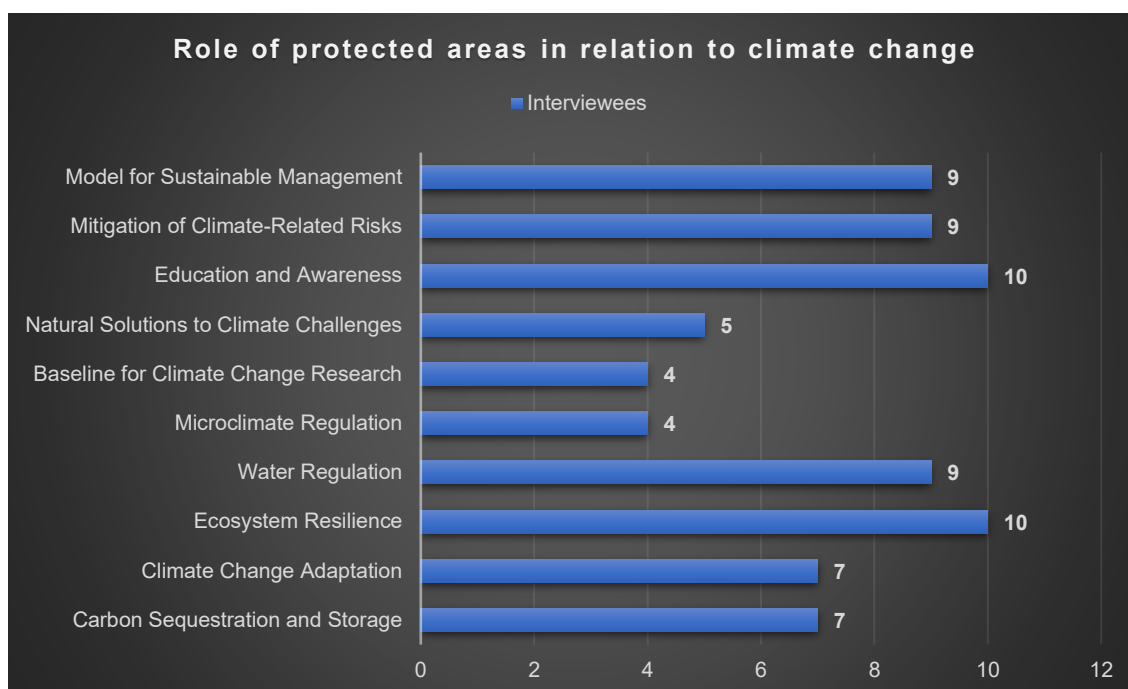


Figure 16 Role of protected areas in relation to climate change.

Ecosystem resilience was highlighted as one of the most essential roles. Large and contiguous PAs help to conserve biodiversity and enhance this capacity in the face of climate change impacts, as noted by Peter Garrett³¹, from Environmental and Climate Change Canada ECCC:

is buffers against extreme weather events, heavy rain events, flood events. There's no guarantee, but a well forested or a well vegetated landscape is going to be more resilient to those kinds of things than is a landscape that's been poorly managed or denuded and has no root structure [November 29, 2024].

PAs also serve as refuges and safe spaces for wildlife and ecosystems adapting to a changing climate as they provide corridors for species migration in response to shifting climate zones. Monitoring and research into the effects of climate change can support the actions that need to be taken to strengthen the resilience of ecosystems. To maximize these benefits in the face of climate change, large, interconnected PAs and adaptive management strategies are needed. Hammond, asserted:

if we want parks to help us adapt to what's coming in terms of climate change, then we need to start thinking about having complete transects of protected

³¹ Anonymous participant

areas, not just located at in upper elevation areas where industry doesn't really want to operate. Instead, protected areas need to occur uniformly along the transects from valley bottom to mountain top. That protected area design not only provides resilience, but it also provides unbroken, unfragmented corridors for species to migrate from unsuitable to suitable habitats, because of climate change. It is important to remember that the migration of plants requires much longer timeframes than animals. We need to avoid significantly fragmented landscapes, like landscape dominated by clear cuts and cities and farms. These types of landscapes effectively block migration, and protected areas in these landscapes can't buffer the effects of climate change or provide a way of adapting [October 30, 2024].

This reflection highlights the need for the design of PAs to be informed by climate considerations to ensure ecological connectivity across elevation gradients. Without such planning, fragmented landscapes will limit species migration and undermine the role of PAs in supporting climate adaptation.

Education and awareness were also identified as a significant aspect of addressing climate change, as PAs provide opportunities to educate the public about this issue and its impacts. Johnston, explained:

I think education is a really a big one. Something I've liked about my work in tourism is that you create direct connections between somebody who might have never been in a forested area. You're actually going and walking and touching things and seeing things, and you can explain to them. Making people realize that connection and tying connections in. I think people going to places like national parks, can build a connection where they can see themselves being impacted by whatever it is. That connection is about the loss of biodiversity and the decline in healthy ecosystems, forests just aren't growing the way they used to. You're having more flooding, more murky water coming down, less fish, higher populations of insects, where you can even see a connection there? Education has the biggest part making people understand why it's important their connection to this, whether they're far removed or living close by [September 10, 2024].

This observation emphasizes how direct experiences in PAs can foster personal connections to nature and climate changes impacts. Education within these spaces plays a crucial role in helping people understand not only the science behind environmental shifts but also how those changes affect their lives, connecting the gap between awareness and meaningful engagement.

The role of PAs in water regulation, climate-related risk mitigation, and sustainable land management was also mentioned in the interviews. Wetlands and forests within PAs are especially essential for flood mitigation and water

storage, functions that will become increasingly vital as climate change drives more extreme weather events. Hillary Page, Senior Director for BC at Nature Conservancy Canada (NCC), stated:

I think conservation area management can serve as a model for other public/private lands. Areas that have been thinned for resilience are more resistant to catastrophic forest fire. Perhaps that example would move others to adopt similar land management practices [October 2, 2024].

PAs can reduce climate-related risks through forest fire management strategies such as controlled burns and the maintenance of natural fire regimes. These practices support more sustainable landscape management in a changing climate, helping to maintain ecological integrity and reduce climate risk (Wang et al., 2022).

PAs can also help improve local climates by cooling urban areas and buffering against extreme weather events. Similarly, by protecting and maintaining natural infrastructure, such as wetlands for flood control, they help to address climate-related challenges. Potapov et al. (2017) note that until 2000, Canada maintained 40% of its forested area as intact forest landscapes. In recent years, however, the country has experienced a significant loss of this cover due to natural resource extraction activities such as clearcutting, road construction for forestry, and wildfires. Resource extraction activities take place outside PAs but disrupt the ecological integrity within them. Conservation efforts are an essential nature-based solution³² to maintain biodiversity and its productivity to cope with the effects of climate change. According to Mori et al. (2021), there is now greater recognition of the need for nature-based solutions, which involve working with nature to address the societal challenges posed by climate change.

The establishment of new PAs, the expansion of existing ones, and the creation of buffer zones can contribute to key aspects of reducing greenhouse gas emissions, which in turn helps maintain greater biodiversity that supports the

³² Actions designed to address societal challenges by protecting, conserving, restoring, and sustainably managing natural or modified ecosystems, while simultaneously benefiting human well-being and biodiversity (Choi et al., 2023).

productivity of regions and communities. Better management and restoration of natural ecosystems, such as forests and wetlands, help provide multiple benefits to society, including biodiversity conservation and carbon sequestration.

Stakeholder Involvement in Management Decisions

As some interviewees pointed out, greater awareness of ecosystems and ES could have an impact on management and decision-making. Highlighting the value of PAs beyond recreation and biodiversity could encourage more funding and strategic distribution of financial resources to support PAs. Julia Howe³³ from the Ministry of Environment and Parks said:

I would like to know the value that parks provide to us beyond recreational and I think that parks should know that too, because I think that when they argue that they need more dollars, or our protected areas are stressed, I think by showing the value they provide, will be incentive for elected officials to provide more funding for management or expansion of protected areas. From a BC Parks perspective, I think what they could do better is highlighting really more of the value beyond just recreational and biodiversity. Like really highlighting the services piece {November 28, 2024}.

And Sarah Clem, from BC parks Foundation emphasized:

there's chronic, sort of systemic underfunding, and I don't know what it takes to crack that. That needs to be changed, and now, being in the world of philanthropy, that's part of the solution. So, it's so complicated, one of our hopes is ideally targeting investment in the areas of greatest biodiversity importance, or climate resilience and connectivity. But you also need willing, you know, willing communities, willing proponents, of which the primary interest now is certainly First Nations communities. And so, ideally where that all aligns up in areas of hot spots would be fantastic. But some of the hot spots are remnant, like they're really the last holdouts. And there are some areas that are highly productive and could be very rich if restored. And so, there's just all these different lenses you could put on. Where do you make your investments to have the greatest impact? [October 28, 2024].

These perspectives indicate the relevance of effectively communicating the full range of benefits that PAs provide. By drawing attention to ES, such as clean water, carbon storage, and climate resilience, PAs managers can reinforce the need for increased funding and broader public and political support for PAs management and expansion.

³³ Anonymous participant

The creation of a natural asset inventory of PAs and Crown land to emphasize the value of these ecosystems was also mentioned. This could influence decision-makers, particularly those in urban areas, who may not see the immediate value of remote natural areas. Dickinson, explained:

I think climate change issue is this long-term thing, and the recognition that some of the ecosystems are going to change. What they should probably do is to have an inventory of what they got. Until you know what you have, you can't sort of anticipate what's going to change. If a wetland dries up and there's millions of wetlands, then maybe that's not a big deal. But if the wetland dries up and there's only a few wetlands, and it's the most important one, then you should pay attention to it and enhance the ability for it to maintain itself. But I honestly don't think parks are things that you should put fences around and say, whatever happens, happens. You have to be actively involved, because things change. I think management has to be very reluctant to intercede [September 19, 2024].

Awareness of ecosystems and ES could lead to more holistic land management approaches and better long-term decision-making. Greater awareness could help inform decisions about different levels and types of use within PAs and balancing conservation with sustainable human activities. Toperczer commented:

Enabling for more adaptive management allows for flexibility and learning, ensuring that management strategies can be adjusted as new information emerges. [...] A more holistic approach to land use is needed, one that involves collaborative discussions and considers the ecological and social impacts of our decisions [October 31, 2024].

The need for a proactive approach, starting with knowing what exists, can lead to informed, strategic, and responsive management decisions in the face of ecological change. Moreover, this appreciation could lead to better educational programs and more sustainable tourism practices in PAs. Johnston, clarified:

tourism is important, it brings money and provides resources to maintain these places, but also the education component of it, and when we lose funding, that could cut education. And what that does? It doesn't necessarily mean less people come there, it means less people are being educated about their impacts or the value of these places, which can lead to less pressure on the government, and potentially lead to less funding to do research. I think tourism is very important, but it also is very harmful, because we're seeing more and more over tourism issues all over the world, from an ecosystem perspective, but also cultural perspectives in cities and just overcrowding. So, tourism definitely has pros and cons, but I think it's very valuable for promoting national parks and increases in resources to do what parks should be doing [September 10, 2024].

Finally, more Indigenous communities have established their own PAs (Indigenous Protected and Conserved Areas – IPCAs) and are now pushing for policies that balance resource use with conservation, as Weilandt, expressed:

I think the shift has been to more public consultation for specific parks as far as planning goes. And of course, First Nations, involving them. A while back, 20 years ago, for First Nations, you asked them their opinion, but we'll go do our thing, and if we feel like it, we will put in what you said and try to account for it. Now, we listen to them a lot more, try not to do anything against what their wishes are. I think it helps us having to discuss things with them more, because they tend to be a lot more protective of the land. They're getting into Indigenous Protected Areas, providing more input to our planning processes, and not only for parks, they bring in the other ministries, so we don't have to fight those other ministries by ourselves [October 9, 2024].

This perspective reflects a growing shift toward more meaningful collaboration with Indigenous communities, recognizing their leadership in conservation and the value of IPCAs in shaping more inclusive and land-conscious planning processes.

Considering the influence of integrating the values that ecosystems and ES represent in the planning of PAs, it makes discussions among the different actors involved in decision-making essential. However, it is critical to note that these values may vary within stakeholder interests. As suggested by Jacobs et al. (2018), the development of regional workshops to identify values, as well as current and future risks, becomes a key factor that governments must address to achieve transitions in the way PAs are planned, especially in the context of climate change.

Future Directions for the Effective Management of Protected Areas

During the interviews, discussions centered on the future directions for effective PAs management. The stakeholders indicated the need to incorporate several key strategies: adaptive management, education programs, collaborative management, and climate change adaptation. These should be followed by fire management, restoration projects, and visitor capacity limits as the main directional strategies to consider. Table 6 shows the directions identified by

interviewees, with a brief description of the management approaches that need to be integrated into the planning process for PAs.

FUTURE DIRECTIONS	DESCRIPTION
Visitor Capacity Limits	Implement caps on the number of visitors allowed in certain areas to prevent overuse and environmental degradation.
Reservation Systems	Introduce reservation systems for popular areas to manage visitor numbers and spread-out use over time.
Zoning	Designate specific areas for different uses.
Infrastructure Planning	Carefully plan the placement of infrastructure to minimize ecological impact while providing necessary facilities for visitors.
Adaptive Management	Use monitoring data to inform and adjust management strategies over time.
Education Programs	Implement educational programs to inform visitors about conservation values and appropriate behavior in PAs. Implementation of naturalist programs to educated park visitors.
Wildlife Management	Employ strategies like Wildlife Guardians to manage human-wildlife interactions and protect animals from visitor impacts.
Alternative Site Development	Create and promote alternative recreation sites to disperse visitor pressure from overused areas.
Seasonal Management	Adjust management strategies based on seasonal changes in visitor numbers and ecological sensitivity.
Collaborative Management	Involve Indigenous communities and local stakeholders in decision-making processes for more holistic management approaches. A trend towards more diverse and flexible approaches to PAs creation and management, including buffer zones, Indigenous-led conservation, and landscape-level planning.
Ecosystem-based Planning	Implement comprehensive planning that considers entire ecosystems and their interconnections.
Restoration Projects	Undertake ecological restoration projects in areas impacted by recreation to maintain or improve conservation values.
Sustainable Tourism Practices	Promote and implement sustainable tourism practices that minimize environmental impact while still allowing for recreational use.
Fire Management	Implement controlled burns and other fire management strategies to maintain ecosystem health while considering recreational use.
Climate Change Adaptation	Incorporate climate change models into both recreation and conservation planning.

Table 6 Future directions for the effective management of protected areas

Some of these directions, such as reservation systems, zoning, education programs, and wildlife management, are already established in policies, frameworks, and guidelines at the federal, provincial, and territorial levels. For example, Parks Canada implements reservation systems and zoning strategies within national parks. BC Parks applies zoning and supports environmental education through interpretation programs. Wildlife management approaches are addressed in federal biodiversity strategies (like Canada's 2030 Nature Strategy³⁴ and SARA³⁵) and provincial conservation frameworks (like the BC Wildlife Act 1996). However, the extent and consistency of implementation across jurisdictions vary. This highlights the need for ecosystem-based planning that aligns these efforts. In this context, there are currently no clear actions or strategies to address the risks that PAs face. As set by Ray et al. (2021), the pathways developed are inadequate to achieve the goals of biodiversity conservation. They need to take part in a transformative change by implementing a government approach to sustainability, where conservation is consolidated into decision-making. This implies the need to shift from a short-term profit-maximization model to one that explicitly considers future generations, incorporates Indigenous-led conservation systems, and coordinates actions at all levels of government to overcome jurisdictional fragmentation.

Climate change will have a tremendous impact on ecosystems, altering species distributions, disrupting ecological interactions, and transforming ecosystem structure and function (Pecl et al., 2017). It intensifies the effects of natural processes, making the impacts on biodiversity more severe and affecting the well-being of current and future generations (Polasky et al., 2011). Climate change is only one of the significant risks that PAs will encounter. Other risks are resource extraction and shifting political agendas. Both create major problems when it comes to achieving conservation goals. These risks, combined with

³⁴ Canada's 2030 Nature Strategy: Halting and Reversing Biodiversity Loss in Canada (Government of Canada, 2024)

³⁵ Species at Risk Act (S.C. 2002, c. 29)

climate change, are accelerating the process of biodiversity loss, which have both urgent short-term consequences and serious long-term effects.

The directions mentioned here are a sample of possible actions that governments and agencies across Canada should consider when implementing planning processes. The proposed directions are in line with the learning framework for Adaptation Pathway Development suggested by Werners et al. (2021). According to this framework, expected outcomes must be consistent with short- and long-term adaptation processes. They must also promote collaborative learning through adaptive planning and capacity building while considering complex changes and transformations over the long term. The need to develop more in-depth measures that truly enable PAs to balance conservation and climate change objectives is necessary. Those measures should include: i) further research, workshops, and scenario planning processes; ii) creative thinking; and iii) systematic approaches regarding complex futures (Polasky et al., 2011), like the ones posed by climate change with wider groups of stakeholders.

Ecosystem Principles for Protected Areas Management

A principle is a fundamental proposition that serves as the basis for a guiding system. In this case, ecosystem principles for decision-making in PAs conservation provides guidance on how to include key factors to overcome the barriers to achieve the 30-by-30 conservation goal (COP15)³⁶ as well as the challenges posed by climate change. The ecosystem principles presented here (Figure 17) were developed based on stakeholder inputs, current literature, and best practices at both the federal and provincial levels, which are currently not integrated into a common guideline. This ecosystem principles are the result of an iterative analysis combining insights from the qualitative stakeholder interviews and a review of relevant literature.

³⁶ COP15: Kunming-Montreal Global Biodiversity Framework (Convention on Biological Diversity, 2022a).

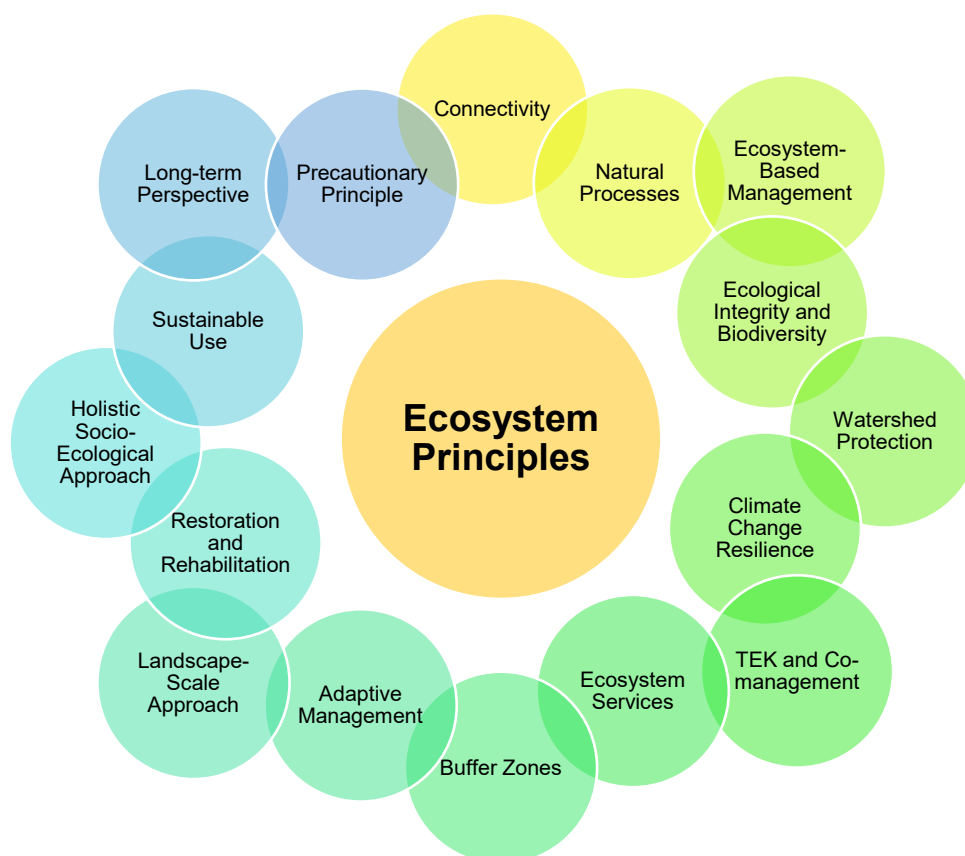


Figure 17 Core Ecosystem Principles for Protected Areas Management

These principles emphasize a holistic, ecosystem-based approach to PA planning and management. They focus on maintaining ecological integrity while also considering human needs, long-term sustainability, and the integration of Indigenous knowledge and co-management. These ecosystem principles are interconnected in several ways, therefore for the purpose of this research they were grouped in four core areas that represent the bases of a framework for management for PAs (Figure 18). The final categories are my own combination, developed to capture recurring themes and key values that emerged across the qualitative data and literature review.

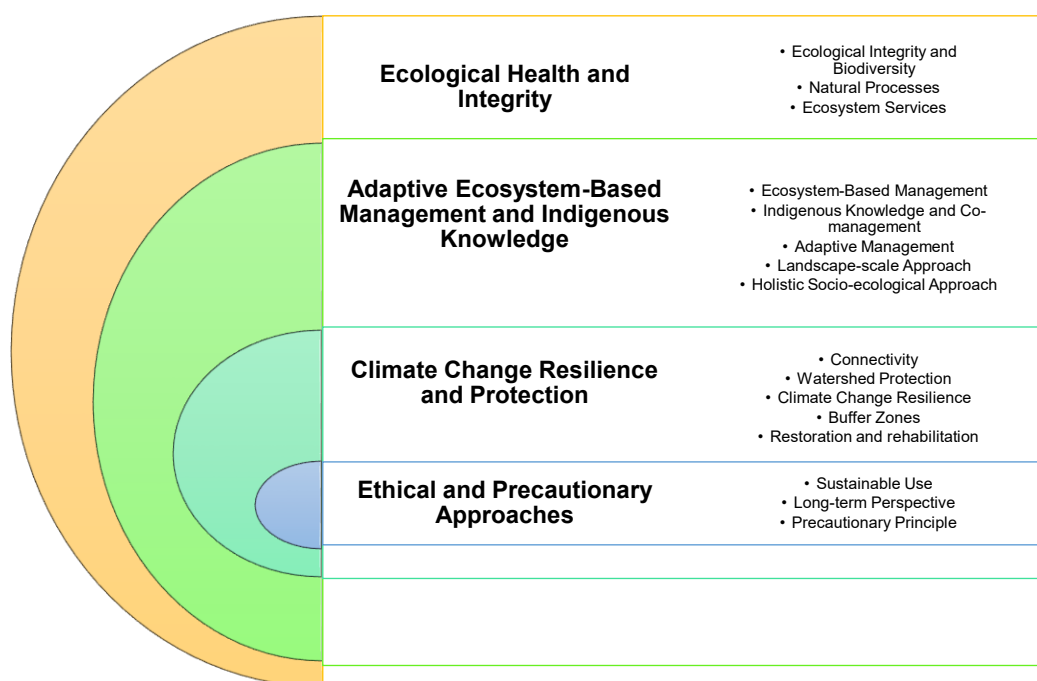


Figure 18 Ecosystem Principles for Protected Areas Management

Ecological Health and Integrity

The aim of this principle is to focus on maintaining healthy, functioning ecosystems with diverse species, prioritizing the protection of representative ecosystems. To ensure this, PA managers must allow and support natural processes. They also need to conduct research and monitor natural spaces to understand their condition and define actions that help them adapt to change. By integrating practices such as fire regimes and recognizing the importance of natural disturbances in maintaining ecosystem health, managers can help PAs adapt more effectively to climate change.

To have an accurate measurement of this indicator, it is imperative to assess their composition, structure, and function. In this context, the Ecological Health and Integrity principle should be aligned with the monitoring framework for the Post-2020 Global Biodiversity Framework (Convention on Biological Diversity, 2022). Awareness of the ecological changes in the wide range of ecosystems will help inform management decisions.

There is also a need for education that allows the public to engage with conservation efforts. There should also be clearly defined partnerships with First Nations, NGOs, inter-jurisdictional government approaches, and communities. Sustainable management practices are also required for resource extraction industries to prioritize permanent protection of primary forests, lands, and waters, as well as to promote models that offer incentives to farmers and ranchers for restoration and adoption of sustainable agricultural practices to support biodiversity and ecosystem goods and services. Finally, integrating Indigenous rights and knowledge, for example Indigenous fire management practices that have been developed over millennia, can improve ecosystem governance and resilience in PAs. Lastly, providing sufficient long-term funding to protect land and enhance conservation efforts can contribute to the ecological integrity of the system (Canadian Parks and Wilderness Society, 2023).

Adaptive Ecosystem-Based Management and Indigenous Knowledge

This principle aims to explore how to manage PAs from an ecosystem perspective rather than a human-centric view. It considers the entire interaction between ecosystems, including human needs, and not just individual species, resources, or ES. Implementing adaptive management strategies, based on ongoing monitoring and research, is fundamental.

One of the main aspects that this principle should encompass is the incorporation of TEK in planning and management for PAs. Supporting Indigenous-led conservation efforts and co-management, as well as planning and managing PAs as part of larger regional ecosystems, helps consider the interconnections between ecological and social systems. This approach brings a new perspective to how PAs can protect and conserve the land and ecosystems.

An ecosystem management approach provides a conceptual and strategic foundation for the protection and conservation of PAs. This approach involves viewing natural surroundings holistically and ensuring that land use decisions consider the various interconnections and the limited capacity of ecosystems to resist and recover from human activities that create pressure. The quality of the

ecosystems within these areas will influence the quality and management of surrounding areas (Parks Canada Agency, 2017).

The province of BC, the Nanwakolas Council, and Coastal First Nations had developed a planning and practice guide to implement Ecosystem-based Management for land use decisions on BC's Central and North Coast (Great Bear Rainforest—GBR) (Government of British Columbia, 2024). This guide integrates objectives and values regarding land, water, forests, and wildlife. In addition, it includes biodiversity objectives aimed at maintaining ecosystem health in the region while also improving the well-being of local communities. The guidance represents the stewardship needed across all ecological regions of BC and adjacent lands to implement ecosystem-based management and TEK.

Indigenous planning is based on traditional Indigenous worldviews that are grounded in the connection between human beings, nature, and communities (Walker, 2013). It also includes important principles of the resurgence of Indigenous cultures and governance, as well as resistance against colonial systems (Corntassel, 2012). Through these foundations, Indigenous planning aims to reshape and influence decision-making processes to better reflect Indigenous values and priorities (Morgan et al., 2021). Indigenous planning promotes the integration of traditions, culture, and Indigenous identities. The incorporation of Indigenous planning within the framework of existing planning schemes allows for the recovery of processes that incorporate a historical, contemporary, and future vision of ancestral knowledge among First Nations (Nadeau & Doyon, 2024). The foundations of Indigenous planning are based on the understanding of the place that wants to be planned, the community that inhabits it, and the stakeholders that have a connection with it. This means that planning must be carried out with the people of that place to engage planning in the traditions or principles that govern the way the world is viewed from an Indigenous perspective. This collective view empowers those involved in a planning process to think beyond individual needs and create strategies that anticipate, rather than react to, events (Walker, 2013).

Climate Change Resilience and Protection

The aim of this principle is to plan PAs for climate change impacts and focus on supporting resilient landscapes. It also looks to incorporate future climate scenarios in management decisions to define strategies that respond effectively and efficiently to the risks set by changing climates. To achieve this, it is necessary to ensure landscape-level connectivity between PAs and create networks through ecological patches, watersheds, and riparian corridors. Also, it is fundamental to clearly define what are the ecosystems that PAs are trying to preserve. For example, some PAs have entire watersheds within their boundaries; nonetheless, this was not the main aspect under which these areas were created. Most PAs in Canada were created under other premises, mainly associated with economic perspectives and utilitarian approaches to resource management of the 19th century. These approaches were based on the idea that federal or provincial governments should control and manage natural resources, particularly those related to timber and tourism (Sandlos, 2013), and at the same time denying access to Indigenous communities for land-based practices and local food procurement (Mason et al., 2022). Considering that conservation values have evolved, establishing what ecosystems are representative of PAs can lead to setting actions and strategies that look to maintain and enhance their characteristics.

Preserving water resources is crucial for both ecosystems and communities. Tools such as the BC Water Resources Atlas (Government of British Columbia, 2025) reveal that many aquifers and watersheds are only partially included within PA boundaries, suggesting opportunities to expand networks and create corridors that also safeguard water flows.

In a climate change scenario, the connectivity of PAs becomes a fundamental strategy. It promotes resilience, protects biodiversity, and improves the adaptive potential of natural systems. This is especially important given the role these areas play as refuges for species migration (Beckers & Carroll, 2020). As temperatures shift faster than the natural migration rate of many tree species (Natural Resources Canada, 2025), coordinated efforts are needed to assess

tree species distribution and forest composition to identify suitable areas for future establishment. Parks Canada and Nature Conservancy Canada, for example, have joined to promote ecological corridors adjacent to national parks (Parks Canada Agency, 2023).

Developing adaptation strategies in PAs can target two main challenges: climate change and biodiversity loss, as PAs sequester carbon while also serving as havens for biodiversity. The effects of climate change in PAs will generate pressure on the species that exist within these areas. However, this does not necessarily imply a decline in ecosystem biodiversity (Vellend et al., 2017). PAs are set aside mainly to maintain native species diversity, which has led to conservation approaches where change due to climate change is inevitable. Future scenarios that combine biodiversity loss and ecological changes have been suggested to define more dynamic and adaptive management approaches to face climate change and maintain ecosystem biodiversity (Jacobs et al., 2018). Future climate scenario models and the consideration of areas with a higher amount of carbon storage, such as primary forests, grasslands, and wetlands, can contribute to having a more resilient network. In addition, by integrating these areas into a network of PAs, either through IPCAs that connect with existing PAs or the extension of those that already exist, can create a more flexible and dynamic management system (IUCN, 2025).

Establishing buffer zones around PAs helps minimize edge effects and external pressures. Strategies for restoring degraded ecosystems within and around these areas are essential and should be addressed in this principle. These transitional spaces link PAs with surrounding landscapes, enabling genetic exchange, and supporting species survival (Bennett & Mulongoy, 2006). Creating effective buffer zones and ecological corridors requires a comprehensive assessment of habitat suitability and the prioritization of areas for restoration and conservation (Giannini et al., 2015). Following the Principles and Guidelines for Ecological Restoration in Canada's Protected Natural Areas (Parks Canada & Canadian Parks Council, 2008), restoration can enhance biodiversity, expand conservation areas, and strengthen PA networks.

Ethical and Precautionary Approaches

The aim of this principle is to allow for sustainable, low-impact human use that does not compromise ecological integrity within PAs. This principle integrates a long-term perspective, prioritizing ecological timeframes over short-term political or economic cycles. It also considers the use of the precautionary principle in decision-making, especially when dealing with uncertain ecological impacts.

Currently, management actions focus on short-term impacts, such as reducing carbon emissions or footprints, in alignment with federal and provincial goals. Given the ongoing biodiversity crisis, transformative actions at societal and organizational levels are needed. Long-term strategies must go beyond quantitative reduction targets and work towards creating outcomes that help us achieve desired futures (Von Flittner et al., 2022). To develop strategies aligned with the possible future scenarios, it is relevant to understand both the past and the present context. Integrating decision-makers, the scientific community, and local knowledge into this understanding is crucial for building the necessary approaches (Rodríguez et al., 2023).

The core values of PAs are to protect biodiversity and support a variety of ES that are relevant not only for human well-being but also for the intrinsic function of ecosystems. These services include climate regulation, recreation, and freshwater. Additionally, PAs play a key role in climate change adaptation and mitigation (Fromont et al., 2024). Long-term management strategies are needed to be in alignment with all these values. Socio-economic issues must be considered as well as local community involvement to create common values among decision-makers and stakeholders (Vuola & Pyhälä, 2016). This way, actions can gain support and, in the short and long term, become achievable.

The long-term perspective for PAs implies that these areas should be managed with a perpetuity point of view instead of a temporary approach (Dudley, 2013). This highlights the necessity of establishing conservation commitments and creating management plans that are ongoing and monitored. These plans should be revised to adjust approaches, identify actions that are not

working, and enhance those that generate positive outcomes in relation to the set goals. In this context, the sustainable management approach for PAs must incorporate the preservation of ecosystems and biodiversity. ES and cultural values must be considered by setting actions to manage the natural resources that are encompassed in PAs and defining strategies for the surrounding areas that might interfere with the conservation goals. The uncertainty created by future scenarios brought by climate change is not a justification for not implementing actions imperative to stop biodiversity loss and environmental degradation (European Commission, 2017). PAs must incorporate the precautionary principle into their decision-making process to establish actions that align with their goals.

Conclusion

This chapter specified the risks that PA managers face in their efforts to achieve conservation objectives. Major obstacles include human activities and overuse, resource extraction industries in their surroundings, habitat fragmentation, and political-economic pressures. These factors weaken conservation measures and actions. To guide land management decisions and maintain ecological integrity, the chapter illustrates the influence of planning strategies, such as linking land cover with ecosystem dynamics. As a strategy, this approach must also account for additional risks and diverse perspectives, recognizing that ecosystems extend beyond land cover features. Achieving balance requires large-scale and regional planning that establishes networks of PAs.

Other themes of importance were also noted. In some cases, the role of recreation takes priority over the role of conservation. The system needs to be changed to create a balance between these two goals. The need to integrate alternative management practices to overcome the challenges posed by climate change was also demonstrated. Perspectives on how to rethink management decision-making processes to emphasize strategies that focus on adaptive management, education programs, and collaborative management are crucial. These include TEK, climate change adaptation, fire management, restoration

projects, and visitor capacity limits. It became clear that more research, regional workshops, and scenario planning processes with stakeholders of varying backgrounds are required to identify and create future adaptation pathways to achieve conservation goals (Werners et al., 2021).

The number of beneficiaries, cultural preferences, accessibility, and availability influence the demand for ES. The values of ES also vary spatially by nature, as the factors of both the supply and demand of ES differ. The spatial dimension of certain services is further misrepresented by the geographical separation between the ecosystem unit that produces the service and its beneficiaries (Brander et al., 2022). As a result, the utilization of defined unit values in the evaluation or accounting of ES is invalid (Schmidt et al., 2016). Therefore, the economic value of ecosystems can no longer be the sole consideration of development. Ecosystem valuation goes beyond monetizable value and requires a paradigm shift. Decisions have implications that can affect the entire intrinsic functioning of an ecosystem and, consequently, the services that humans derive from them.

Indigenous peoples have a better perception of the ecosystems with which they coexist (Reyes-García et al., 2019). This knowledge can help societies adapt to socio-ecological changes and improve long-term sustainability because it provides additional information at a local scale that can be more suitable than what scientific data offers (Bethel et al., 2022). TEK offers an inclusive appreciation of ecosystem functions and their correlation with resource utilization systems, social structures, and strategies (Haq et al., 2023). Integrating TEK into land management and decision-making plays a significant role not only in defining new PAs (such as IPCAs) but also in managing those that already exist. TEK can improve current practices to extend the boundaries of established PAs and create connectivity corridors that reflect the areas an ecosystem needs to function effectively.

PAs can encompass various land covers, ecosystems, and ES. Some recreational parks also contain significant ecological features, making it essential to define their uses and capacity during the planning process. When a PA is

designated for conservation, clear goals are necessary to guide management and anticipate potential changes. Although recreational use may still be permitted, it must be carefully managed to prevent unnecessary pressure on the land. In this context, this chapter explores directional strategies identified by interviewees, which were grouped into four main ecosystem principles. These principles serve as a guide for PA management to support Canada's 30-by-30 conservation goals and inform actions to improve ecosystems and biodiversity within BC's PA networks (Weiskopf et al., 2024). The principles focus on Ecological Health and Integrity, Adaptive Ecosystem-based Management and Indigenous Knowledge, Climate Change Resilience and Protection, and Ethical and Precautionary Approaches. By integrating these principles, conservation objectives and biodiversity loss can be addressed, which can lead to improved management practices.

References

- Battiste, M. A., & Henderson, J. Y. (2000). *Protecting indigenous knowledge and heritage: a global challenge*. Purich Pub.
- BC Parks. (2020). *Conservation resources - Province of British Columbia | BC Parks*. BC Parks. <https://bcparks.ca/conservation/resources/>
- Beckers, J., & Carroll, C. (2020). *AdaptWest Climate Resilience Data Explorer*. Zenodo. <https://doi.org/10.5281/ZENODO.3824538>
- Bennett, G., & Mulongoy, K. J. (2006). *Review of experience with ecological networks, corridors and buffer zones*. CBD. <https://www.cbd.int/doc/publications/cbd-ts-23.pdf>
- Bartlett, C., Marshall, M., & Marshall, A. (2012). Two-Eyed Seeing and other lessons learned within a co-learning journey of bringing together indigenous and mainstream knowledges and ways of knowing. *Journal of Environmental Studies and Sciences*, 2(4), 331–340. <https://doi.org/10.1007/s13412-012-0086-8>
- Bethel, M. B., Braud, D. H., Lambeth, T., Dardar, D. S., & Ferguson-Bohnee, P. (2022). Mapping risk factors to climate change impacts using traditional ecological knowledge to support adaptation planning with a Native American Tribe in Louisiana. *Journal of Environmental Management*, 301, 113801. <https://doi.org/10.1016/j.jenvman.2021.113801>
- Brander, L., Schägner, J. P., & De Groot, R. (2022). On the potential use of the Ecosystem Services Valuation Database for valuation in the System of Environmental Economic Accounting. *One Ecosystem*, 7, e85085. <https://doi.org/10.3897/oneeco.7.e85085>
- Canada, E. and C. C. (2022, November 18). *Other Effective area-based Conservation Measures*. Wwww.canada.ca. <https://www.canada.ca/en/environment-climate-change/services/nature-legacy/other-effective-area-based-measures.html>
- Canadian Parks and Wilderness Society. (2023). *Joint environmental organization input into Canada's National Biodiversity Strategy and Action Plan*. https://cpaws.org/wp-content/uploads/2023/09/2030-Biodiversity-Strategy-Joint-Recommendations_Updated-Final-Version_19-Sept-2023.pdf
- Choi, E., Rao, R., & Czebiniak, R. (2023). What Exactly Are “Nature-based Solutions”? *Wwww.wri.org*. <https://www.wri.org/insights/what-exactly-are-nature-based-solutions>

- Convention on Biological Diversity. (2022a). *COP15: Final text of Kunming-Montreal Global Biodiversity Framework available in all UN languages*. Convention on Biological Diversity. <https://www.cbd.int/article/cop15-final-text-kunming-montreal-gbf-221222>
- Convention on Biological Diversity. (2022b). *Proposed Monitoring Framework for The Post-2020 Global Biodiversity Framework*. <https://www.cbd.int/doc/c/f191/8db7/17c0a45b42a5a4fcd0bbbb8c/sbstta-24-l-10-en.pdf>
- Corntassel, J. (2012). Re-envisioning resurgence: Indigenous pathways to decolonization and sustainable self-determination. *Decolonization: Indigeneity, Education & Society*, 1(1). <https://jps.library.utoronto.ca/index.php/des/article/view/18627>
- Dudley, N. (Ed.). (2013). *Guidelines for applying protected area management categories*. IUCN. <https://portals.iucn.org/library/node/9243>
- European Commission: Directorate-General for Environment and University of the West of England (UWE). Science Communication Unit (2017). *The precautionary principle: decision making under uncertainty*. Publications Office. <https://data.europa.eu/doi/10.2779/709033>
- Field, R. D., & Parrott, L. (2022). Mapping the functional connectivity of ecosystem services supply across a regional landscape. *ELife*, 11, e69395. <https://doi.org/10.7554/eLife.69395>
- Fisher, J. A., Patenaude, G., Giri, K., Lewis, K., Meir, P., Pinho, P., Rounsevell, M. D. A., & Williams, M. (2014). Understanding the relationships between ecosystem services and poverty alleviation: A conceptual framework. *Ecosystem Services*, 7, 34–45. <https://doi.org/10.1016/j.ecoser.2013.08.002>
- Fromont, C., Carrière, S. M., Bédécarrats, F., Razafindrakoto, M., & Roubaud, F. (2024). Long-term socio-environmental monitoring of protected areas is a persistent weak point in developing countries: Literature review and recommendations. *Biological Conservation*, 290, 110434. <https://doi.org/10.1016/j.biocon.2023.110434>
- Giannini, T. C., Tambosi, L. R., Acosta, A. L., Jaffé, R., Saraiva, A. M., Imperatriz-Fonseca, V. L., & Metzger, J. P. (2015). Safeguarding Ecosystem Services: A Methodological Framework to Buffer the Joint Effect of Habitat Configuration and Climate Change. *PLOS ONE*, 10(6), e0129225. <https://doi.org/10.1371/journal.pone.0129225>

- Gordon (Iñupiaq), H. S. J., Ross, J. A., Cheryl Bauer-Armstrong, Moreno, M., Byington (Choctaw), R., & Bowman (Lunaape/Mohican), N. (2023). Integrating Indigenous Traditional Ecological Knowledge of land into land management through Indigenous-academic partnerships. *Land Use Policy*, 125, 106469. <https://doi.org/10.1016/j.landusepol.2022.106469>
- Gohr, C., Von Wehrden, H., May, F., & Ibisch, P. L. (2022). Remotely sensed effectiveness assessments of protected areas lack a common framework: A review. *Ecosphere*, 13(4), e4053. <https://doi.org/10.1002/ecs2.4053>
- Government of Canada. (2024). *Canada's 2030 Nature Strategy: Halting and Reversing Biodiversity Loss in Canada - Canada.ca*. Canada.ca. <https://www.canada.ca/en/environment-climate-change/services/biodiversity/canada-2030-nature-strategy.html>
- Government of British Columbia. (2024). *Implementing the 2023 Great Bear Rainforest Land Use Order Ecosystem-Based Management Planning and Practice Guidance*. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-resource-use/land-water-use/crown-land/land-use-plans-and-objectives/westcoast-region/great-bear-rainforest/ebm_planning_and_practice_guidance_v1-1.pdf
- Government of British Columbia. (2025). *BC Water Resources Atlas*. Maps.gov.bc.ca. <https://maps.gov.bc.ca/ess/hm/wrbc/>
- Grenz, J. (2024). *Medicine wheel for the planet: a journey toward personal and ecological healing*. Knopf Canada.
- Grêt-Regamey, A., & Weibel, B. (2020). Global assessment of mountain ecosystem services using earth observation data. *Ecosystem Services*, 46, 101213. <https://doi.org/10.1016/j.ecoser.2020.101213>
- Haq, S. M., Pieroni, A., Bussmann, R. W., Abd-ElGawad, A. M., & El-Ansary, H. O. (2023). Integrating traditional ecological knowledge into habitat restoration: implications for meeting forest restoration challenges. *Journal of Ethnobiology and Ethnomedicine*, 19(1), 33. <https://doi.org/10.1186/s13002-023-00606-3>
- He, X., Liang, J., Zeng, G., Yuan, Y., & Li, X. (2019). The Effects of Interaction between Climate Change and Land-Use/Cover Change on Biodiversity-Related Ecosystem Services. *Global Challenges*, 3(9), 1800095. <https://doi.org/10.1002/gch2.201800095>
- Houde, N. (2007). *The Six Faces of Traditional Ecological Knowledge: Challenges and Opportunities for Canadian Co-Management*

Arrangements. *Ecology and Society*, 12(2), 34. <https://doi.org/10.5751/ES-02270-120234>

Institute for Integrative Science and Health. (2004). *Guiding principles (Two Eyed Seeing)*. [Www.integrativescience.ca](http://www.integrativescience.ca).
<http://www.integrativescience.ca/Principles/TwoEyedSeeing/>

Isbell, F., Tilman, D., Polasky, S., & Loreau, M. (2015). The biodiversity-dependent ecosystem service debt. *Ecology Letters*, 18(2), 119–134.
<https://doi.org/10.1111/ele.12393>

IUCN Red List. (2022). *Threats Classification Scheme (Version 3.3)*. IUCN Red List of Threatened Species. <https://www.iucnredlist.org/resources/threat-classification-scheme>

IUCN Red List of Ecosystems. (2022). *Red List of Ecosystems Categories & Criteria*. [iucnrl.org. https://iucnrl.org/rle-categ-and-criteria](https://iucnrl.org/rle-categ-and-criteria)

IUCN. (2025). *Protected areas and land use | IUCN*. [iucn.org. https://iucn.org/our-work/protected-areas-and-land-use](https://iucn.org/our-work/protected-areas-and-land-use)

Jacobs, B., Boronyak, L., Mitchell, P., Vandenberg, M., & Batten, B. (2018). Towards a climate change adaptation strategy for national parks: Adaptive management pathways under dynamic risk. *Environmental Science & Policy*, 89, 206–215. <https://doi.org/10.1016/j.envsci.2018.08.001>

Keith, D. A., Ferrer-Paris, J. R., Nicholson, E., Bishop, M. J., Polidoro, B. A., Ramirez-Llodra, E., Tozer, M. G., Nel, J. L., Mac Nally, R., Gregr, E. J., Watermeyer, K. E., Essl, F., Faber-Langendoen, D., Franklin, J., Lehmann, C. E. R., Etter, A., Roux, D. J., Stark, J. S., Rowland, J. A., ... Kingsford, R. T. (2022). A function-based typology for Earth's ecosystems. *Nature*, 610(7932), 513–518. <https://doi.org/10.1038/s41586-022-05318-4>

Kramer, K., Bouriaud, L., Feindt, P. H., Van Wassenae, L., Glanemann, N., Hanewinkel, M., Van Der Heide, M., Hengeveld, G. M., Hoogstra, M., Ingram, V., Levermann, A., Lindner, M., Mátyás, C., Mohren, F., Muys, B., Nabuurs, G.-J., Palahi, M., Polman, N., Reyer, C. P. O., ... Yousefpour, R. (2022). Roadmap to develop a stress test for forest ecosystem services supply. *One Earth*, 5(1), 25–34.
<https://doi.org/10.1016/j.oneear.2021.12.009>

Kuemmerle, T. (2024). Moving beyond simplistic representations of land use in conservation. *Conservation Letters*, 17(5), e13055.
<https://doi.org/10.1111/conl.13055>

- Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research Policy*, 41(6), 955–967. <https://doi.org/10.1016/j.respol.2012.02.013>
- Mason, C. W., Carr, A., Vandermale, E., Snow, B., & Philipp, L. (2022). Rethinking the Role of Indigenous Knowledge in Sustainable Mountain Development and Protected Area Management in Canada and Aotearoa/New Zealand. *Mountain Research and Development*, 42(4). <https://doi.org/10.1659/mrd.2022.00016>
- Morgan, T. K. K. B., Reid, J., McMillan, O. W. T., Kingi, T., White, T. T., Young, B., Snow, V., & Laurenson, S. (2021). Towards best-practice inclusion of cultural indicators in decision making by Indigenous peoples. *AlterNative: An International Journal of Indigenous Peoples*, 17(2), 202–214. <https://doi.org/10.1177/11771801211015686>
- Mori, A. S., Dee, L. E., Gonzalez, A., Ohashi, H., Cowles, J., Wright, A. J., Loreau, M., Hautier, Y., Newbold, T., Reich, P. B., Matsui, T., Takeuchi, W., Okada, K., Seidl, R., & Isbell, F. (2021). Biodiversity–productivity relationships are key to nature-based climate solutions. *Nature Climate Change*, 11(6), 543–550. <https://doi.org/10.1038/s41558-021-01062-1>
- Nadeau, M., & Doyon, A. (2024). Exploring ethical space in land use planning. *Critical Policy Studies*, 18(4), 660–681. <https://doi.org/10.1080/19460171.2024.2305920>
- Natural Resources Canada. (2025). *Distribution of tree species - Natural Resources Canada*. Canada.ca. <https://natural-resources.canada.ca/climate-change/climate-change-impacts-forests/distribution-tree-species>
- Parks Canada Agency. (2017). *Protecting and Managing Park Ecosystems*. Canada.ca. <https://parks.canada.ca/agence-agency/bib-lib/politiques-policies/gestion-management/princip/sec2/part2a/part2a5>
- Parks Canada Agency. (2023). *Connecting wildlife habitats for a healthy planet - Nature and science*. Parks.canada.ca. <https://parks.canada.ca/nature/science/conservation/connectivite-connectivity>
- Parks Canada, & Canadian Parks Council (Eds.). (2008). *Principles and guidelines for ecological restoration in Canada's protected natural areas*. National Parks Directorate, Parks Canada Agency. <https://parks.canada.ca/nature/science/conservation/ie-ei/re-er/pag-pel#a.2.2>

- Pecl, G. T., Araújo, M. B., Bell, J. D., Blanchard, J., Bonebrake, T. C., Chen, I.-C., Clark, T. D., Colwell, R. K., Danielsen, F., Evengård, B., Falconi, L., Ferrier, S., Frusher, S., Garcia, R. A., Griffis, R. B., Hobday, A. J., Janion-Scheepers, C., Jarzyna, M. A., Jennings, S., ... Williams, S. E. (2017). Biodiversity redistribution under climate change: Impacts on ecosystems and human well-being. *Science*, 355(6332), eaai9214. <https://doi.org/10.1126/science.aai9214>
- Polasky, S., Carpenter, S. R., Folke, C., & Keeler, B. (2011). Decision-making under great uncertainty: environmental management in an era of global change. *Trends in Ecology & Evolution*, 26(8), 398–404. <https://doi.org/10.1016/j.tree.2011.04.007>
- Potapov, P., Hansen, M. C., Laestadius, L., Turubanova, S., Yaroshenko, A., Thies, C., Smith, W., Zhuravleva, I., Komarova, A., Minnemeyer, S., & Esipova, E. (2017). The last frontiers of wilderness: Tracking loss of intact forest landscapes from 2000 to 2013. *Science Advances*, 3(1), e1600821. <https://doi.org/10.1126/sciadv.1600821>
- Quine, C. P., Bailey, S. A., & Watts, K. (2013). PRACTITIONER'S PERSPECTIVE: Sustainable forest management in a time of ecosystem services frameworks: common ground and consequences. *Journal of Applied Ecology*, 50(4), 863–867. <https://doi.org/10.1111/1365-2664.12068>
- Ray, J. C., Grimm, J., & Olive, A. (2021). The biodiversity crisis in Canada: failures and challenges of federal and sub-national strategic and legal frameworks. *FACETS*, 6, 1044–1068. <https://doi.org/10.1139/facets-2020-0075>
- Reyes-García, V., Fernández-Llamazares, Á., McElwee, P., Molnár, Z., Öllerer, K., Wilson, S. J., & Brondizio, E. S. (2019). The contributions of Indigenous Peoples and local communities to ecological restoration. *Restoration Ecology*, 27(1), 3–8. <https://doi.org/10.1111/rec.12894>
- Rodríguez, T., Reu, B., Bolívar-Santamaría, S., Cortés-Aguilar, A., & Buendía, C. (2023). A framework for participatory scenario planning to guide transitions towards sustainability in mountain social-ecological systems: A case study from the Colombian Andes. *Land Use Policy*, 132, 106817. <https://doi.org/10.1016/j.landusepol.2023.106817>
- Sandlos, J. (2013). Nature's nations: the shared conservation history of Canada and the USA. *International Journal of Environmental Studies*, 70(3), 358–371. <https://doi.org/10.1080/00207233.2013.800356>

- Schulze, K., Knights, K., Coad, L., Geldmann, J., Leverington, F., Eassom, A., Marr, M., Butchart, S. H. M., Hockings, M., & Burgess, N. D. (2018). An assessment of threats to terrestrial protected areas. *Conservation Letters*, 11(3), e12435. <https://doi.org/10.1111/conl.12435>
- Schmidt, S., Manceur, A. M., & Seppelt, R. (2016). Uncertainty of Monetary Valued Ecosystem Services – Value Transfer Functions for Global Mapping. *PLOS ONE*, 11(3), e0148524. <https://doi.org/10.1371/journal.pone.0148524>
- Vellend, M., Baeten, L., Becker-Scarpitta, A., Boucher-Lalonde, V., McCune, J. L., Messier, J., Myers-Smith, I. H., & Sax, D. F. (2017). Plant Biodiversity Change Across Scales During the Anthropocene. *Annual Review of Plant Biology*, 68(1), 563–586. <https://doi.org/10.1146/annurev-arplant-042916-040949>
- Von Flittner, Z. F., Gaziulusoy, I., Nielsen, S., & Marttila, S. (2022). Design for Sustainability Transitions: Reflections on Practice. *Cuadernos Del Centro de Estudios de Diseño y Comunicación*, 157. <https://doi.org/10.18682/cdc.vi157.6850>
- Vuola, M., & Pyhälä, A. (2016). Local community perceptions of conservation policy: rights, recognition and reactions. *Madagascar Conservation & Development*, 11(2), 77. <https://doi.org/10.4314/mcd.v11i2.6>
- Walker, R. (2013). *Reclaiming Indigenous Planning*. McGill-Queen's University Press.
- Wang, W., Wu, W., Guo, F., & Wang, G. (2022). Fire regime and management in Canada's protected areas. *International Journal of Geoheritage and Parks*, 10(2), 240–251. <https://doi.org/10.1016/j.ijgeop.2022.04.003>
- Weiskopf, S. R., Isbell, F., Arce-Plata, M. I., Di Marco, M., Harfoot, M., Johnson, J., Lerman, S. B., Miller, B. W., Morelli, T. L., Mori, A. S., Weng, E., & Ferrier, S. (2024). Biodiversity loss reduces global terrestrial carbon storage. *Nature Communications*, 15(1), 4354. <https://doi.org/10.1038/s41467-024-47872-7>
- Werners, S. E., Wise, R. M., Butler, J. R. A., Totin, E., & Vincent, K. (2021). Adaptation pathways: A review of approaches and a learning framework. *Environmental Science & Policy*, 116, 266–275. <https://doi.org/10.1016/j.envsci.2020.11.003>
- Xiao, Y., Huang, M., Xie, G., & Zhen, L. (2022). Evaluating the impacts of land use change on ecosystem service values under multiple scenarios in the

Hunshandake region of China. *Science of The Total Environment*, 850, 158067. <https://doi.org/10.1016/j.scitotenv.2022.158067>

Xu, Z., & Peng, J. (2024). Recognizing ecosystem service's contribution to SDGs: Ecological foundation of sustainable development. *Geography and Sustainability*, 5(4), 511–525. <https://doi.org/10.1016/j.geosus.2024.05.001>

CHAPTER 4

An Ecosystem-Based Approach: Strategic Planning and Decision-Making in Wells Gray Provincial Park

The purpose of this chapter is to present Wells Gray Provincial Park as a case study to demonstrate how an ecosystem-based approach, one of the key ecosystem principles identified in Chapter 3, can be incorporated to prioritize ecosystems and their services as Critical Decision Factors (CDFs)³⁷. This approach supports the development of a strategic thinking model for stakeholder dialogue and aims to improve decision-making in the park's planning processes. The chapter also explores how ecosystem principles can inform a more effective master plan. The development of this involved integrating and spatially interconnecting ecosystems, land cover types, and Biogeoclimatic Ecosystem Classification (BEC) zones within the park. Additionally, it illustrates how climate change may impact ecosystems and their associated ecosystem services (ES). This process utilized future BEC change scenarios based on Intergovernmental Panel on Climate Change projections (IPCC, 2023; Hausfather, 2018).

There is a need to integrate the COP15³⁸ target (protect at least 30% of land and oceans by 2030) with other goals of the Convention on Biological Diversity (CBD). This integration should focus on increasing the extent of protected areas (PAs), but also on enhancing the resilience of the ecosystems that currently exist within them. Mapping ecosystems and identifying their associated risks is crucial. In addition, establishing buffer areas to protect existing ecosystems and analyzing wildlife refugia for species as a response to climate change can also significantly prevent further biodiversity loss. Consequently, it is fundamental to consider the heterogeneity (species diversity) and restoration of

³⁷ CDFs are key elements or criteria that are fundamental in guiding and evaluating decisions related to land use, policy, or planning. These factors need to be identified early in the planning process and serve as the foundation for assessing the potential impacts of proposed actions on the environment, society, and economy (Partidario & Gomes, 2013).

³⁸ COP15: Final text of Kunming-Montreal Global Biodiversity Framework (CBD, 2022).

PAs, not only in terms of quantity but also the quality of ecosystems and their functions (Weiskopf et al., 2024).

According to the assessment developed by Mitchell et al. (2021), most of the ES hotspots across Canada related to climate regulation, freshwater, and nature-based recreation remain outside the PAs network of the country. This presents challenges to achieve conservation goals. Only 12% of the total area with a climate regulation ES potential, 11% of freshwater, and 11% of nature-based recreation are within PA and OECMs. While natural resource extraction economies, such as forestry, mining, oil and gas, and agriculture, cover 11% of climate regulation, 66% of freshwater, and 63% of nature-based recreation ES.

Legislation in Canada governs the ecosystem principles of natural areas through the concept of ecological integrity. While zoning guidelines and indicators measure species, habitat, and resource variables, the incorporation of additional factors that influence ecosystem development and behaviour must be established from the very beginning of the planning process. In this chapter, I argue that adopting a dynamic functional perspective of ecosystems, rather than depending only on biogeographic or biophysical approaches, may offer a more effective and direct way to address the challenge of conserving biodiversity and sustaining ES (Keith et al., 2022).

Wells Gray Provincial Park

Wells Gray Provincial Park was established in 1939 and named after the Minister of Lands for British Columbia Wellesley Gray (Figure 19). The decision to create this PA was based on considerations of tourism, hunting, fishing, waterfalls, and other natural features (Government of British Columbia et al., 1986). This area was classified as a Class A park under the Parks Act (1996), which are areas '*dedicated to the preservation of their natural environment for the inspiration, use and enjoyment of the public*' (Government of British Columbia, 1996).

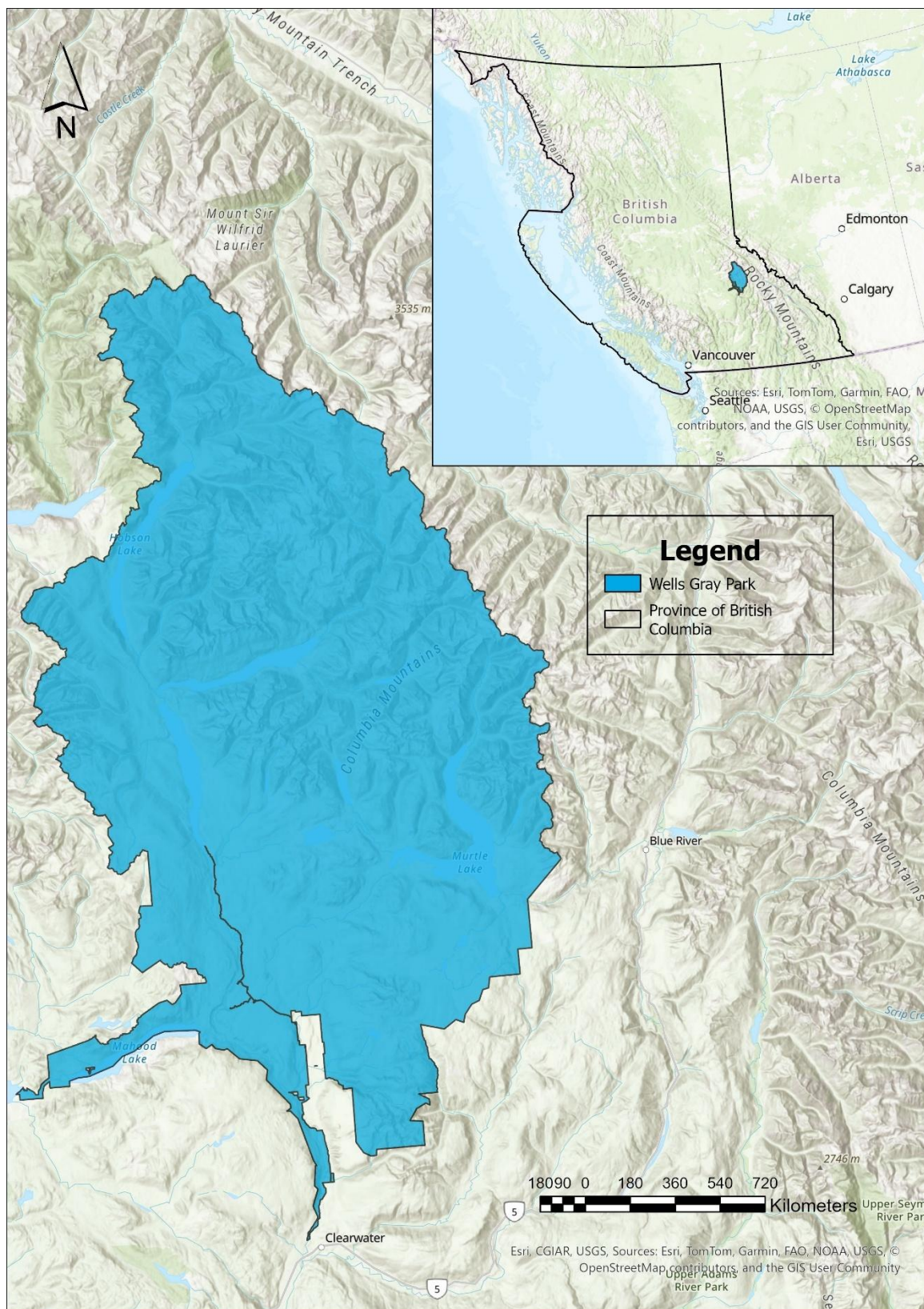


Figure 19 Wells Gray Provincial Park

This PA has a Master Plan established by the Government of BC in 1986, an Interim Management Statement from 1991, and a Management Direction Statement from 1999 for the addition of the Clearwater River corridor. The Wells Gray Master Plan (1986) establishes the role of the park in regard to the conservation of undisturbed natural resources and recreation by providing the public access to experience nature through a wide range of outdoor opportunities (camping, hiking, fishing, angling, hunting, motorboating, horseback riding, alpine appreciation, canoeing, and research). Additionally, a zoning strategy was defined for the management of different units of the park to differentiate levels of recreational use (intensive recreation, natural environment, and wilderness). Within this management, objectives and policies were specified based upon the Parks Act for natural resources related to land, water, vegetation, wildlife, cultural heritage, visual amenities, and minerals. The central principle connecting them was that the natural resources of Wells Gray Park will be managed to preserve and enhance high-quality wilderness settings that represent the park's three regional landscapes (Cariboo Mountains, Quesnel Highland, and Northern Shuswap Highland ecosections³⁹).

It is imperative to emphasize here, that this Master Plan considered four main issues at the center of the plan: i) What is Wells Grey Park's park system role and potential and how should its main assets be handled and shared with visitors?; ii) Given the future of park extensions, and private inholdings with non-conforming land uses, what land management strategies are appropriate?; iii) What forest, fish, and wildlife resources management policies should consider forest health, fishery capabilities, wildlife populations and habitats, habitat enhancement, and recreational pressures?; and iv) How can recreationalists use the park while preserving its values? Considering the vastness of Wells Gray Provincial Park, recreational use and enjoyment can be limited by access challenges. Therefore, options such as roads, horses, and helicopters should be

³⁹ In British Columbia, ecosections are smaller areas within a larger ecological region that have similar landforms, climate, and natural features. They show repeating patterns of things like hills, soil types, and plant communities. Ecosections help to describe the province's ecological diversity (Government of British Columbia, 2011).

considered to improve accessibility. Although there were numerous meetings with stakeholders to address these issues, a consensus was not achieved. The Master Plan reflects the main actions needed to preserve the future of one of the most significant parks in the province (Government of British Columbia et al., 1986).

Wells Gray has a total area of 5,404 km² (540,412 hectares or 1.33 million acres). It is located in the Thompson-Nicola and Cariboo Regional Districts of BC and belongs to the Interior Wet Belt⁴⁰ of the province. According to the Ecoregion Classification System⁴¹ established by the Province of British Columbia (BC), Wells Gray is majority placed in the Southern Interior Mountains ecoprovince⁴², between the Northern Columbia Mountains and Columbia Highlands ecoregions⁴³. These ecoregions are subdivided into different ecosections, and Wells Gray Provincial Park is located within the Cariboo Mountains, Quesnel Highland, and Northern Shuswap Highland ecosections (Demarchi, 2011).

Ecodomain:	Humid Temperate
Ecodivision:	Humid Continental Highlands
Ecoprovince:	Southern Interior Mountains
Ecoregions:	Northern Columbia Mountains Columbia Highlands
Ecosections:	Cariboo Mountains Quesnel Highland Northern Shuswap Highland
Ecozones / Biogeoclimatic Zones (BEC):	Interior Douglas-fir (IDH) Interior Cedar-Hemlock (ICH) Engelmann Spruce Subalpine Fir (ESSF) Interior Mountain Heather-Alpine (IMA)

Table 7 Ecoregion Classification of Wells Gray based on the Ecoregion Classification System Province of BC (Demarchi, 2011)⁴⁴

⁴⁰ The Interior Wet Belt (IWB) in British Columbia is a discontinuous region of humid forests located in the Columbia Mountains, within the Interior Cedar Hemlock Ecozone. It includes the rare Inland Temperate Rainforest (ITR), which receives heavy rainfall from Pacific weather systems rising over the mountains. The IWB plays a key role in carbon storage and conservation but faces threats from logging and other human activities (Parks Canada, 2024).

⁴¹ This system stratifies the province's ecosystems into five hierarchical levels, moving from broad regional units to smaller, more specific areas. The system considers physiography, climate, and broad plant and animal distributions to define these ecological units (Demarchi, 2011).

⁴² An ecoprovince is a large area that has similar weather patterns, land shapes, and natural features (Demarchi, 2011).

⁴³ An ecoregion is a specific area within an ecozone that shares similar environmental features like climate, land, plants, and animals. It's a way to group places that have similar natural conditions (Data Basin & Conservation Biology Institute, 2020).

⁴⁴ Ecozone – the broadest ecological unit, Ecoprovince – based on major climatic and physiographic patterns. Ecoregion – grouped by similarities in climate and broad vegetation. Ecosection – finer detail;

The ecological characteristics of this area can be represented in the BEC zones established by the Province of BC to define, describe, and map ecosystem-based units at various spatial scales. An approach that combines climate, soil, and vegetation characteristics to describe an area (Ministry of Forest Lands and Natural Resource Operations, 2021). The BEC zones represented by Wells Gray are Interior Douglas-fir (IDF), Interior Cedar-Hemlock (ICH), Engelmann Spruce Subalpine Fir (ESSF), and Interior Mountain Heather-Alpine (IMA) as seen in Figure 20 and Figure 21. This classification refers to the types of tree species that dominate an area based on climate conditions. These tree types are an important part of the ecosystems found in Wells Gray.

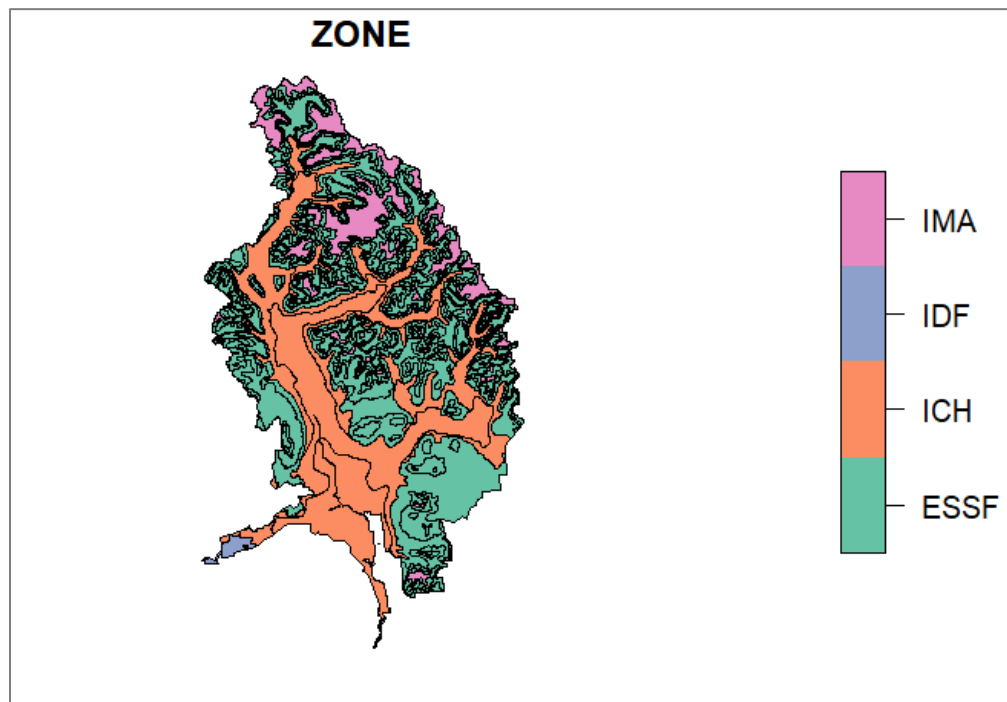


Figure 20 Wells Gray Provincial Park BEC zones based on the BC Data Catalogue (Government of British Columbia, 2025)⁴⁵

distinct terrain and ecological processes. Ecozones/Biogeoclimatic Zones (BEC) – based on climate, soil, and vegetation, often used together with ecozones in land use planning.

⁴⁵ BEC Zones: Interior Douglas-fir (IDH), Interior Cedar-Hemlock (ICH), Engelmann Spruce Subalpine Fir (ESSF), Interior Mountain Heather-Alpine (IMA).

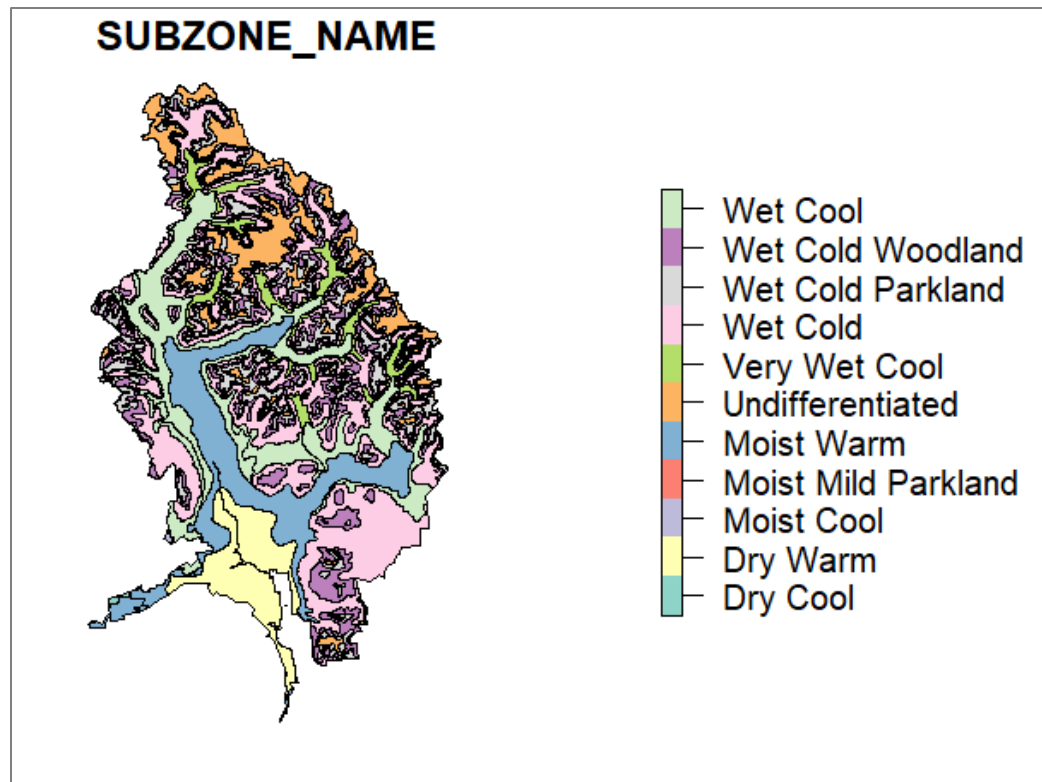


Figure 21 Wells Gray Provincial Park BEC sub-zones based on the BC Data Catalogue (Government of British Columbia, 2025)

The number of interrelationships between the ecological characteristics of a natural area go beyond the type of trees that inhabit it. Other living species and organisms interact to maintain biodiversity, and features such as climate, water bodies, and landscapes play key roles at the ecosystem and ecological levels in sustaining life. The climate and vegetation characteristics used in the BEC zones classification help illustrate the broad ecological diversity found within Wells Gray.

Wells Gray Provincial Park represents a valuable source of biodiversity, with a wide range of land covers and ecosystems. However, it is surrounded by various land uses that pose risks to its conservation. By establishing clear connections between land cover, ecosystems, and ES, Wells Gray's planning processes can better center ecosystem functions, supporting long-term conservation and resilience in this unique natural area.

Shaping Future Management Approaches for Wells Gray

To improve management directions in the Wells Gray Provincial Park master plan, it is necessary to incorporate and align ecosystem principles with the park's values and mission. This will require significant revision of the master plan and the involvement of stakeholders, park managers, and environmental professionals. Planning opportunities can emerge from identifying the ecosystems, ES, and their links to land cover features, BEC zones and associated changes. This strategy can be the first step to achieve an ecosystem-based approach for this park and guide the beginning of actions to update and improve its master plan.

The exercise that follows demonstrates how the ecosystems and ES within Wells Gray can become CDFs. These CDFs can serve as the starting point for a strategic thinking model that promotes stakeholder dialogue and facilitates decision-making. This will provide a more comprehensive and combined assessment of the socio-ecological system that Wells Gray represents for the province of BC (Partidário MR, 2012; Geneletti, 2015). Nonetheless, more research and workshops are necessary to add other actions that the ecosystem principles in Chapter 3 established. Consequently, it is essential to incorporate Traditional Ecological Knowledge (TEK) and long-term management strategies. Additionally, the development and implementation of ecological integrity indicators, along with climate change resilience strategies such as landscape-level connectivity networks and buffer zones, must be carried out.

The Ecosystems and Ecosystem Services of Wells Gray

The System of Environmental-Economic Accounting – Ecosystem Accounting (SEEA EA) combines biophysical data to measure ecosystem services and assess their value in response to economic and human activities (United Nations 2021a). SEEA has developed a reference list of ecosystem services, including those relevant to climate change policies. The ARIES for SEEA tool, developed by the open-source platform ARIES (2021), produces ecosystem accounts in a fast, scalable, and adaptable manner consistent with

the SEEA framework (United Nations, 2021b). Using the ARIES for SEEA Explorer (k.LAB, 2021), the ecosystems in Wells Gray Provincial Park were assessed (Figure 22).

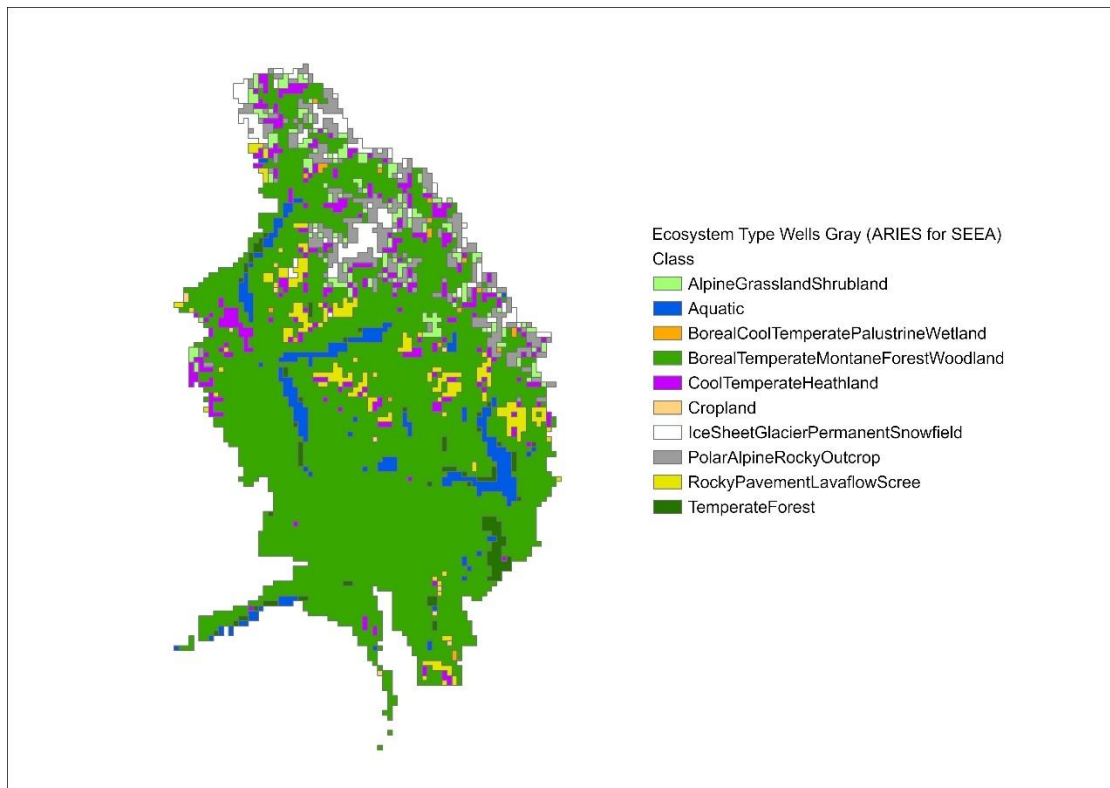


Figure 22 Wells Gray Provincial Park Ecosystem type ARIES for SEEA Explorer (k.LAB, 2021)

ARIES for SEEA uses the IUCN Global Ecosystem Typology (IUCN Global Ecosystem Typology, 2022), a classification framework for Earth's ecosystems that integrates their functional and compositional characteristics. The main ecosystem type in Wells Gray is Boreal Temperate Montane Forest Woodland (Figure 23), which is the equivalent of T2.1 Boreal and Temperate High Montane Forests and Woodlands, and T4.4 Temperate Woodlands in the IUCN Global Ecosystem Typology. This ecosystem covers 69.88% of the PA and supports a variety of species, including fungi, mosses, liverworts, herbivores such as caribou, bears, and deer, as well as insects and omnivores like moose. This typology provides a variety of provisioning ES, including wood, wildlife, plants, and other biomass. It also offers cultural ES, such as recreation, visual amenity,

education, scientific research, and services tied to Indigenous use, such as traditional hunting, gathering, and spiritual practices. This ecosystem also contributes significantly to regulating ES, such as global climate, precipitation patterns, air filtration, soil and sediment retention, pollination, nursery services, and habitat maintenance (United Nations, 2021a). The provisioning and regulating ES presented in Appendix F account for the ecosystem function and potential that Wells Gray represents as PA. Therefore, it is crucial to identify them as the CDFs within which to frame the management plan for this area (Partidario & Gomes, 2013).

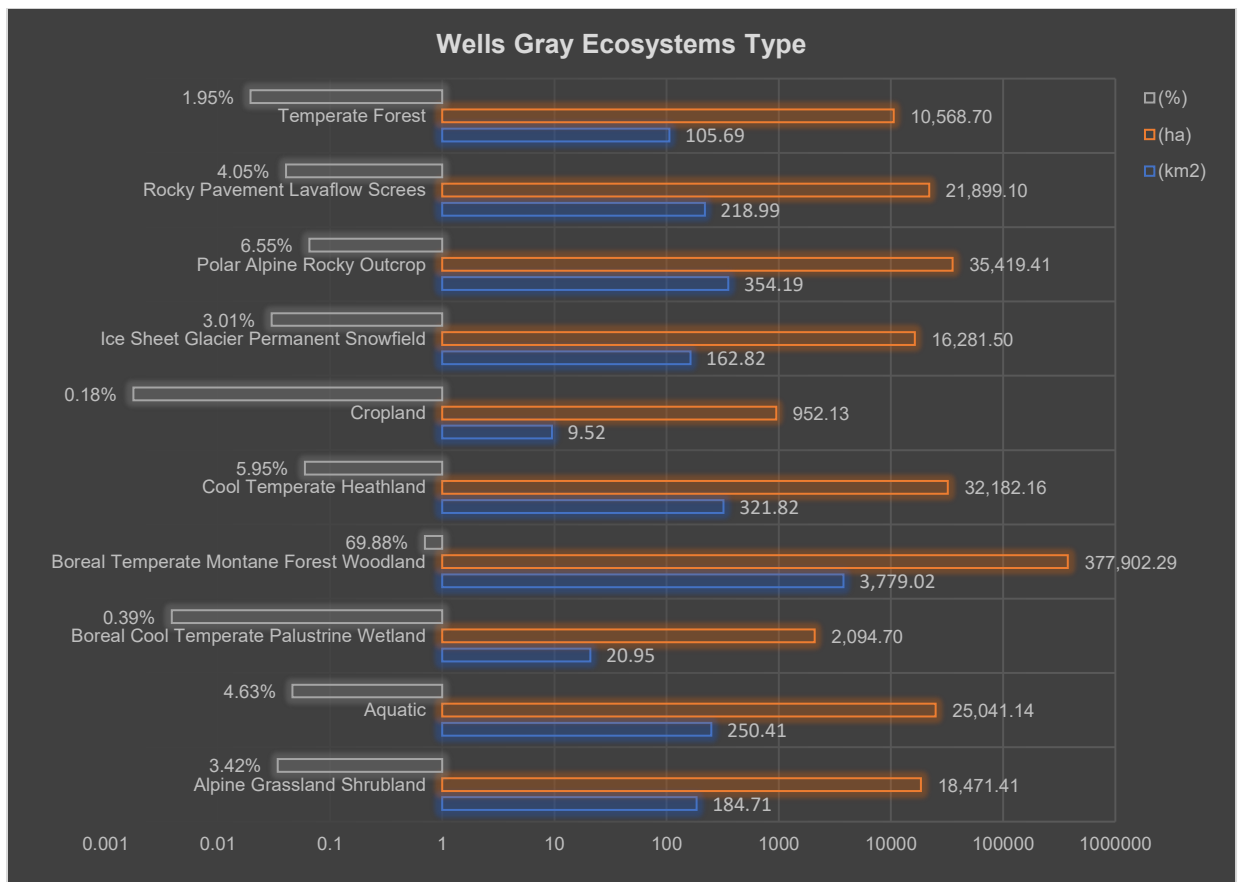


Figure 23 Wells Gray Provincial Park Ecosystems type.

To preserve the quantity (area) and quality (biodiversity) of natural ecosystems is necessary to maintain the functional diversity of ecosystems and the services that flow from them (Isbell et al., 2015). For that reason, it is required

to identify their ecological processes and ecosystem functions. In addition, knowing the role they play in the environment and the factors that enhance or limit their development is crucial (Keith et al., 2022).

The ecosystem properties of the ecosystem types T2.1 Boreal and Temperate High Montane Forests and Woodlands and T4.4 Temperate Woodlands, represent most of the area of Wells Gray (IUCN Global Ecosystem Typology, 2022):

- T2.1: The growth and reproduction of the species is seasonal; hence, it is limited. There is also winter dormancy and hibernation, as well as migration and the forest-tolerated frost environment.
- T4.4: High seasonal diversity and low endemism of plants support a complex trophic network of invertebrate and vertebrate consumers, like large herbivores and their predators, which regulate the chain. There is also a fire- and seasonal drought-tolerant environment.

These ecosystem properties and functions are significant for guiding potential actions and land uses in this area. If the management plan incorporates these properties into its core strategies, the ecosystem's functions can be sustained, and its properties will persist. Additionally, the supply of ES will continue, as their provision depend on the ecosystem's capacity and the flow of ecological processes (Mitchell et al., 2015). Each ecosystem type has unique properties, as outlined in Appendix G, where the general characteristics of these ecosystem typologies are described according to the IUCN Global Ecosystem Typology.

Wells Gray Ecosystems and Ecosystem Services Interconnection

Now that ecosystems and the ES have been identify, it is imperative to link these to land cover features and BEC zones classification in order to know how decisions in the use of these features affect or enhance the ecosystems and their services.

Ecosystems Links to Land Cover Features

Land cover represents a detail map of the physical characteristics of the earth surface, including vegetation, water, soil and urban spaces. Changes in land cover features can be influenced by climate drivers or human actions. Land cover is used to define specific practices of land uses (such as recreational activities), but some land uses (like resource extraction activities) can also influence land cover aspects (Sleeter et al., 2018). These changes can contribute to the loss of natural areas that affect the environment, the population of wildlife species and the ES that flow from these landscapes (ECCC, 2021).

According to the land cover classification for Canada (Canada Centre for Remote Sensing, 2022), Wells Gray Provincial Park entails 13 types of land covers. As seen in Figure 24 and Figure 25, Temperate or Sub-polar Needleleaf Forest is the principal land cover that represents the area as it covers 58.054% of the park. This is followed by Barren Lands (13.29%), Temperate or Sub-polar Shrubland (12.06%), Temperate or Sub-polar Grassland (6.10%), Water (5.26%) and Snow and Ice (5.11%).

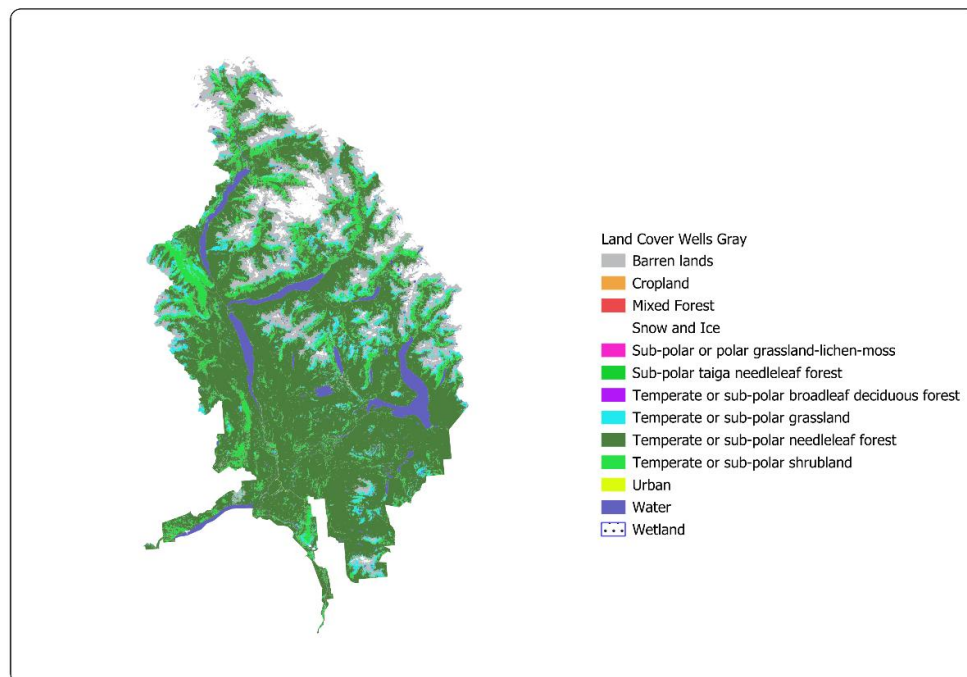


Figure 24 Wells Gray Provincial Park Land Cover classification (Canada Centre for Remote Sensing, 2022)

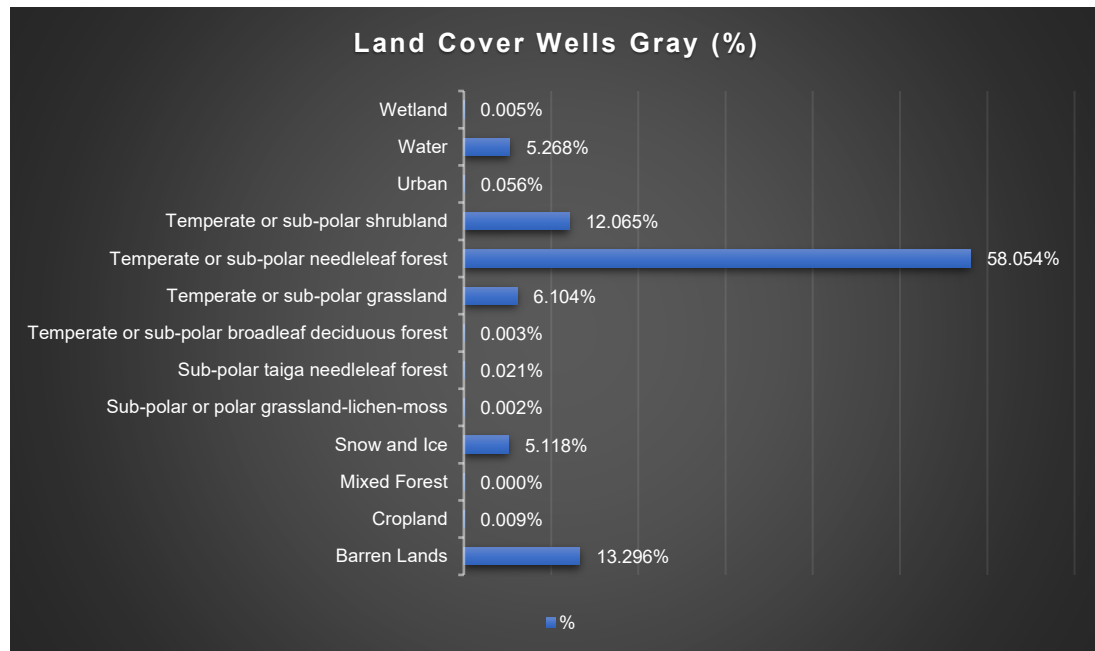


Figure 25 Wells Gray Provincial Park Land Cover classification.

Several land uses, along with environmental and economic factors, affect the frequency and severity of impacts on land cover features. For example, resource extraction or human overuse of recreational areas can impact the availability of clean water and disrupt the migration of wild species. In addition, these activities can affect agricultural and forestry production. Effective land cover planning depends on detailed knowledge of surface characteristics, including the boundaries that define different land cover types and how these change over time. A clear comprehension of the significance of ecosystems and their land cover characteristics will enable the creation of appropriate management strategies. These strategies will support resource extraction and other human activities while ensuring the proper functioning of the ecosystems.

Figure 26 illustrates the use of the Intersection and Dissolve tools in GIS software (ESRI, 2024; ESRI, 2025) to analyze the overlap between the land cover classification and the ecosystem types obtained from the ARIES for SEEA tool for Wells Gray. Since the ecosystem types were developed using a global-scale model, which is less detailed than the land cover classification of Canada, some land covers do not match the ecosystem types. Therefore, for this

research, we can only approximate the ecosystems that align with the land cover classification.

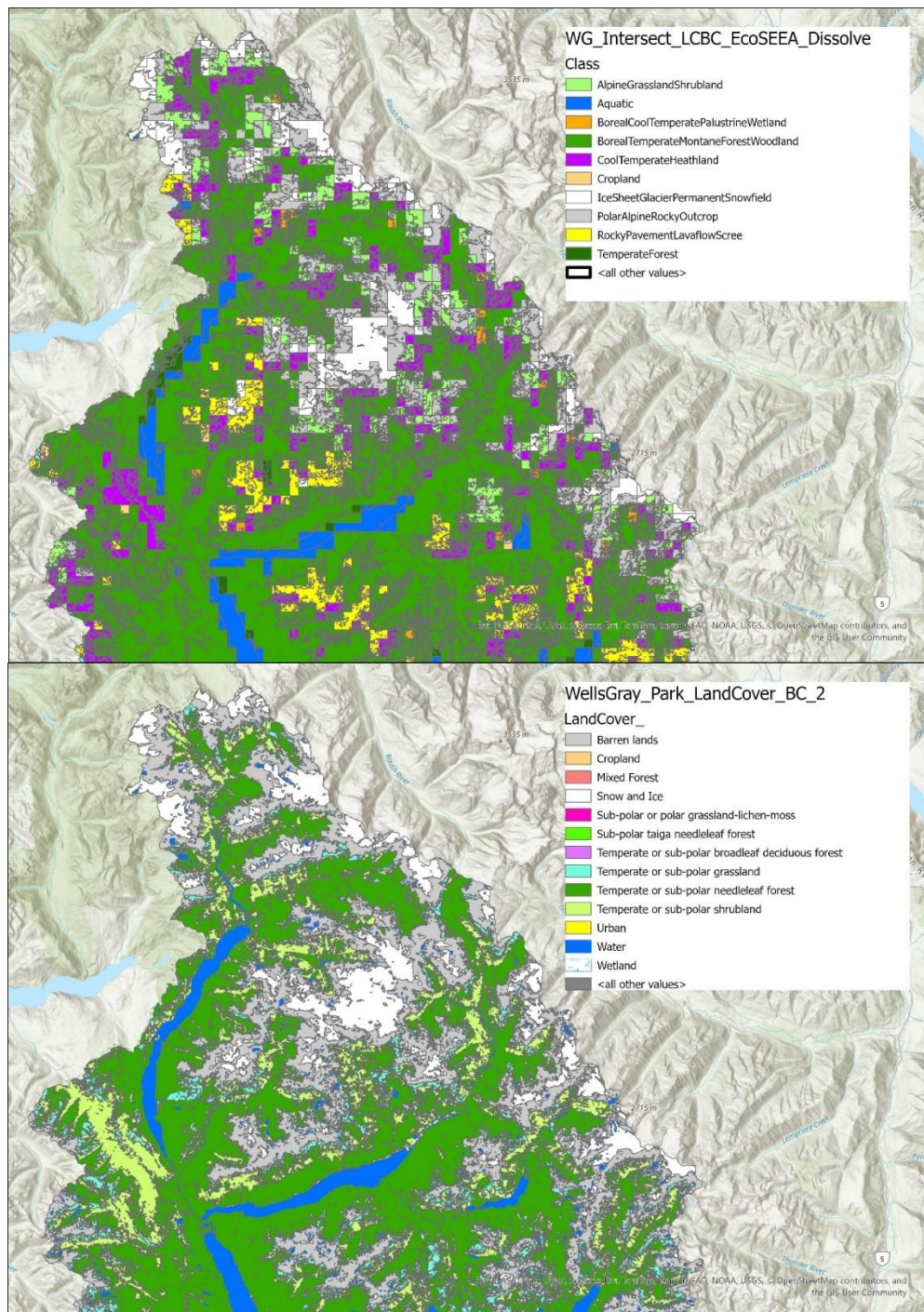


Figure 26 Wells Gray Land Cover and Ecosystem Type Intersection Map

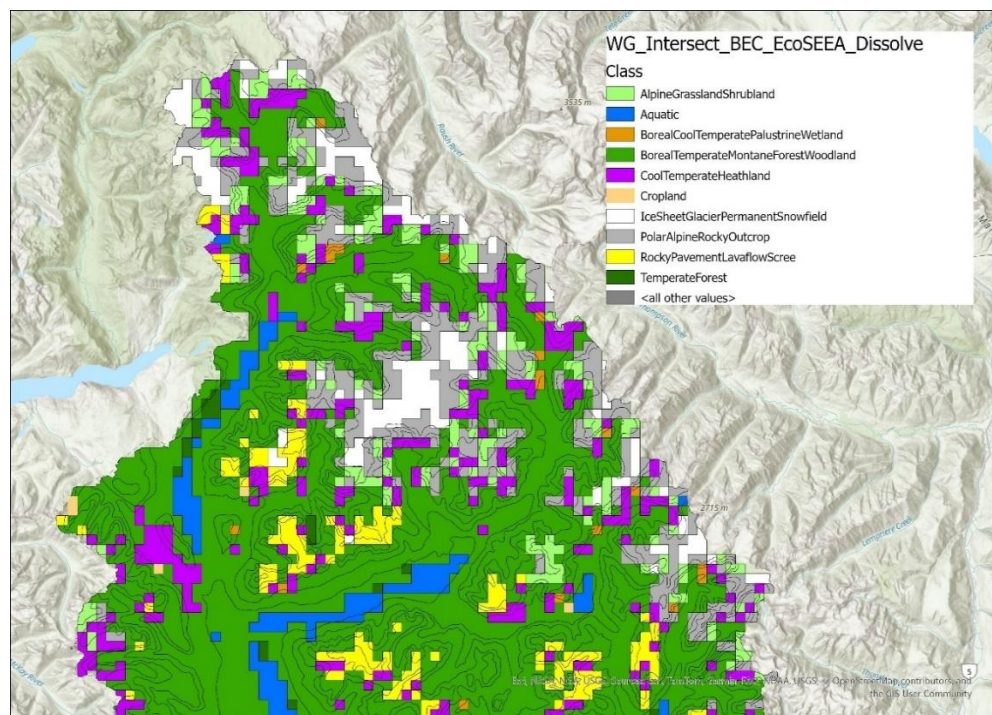
The intersection of Wells Gray land cover with ecosystem types shows that areas classified as Temperate or Sub-polar Needleleaf Forest mainly align with Boreal Temperate Montane Forest Woodland (52.43%), Cool Temperate Heathland (1.35%), and Temperate Forest (1.28%). To a lesser extent, they also match Alpine Grassland Shrubland (0.37%) and Boreal Cool Temperate Palustrine Wetland (0.12%). Areas classified as Temperate or Sub-polar Grassland and Shrubland mostly align with Boreal Temperate Montane Forest Woodland (12.77%), Cool Temperate Heathland (2.78%), and Rocky Pavement Lavaflow Screes (0.84%), with smaller overlaps with Polar Alpine Rocky Outcrop (0.63%) and Alpine Grassland Shrubland (0.55%). Snow and Ice and Barren Lands in the land cover classification in general fit with Polar Alpine Rocky Outcrop (5.13%), Boreal Temperate Montane Forest Woodland (3.52%), Ice Sheet Glacier Permanent Snowfield (2.85%), and Rocky Pavement Lavaflow Screes (2.57%). Finally, Water areas align with the Aquatic ecosystem type (3.06%), as shown in Appendix H.

These intersections highlight the ecological complexity and diversity within Wells Gray Provincial Park, emphasizing the importance of recognizing how different land cover types correspond with specific ecosystem types. This insight provides a valuable foundation for more informed ecosystem-based planning and conservation strategies within the park. Recognizing the environmental changes driven by human actions, including climate change, can provide valuable guidance for adaptation and resilience strategies (Natural Resources Canada, 2025a). The land cover classification of Wells Gray must align with the ecosystems in the area to develop management practices that support ecosystem health and ensure the flow of the services they provide. Ecosystems extend beyond land cover classifications due to the interactions between vegetation, soil, and climate. Managing the area only based on land cover classification does not fully capture the dynamics at play. Therefore, linking land cover with ecosystems helps to establish more effective management actions.

Ecosystems Links to BEC zones classification

Since BC's BEC classification divides the province into ecosystem-based units that incorporate climate, soil, and vegetation characteristics, it offers a more accurate framework for associating Wells Gray's ecosystem types than the broader land cover classification. As noted, the ecosystem types used in this study were developed from a global-scale model, which lacks the regional specificity of the BEC system. Therefore, this research presents only an approximation of how these ecosystem types align with BEC zones. Nevertheless, while the BEC classification provides a more ecologically grounded perspective, the land cover data remains useful for understanding surface-level patterns and supporting complementary spatial analyses.

Figure 27 demonstrates the use of the Intersection and Dissolve tools in GIS software (ESRI, 2024; ESRI, 2025) to compare the Wells Gray BEC zones with ecosystem types from the ARIES for SEEA tool.



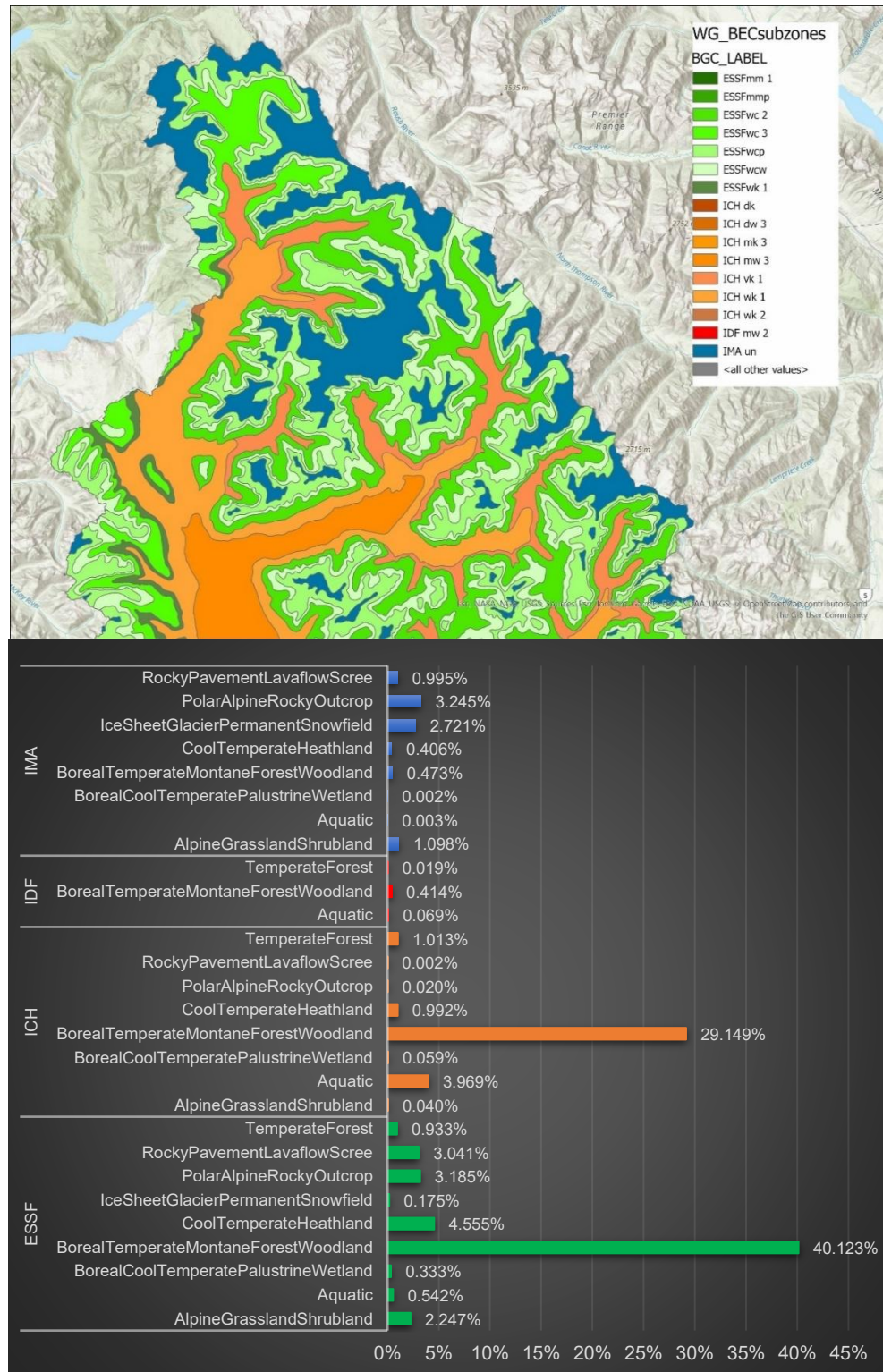


Figure 27 Wells Gray BEC Zones and Ecosystems Type Intersection

The process results suggest that the Wells Gray BEC zones and ecosystem types from ARIES for SEEA show clear overlaps, but the alignment

varies across different BEC zones. It is relevant to establish here that the BEC zones does not account for an aquatic or waterbodies classification. Graphical analysis shows that the lakes and main rivers in Wells Gray primarily align with subzones of the ICH zone, specifically Moist Warm (ICHmw), Wet Cool (ICHwk), and Very Wet Cool (ICHvk). To a lesser extent, they also correspond with subzones of the ESSF zone (Wet Cool ESSFwk and Wet Cold ESSFwc) and the IDF zone (Moist Warm IDFmw). As a result, certain areas within the ICH, ESSF, and IDF subzones align with the Aquatic ecosystem type. This indicates that while the BEC system offers strong ecological detail for terrestrial ecosystems, it lacks specificity for aquatic environments. Consequently, integrating ecosystem classifications like those from ARIES for SEEA can help fill this gap, providing a more comprehensive interpretation of ecosystem distribution, especially in relation to freshwater features within Wells Gray.

Ecosystems and Ecosystem Services Link to Land Cover and BEC

The variation in alignment between ecosystem types, land covers, and BEC zones emphasizes the need for a clear and adapted approach to recognizing ecosystem functions and management within each specific zone of the park. Still, this exercise is valuable for identifying which land covers and BEC zones correlate with ecosystem types, helping to assume the ES associated with each classification (Figure 28 and Appendix I).

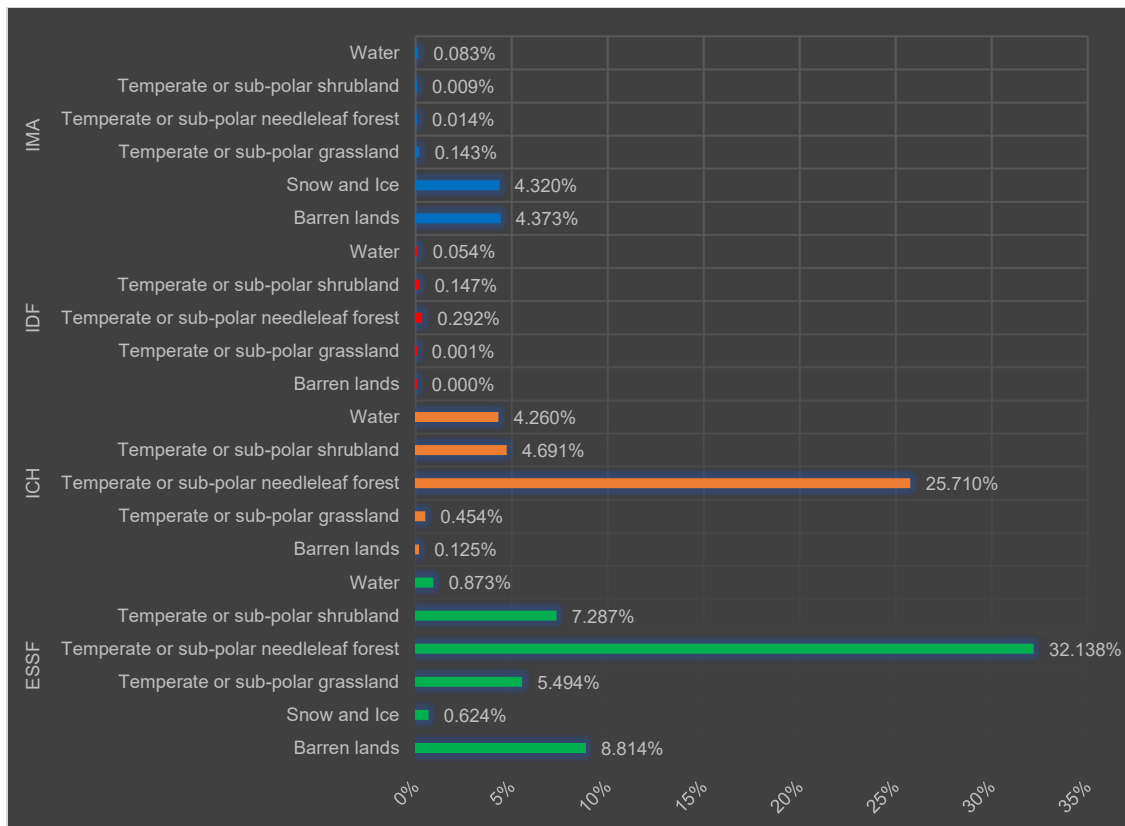


Figure 28 Wells Gray main Land Covers and BEC zones Intersection

As mentioned, Appendix I presents an approach to know how ecosystems and ES are distributed within Wells Gray Provincial Park. For example, recognizing the importance of the Boreal Temperate Montane Forest Woodland ecosystem, due to its biodiversity, carbon storage capacity, and economic and cultural value, illustrates the valuable habitat it provides for a wide range of species and its support for human communities through timber production, tourism, and traditional practices. Planning and management actions for the park should take this value into account, incorporating targeted efforts to protect and improve the ecosystem. At the same time, additional analysis and more detailed ecosystem mapping are needed to better understand the functions of ecosystems throughout the park.

The main provisioning and regulating ES offered by Wells Gray Provincial Park, which play a significant role for the entire province of BC, are described in

Figure 29. Cultural ES which are given by all the ecosystems, were also considered.

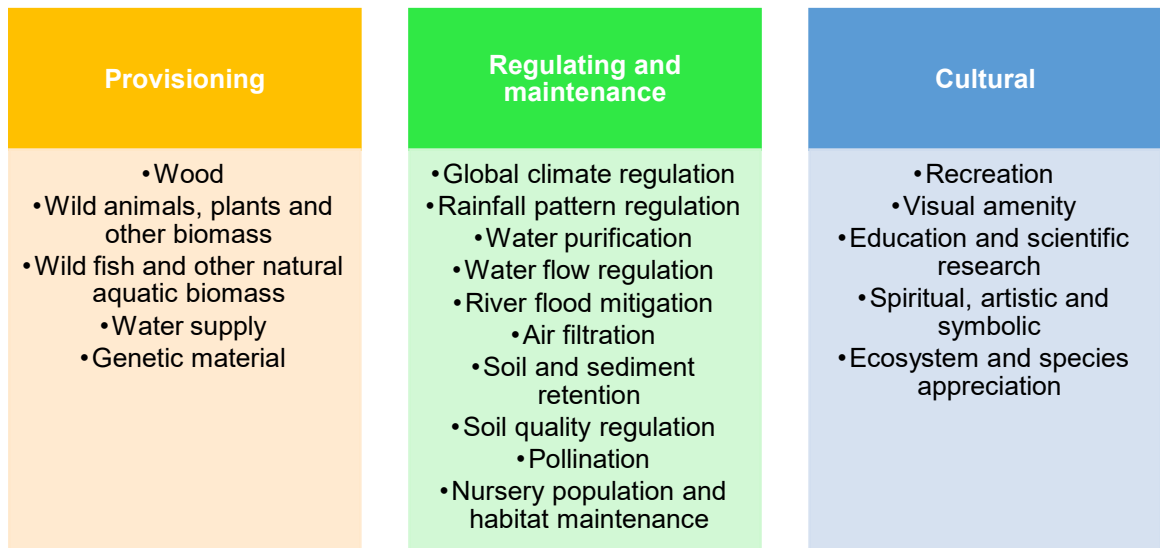


Figure 29 Wells Gray Ecosystem Services

The ecosystems that deliver these ES need to become the main factors (CDFs) on which the management plan of Wells Gray must defines actions and strategies to maintain and enhance them. Based on the reference list of selected ecosystem services (SEEA EA), Appendix J provides a description of each ES provided by Wells Gray (United Nations, 2021a).

Wells Gray and Climate Change

The BEC system groups elements into levels and uses climax vegetation communities to figure out how climate and soil affect the environment as a whole. These zones are large areas of land that have a similar climate and regional or macroclimate. Zones are often named after one, two, or three of the main climax species that live there. The names can also include something that makes the area unique, like its climate (subboreal, boreal, or mountainous) or where it is located (interior or coastal). This classification helps to determine the type of seasons, if they are cool, cold, wet, moist, rain or snowfall levels. As well as if the summers are dry or if the soil has a hydrological deficit which is relevant to

determine the type of growing seasons (Ministry of Forest Lands and Natural Resource Operations, 2021).

As seen in Figure 21, the biogeoclimatic zone levels for Wells Gray Provincial Park have four main classifications (ICH, ESSF, IMA, IDF). In these BEC zones, the climate interacts with land surface materials to create particular environments suitable for the development of specific plant and animal communities (Ministry of Forest Lands and Natural Resource Operations, 2016):

- The lower to mid slopes of Wells Gray form the ICH (Interior Cedar Hemlock Zone). The zone has a cool to warm temperate temperature. Whereas summers are warm and dry, winters are cool and wet. Though drier than the interior subalpine (like ESSF) zone, the ICH zone is the wettest of the interior montane zones (like IDF) and boreal montane zones. This zone has a variety of coniferous trees.
- The middle and high slopes of the mountains of Wells Gray are covered in ESSF (Engelmann Spruce Subalpine Fir Zone). This zone has a subalpine boreal climate. The summers are cool and short, and the winters are long and cold. In the forested subzones, precipitation and snowfall level are higher. Only trees that can tolerate long frozen seasons are able to grow here.
- The tops of mountains of Wells Gray define IMA (Interior Mountain-Heather Alpine Zone). The temperature is cold, with high levels of snowfalls and wind. The winters are long, and the growing season is short. It is dominated by mosses and lichens, and it is essentially treeless; however, some patches of trees with meadows are present.
- IDF (Interior Douglas-fir Zone) sporadically appears in the main valley of Wells Gray. It is considered the second warmest zone. Summers are dry and under moisture stress. Winters are cool and have low snowfalls.

The current BEC classification in Wells Gray Provincial Park reflects the interactions of different plant and animal species over time. Changes in climate and soil conditions will affect these interactions and, in turn, the continued

presence of these species in the area. As shown in Table 8 and Figure 30, the BEC classification in Wells Gray Provincial Park will change by 2040 and 2100 (University of British Columbia & Centre for Forest Conservation Genetics, 2023).

BGC 2024	%	BGC 2011-2040	%	BGC 2071-2100	%
IDF – Interior Douglas-fir	1%	↓ IDF – Interior Douglas-fir	0.07%		
ICH – Interior Cedar Hemlock	35%	↑ ICH – Interior Cedar Hemlock	50.52%	↑ ICH – Interior Cedar Hemlock	61.37%
ESSF – Engelmann Spruce Subalpine Fir	55%	↓ ESSF – Engelmann Spruce Subalpine Fir	42.69%	↓ ESSF – Engelmann Spruce Subalpine Fir	13.47%
IMA – Interior Mountain Heather Alpine	9%	↓ IMA – Interior Mountain Heather Alpine	5.73%	↓ IMA – Interior Mountain Heather Alpine	0.53%
		MH – Mountain Hemlock	0.95%	↑ MH – Mountain Hemlock	15.84%
		SWB – Spruce-Willow-Birch	0.02%	↑ SWB – Spruce-Willow-Birch	0.05%
		CMA – Coastal Mountain Heather Alpine	0.02%	↑ CMA – Coastal Mountain Heather Alpine	0.47%
				CWH – Coastal Western Hemlock	8.13%
				BAFA – Boreal Altai Fescue Alpine	0.15%

Table 8 Percentage of Wells Gray Provincial Park BEC Changes (2024-2100)⁴⁶

Currently, over half of Wells Gray Provincial Park is classified as ESSF, followed by ICH. By the end of the century, this distribution is expected to shift significantly, with ICH covering 61.37%, followed by Mountain Hemlock (MH) at 15.84% and ESSF reduced to 13.47%. Some zones, like IDF, are projected to disappear, while others, such as IMA, will shrink to less than 1%. New zones are expected to emerge, such as MH, SWB (Spruce-Willow-Birch), CMA (Coastal Mountain Heather Alpine), CWH (Coastal Western Hemlock), and BAFA (Boreal Altai Fescue Alpine).

⁴⁶ ClimateBC_Map: Scenario SSP245 Middle of the Road (Medium challenges to mitigation and adaptation). CO2: 650 ppm. Temp anomaly: 2.4 °C global mean temperature rise by the year 2100 (University of British Columbia & Centre for Forest Conservation Genetics, 2023).

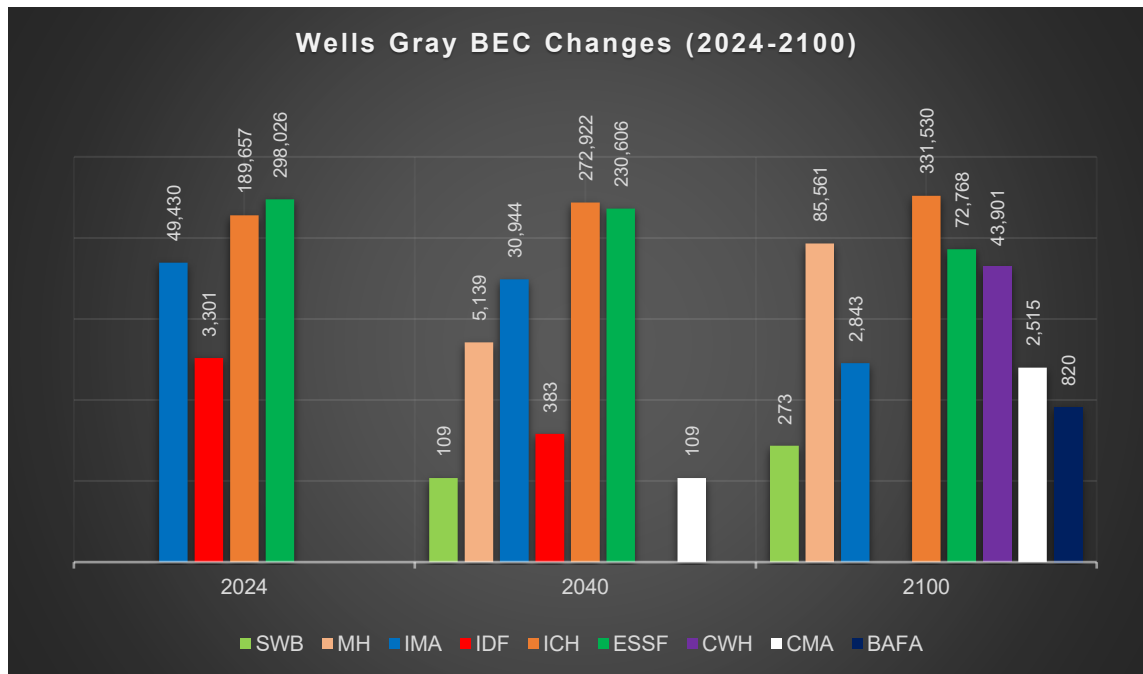


Figure 30 Area (Ha) of Wells Gray Provincial Park BEC Changes (2024 -2100)

According to Demarchi (2011), the MH zone is classified as a subalpine boreal climate, characterized by short, cool summers and cool, wet winters with deep seasonal snow accumulation. The ESSF zone, its continental equivalent, experiences colder, drier winters and has a shorter growing season. Among the three subalpine boreal zones in BC, the SWB zone has the coldest climate and is considered the coldest forested zone in the province, with long, cold winters and extremely short, cool summers. The CWH zone has a more moderate climate, featuring cool summers and mild, wetter winters compared to the ICH zone. At higher elevations, the Alpine Tundra (AT) zone appears as CMA, which has the snowiest conditions, followed by IMA and BAFA, which is the driest. Overall, the AT zone is characterized by a severe climate, with a mean annual temperature of -1.9°C . Extreme cold, in addition to the absence of a warm season and a very short frost-free period, limits tree growth.

As shown in Figure 31 to Figure 33, the expansion of the ICH zone to higher elevations of ESSF may indicate that these areas tend to be less cold and humid, so they could become warmer and drier than they are today. The extension of the CWH zone into higher elevations previously classified as IMA

suggests a shift toward more precipitation falling as rain rather than snow. This indicates a warmer climate that is wetter in some senses but generally drier compared to historical conditions. Winters in Wells Gray will likely be cold but short, with less snow than today and only on the highest peaks. Summers will be warm, dry, and longer, especially in the Clearwater Valley, with a growing season experiencing soil moisture deficits.

These biogeoclimatic zones illustrate the wide climatic variation across elevation gradients in Wells Gray, where subalpine and alpine zones currently experience colder temperatures and shorter growing seasons. The characteristics of zones like MH, ESSF, and SWB reflect a shift from cool, wet conditions to more extreme cold and dryness, while zones like CWH and AT illustrate how changes in temperature and moisture levels may shape vegetation and ecosystem dynamics. Overall, these trends highlight the vulnerability of these ecosystems to climate change, especially due to rising temperatures, reduced snowpack, and altered precipitation patterns.

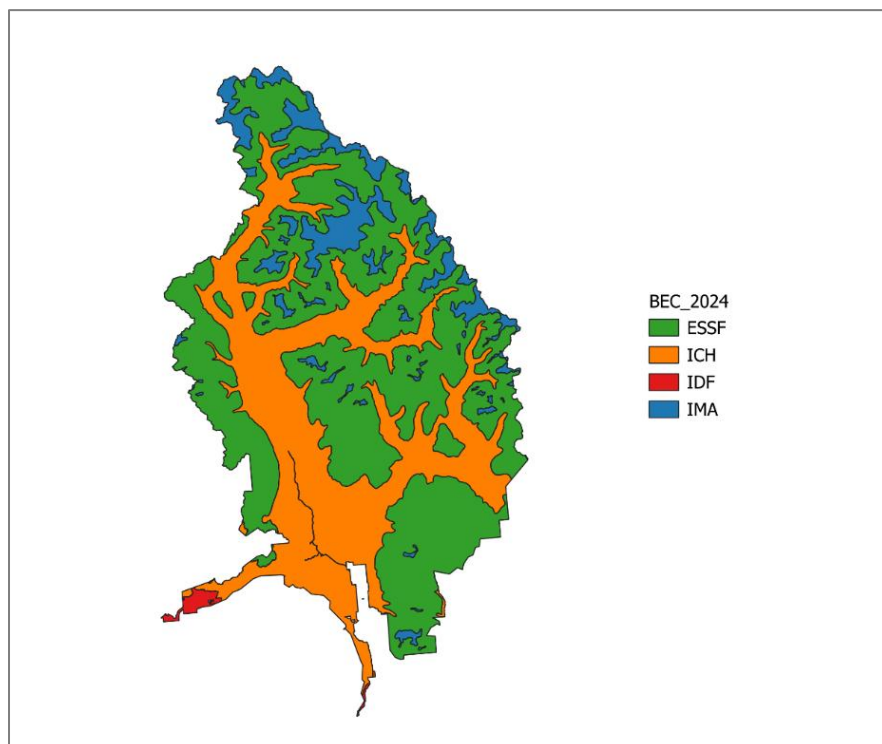


Figure 31 Wells Gray Provincial Park BEC based on the BC Data Catalogue 2024 (Government of British Columbia, 2024b)

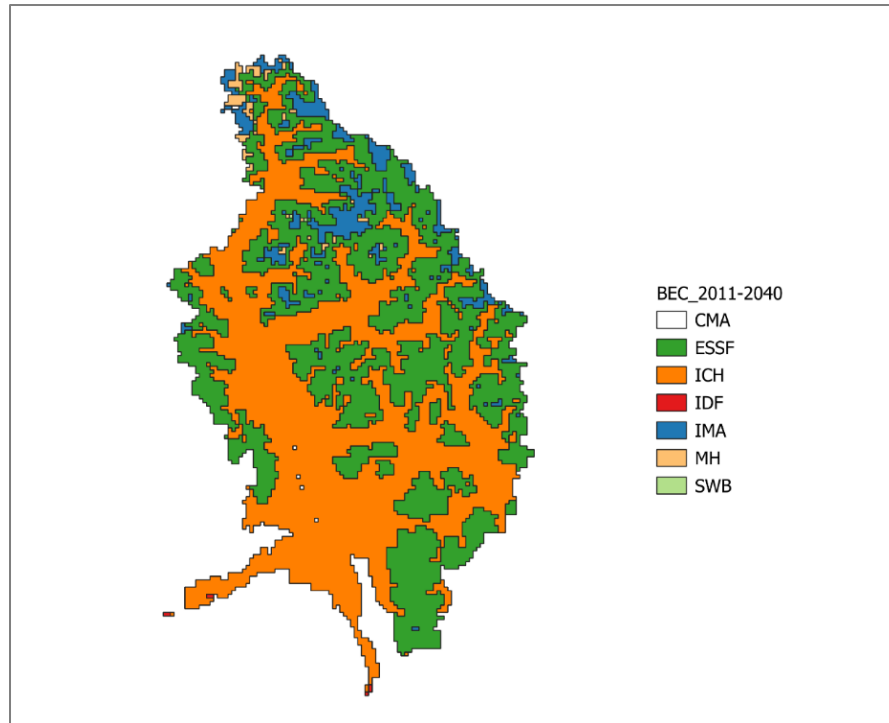


Figure 32 Wells Gray Provincial Park BEC changes based on ClimateBC_MAP model scenario SSSP245 for 2040 (University of British Columbia & Centre for Forest Conservation Genetics, 2023)

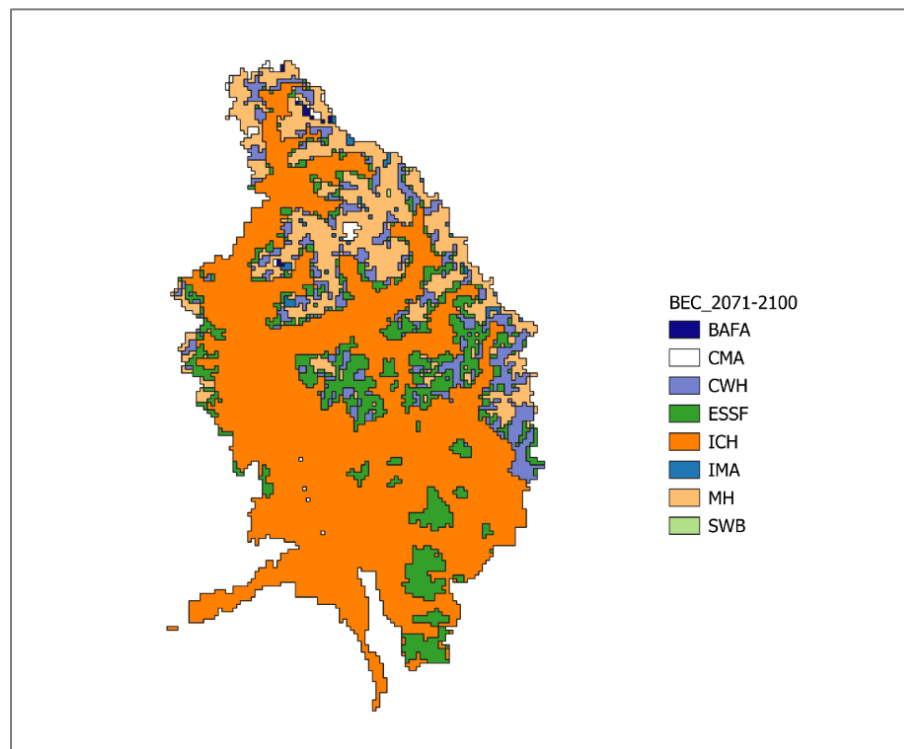


Figure 33 Wells Gray Provincial Park BEC changes based on ClimateBC_MAP model scenario SSSP245 for 2100 (University of British Columbia & Centre for Forest Conservation Genetics, 2023)

The ecosystems will change progressively and adapt to the new conditions. The type of tree species that will emerge here will contribute to attract different wildlife too and will change conditions for other types of wildlife that right now inhabit the area. This will displace some flora and fauna and simultaneously be a refuge for others. According to MacKenzie & Mahony (2021), there is already evidence of changes in forest ecosystems, from variances in growth rates, health, and mortality to changes in the distribution range in regard to climate conditions that are suitable for specific tree species. Other environmental stressors may also increase, such as wildfires, windstorms, and outbreaks of insects or pathogens. These have already become more frequent due to climate change conditions, placing additional pressure on existing ecosystems (Woods et al., 2010).

Moreover, climate resilience metrics for Wells Gray Provincial Park, based on data from AdaptWest and Data Basin (Beckers & Carroll, 2020), indicate that under the RCP8.5⁴⁷ scenario by 2080 (considered the most challenging due to continued fossil fuel-driven development) the park will still serve as a valuable refugia for tree species and wildlife. However, it is essential to note that climate variables such as temperature and precipitation (Figure 34) are projected to increase significantly under this scenario, making adaptive strategies more challenging compared to the SSP245 scenario. The full report, along with the climate data, can be retrieved through the Climate Resilience Data Explorer developed by AdaptWest⁴⁸ (AdaptWest Project, 2022).

⁴⁷ This scenario based on assumptions of high population and relatively slow income growth with modest rates of technological change and improvements in energy intensity. In the absence of climate change policies, this will lead to high energy demand and increased GHG emissions in the long term. Temperature anomaly 4.9°C.

⁴⁸ [AdaptWest Climate Resilience Data Explorer](#) and [Climate displacement in protected areas | AdaptWest](#)

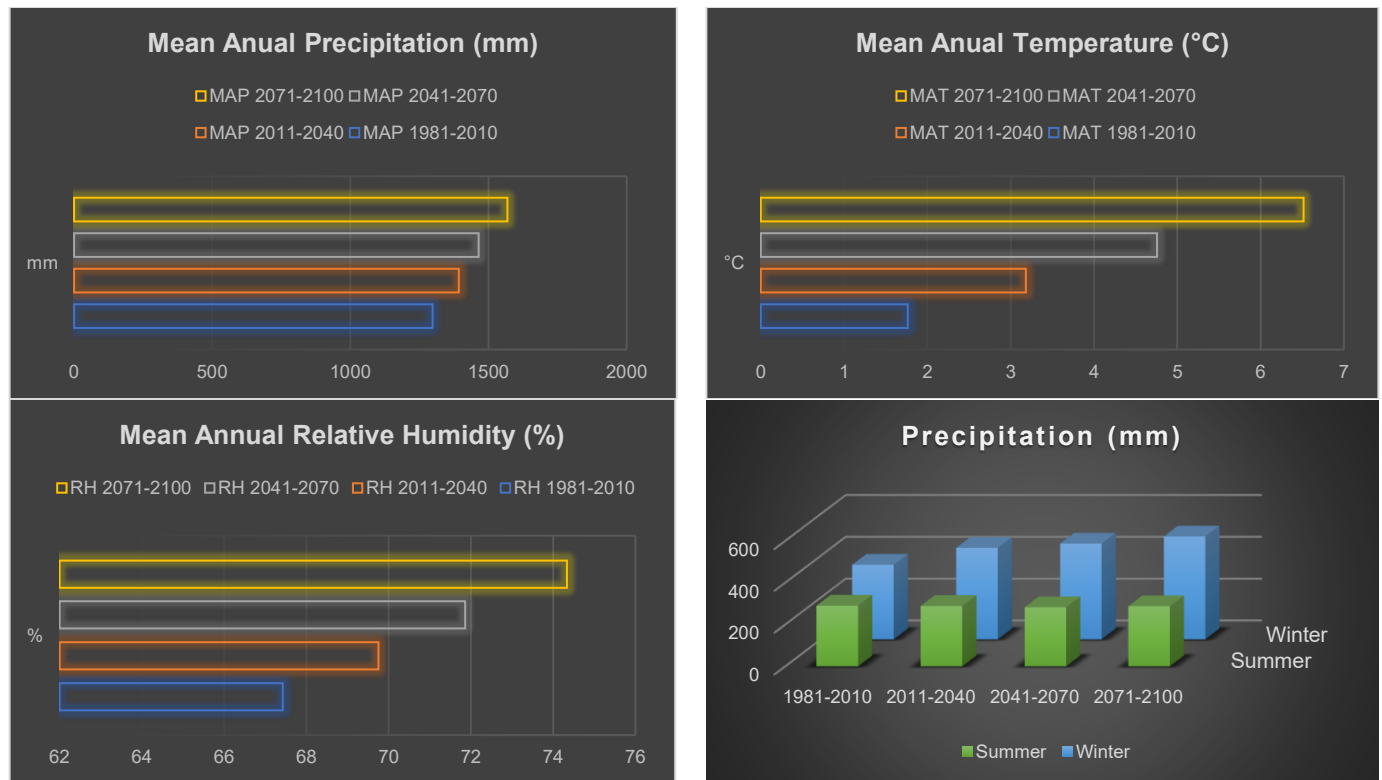


Figure 34 Mean annual climate variables and precipitation for winter and summer seasons in Wells Gray Provincial Park using climate scenario projection for RCP8.5 (AdaptWest Project, 2022; Batllori et al., 2017; Wang et al., 2016; Mahony et al., 2022)

This sets Wells Gray Provincial Park as a key space for climate resilience and biodiversity. It indicates the need for creating connectivity corridors and buffer zones to maintain and facilitate species dispersion and permanence (Carroll & Noss, 2021).

Conclusion

This chapter focused on the role of ecosystem principles in shaping steps to create a more effective master plan by demonstrating how an ecosystem-based approach can prioritize ecosystems and their services as CDFs within Wells Gray Provincial Park. This approach also emphasizes the potential impacts of climate change on ecosystems and their services, to establish the need for adaptive management strategies. Using ecosystems as the foundation for planning can help justify decision-making based on ecological evidence (Spangenberg et al., 2014).

This research mapped the interconnectedness of ecological features within the park by combining information on ecosystems, land cover types, and BEC zones. The Boreal Temperate Montane Forest Woodland ecosystem is the most representative ecosystem in Wells Gray. Considering that Canada's boreal forest represents 28% of the world's boreal zone and plays a key role in carbon storage, biodiversity, and cultural values (Natural Resources Canada, 2025b). Recognizing this ecosystem and its services as a CDF in the management of Wells Gray will help ensure ecological integrity, climate resilience, and alignment with national conservation targets.

The analysis also demonstrated that looking at ecosystems from a more dynamic and functional perspective, instead of using only biogeographic or biophysical classifications such as land cover and BEC, provides a more practical way to conserve biodiversity and sustain ES. Despite some variation in alignment between classification systems, the exercise illustrated the value of using a combined, integrative approach to inform management decisions within Wells Gray. Although each system has its limitations, the correlations between them provided valuable information that can support planning and ecologically informed conservation actions. Likewise, although the BEC system provides more accurate information on terrestrial ecosystems than land cover data, using ARIES for SEEA helps improve the representation of aquatic environments within the BEC classification. This contributes to a more complete understanding of the distribution of ecosystems in Wells Gray.

Further research is needed to evaluate the potential of BC's PA network, especially its contributions to Canada's conservation targets. Particular attention should be paid to the Interior Wet Belt, where many areas with high biodiversity currently lack formal protection status. An assessment by DellaSala et al. (2021) established this region as endangered, with logging representing 57% of human disturbance. Essential biotic elements such as Old-Growth Birds, Southern Woodland Caribou, Sensitive Fish, and Old-Growth Lichen habitats were identified as vulnerable to critically endangered.

In addition to the conservation values of Wells Gray, contiguous areas in the Interior Wet Belt provide essential ES, including climate regulation, freshwater supply, and nature-based recreation (Mitchell et al., 2021). This PA and the parts of the Interior Wet Belt that are not protected require urgent attention from researchers, decision-makers, and activists to establish buffer zones and ecological corridors that build a connected network of PAs, which will keep important ecosystem functions and protect biodiversity for the future.

References

- AdaptWest Project. (2022). *Current and projected climate data for North America (CMIP6 scenarios generated using ClimateNA v7.3)*.
Adaptwest.databasin.org.
<https://adaptwest.databasin.org/pages/adaptwest-climatena/>
- Artificial Intelligence for Environment and Sustainability (ARIES). (2021). *Making science matter in policy where nature counts*. ARIES Project.
<https://aries.integratedmodelling.org/>
- Batllori, E., Parisien, M., Parks, S. A., Moritz, M. A., & Miller, C. (2017). Potential relocation of climatic environments suggests high rates of climate displacement within the North American protection network. *Global Change Biology*, 23(8), 3219–3230. <https://doi.org/10.1111/qcb.13663>
- Beckers, J., & Carroll, C. (2020). *AdaptWest Climate Resilience Data Explorer*. Zenodo. <https://doi.org/10.5281/ZENODO.3824538>
- Canada Centre for Remote Sensing. (2022). *2020 Land Cover of Canada - Open Government Portal*. Open.canada.ca; Natural Resources Canada.
<https://open.canada.ca/data/en/dataset/ee1580ab-a23d-4f86-a09b-79763677eb47>
- Carroll, C., & Noss, R. F. (2021). Rewilding in the face of climate change. *Conservation Biology*, 35(1), 155–167. <https://doi.org/10.1111/cobi.13531>
- Convention on Biological Diversity. (2022). *COP15: Final text of Kunming-Montreal Global Biodiversity Framework available in all UN languages*. Convention on Biological Diversity. <https://www.cbd.int/article/cop15-final-text-kunming-montreal-qbf-221222>
- Data Basin, & Conservation Biology Institute. (2020). *Canada Ecoregions | Data Basin*. Databasin.org.
<https://databasin.org/datasets/6dfe01568b844a5c84549670552221b2/>
- DellaSala, D. A., Strittholt, J. R., Degagne, R., Mackey, B., Werner, J. R., Connolly, M., Coxson, D., Couturier, A., & Keith, H. (2021). Red-Listed Ecosystem Status of Interior Wetbelt and Inland Temperate Rainforest of British Columbia, Canada. *Land*, 10(8), 775.
<https://doi.org/10.3390/land10080775>
- Demarchi, D. (2011). *An Introduction to the Ecoregions of British Columbia*.
https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/ecosystems/broad-ecosystem/an_introduction_to_the_ecoregions_of_british_columbia.pdf

- Environment and Climate Change Canada. (2021). *Land-use change*. [Www.canada.ca. https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/land-use-change.html](https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/land-use-change.html)
- ESRI. (2024). *How Intersect works—ArcGIS Pro | Documentation*. [Pro.arcgis.com. https://pro.arcgis.com/en/pro-app/latest/tool-reference/analysis/how-intersect-analysis-works.htm](https://pro.arcgis.com/en/pro-app/latest/tool-reference/analysis/how-intersect-analysis-works.htm)
- ESRI. (2025). *How Dissolve (Data Management) works—ArcGIS Pro | Documentation*. [Arcgis.com. https://pro.arcgis.com/en/pro-app/latest/tool-reference/data-management/h-how-dissolve-data-management-works.htm](https://pro.arcgis.com/en/pro-app/latest/tool-reference/data-management/h-how-dissolve-data-management-works.htm)
- Geneletti, D. (2015). A Conceptual Approach to Promote the Integration of Ecosystem Services in Strategic Environmental Assessment. *Journal of Environmental Assessment Policy and Management*, 17(04), 1550035. <https://doi.org/10.1142/S1464333215500350>
- Government of British Columbia, Ministry of Lands Parks and Housing, & Parks and Outdoor Recreation Division. (1986). *Wells Gray Park Master Plan*. <https://Bcparks.ca/About/Management-Plans/Approved/>. https://nrs.objectstore.gov.bc.ca/kuwyyf/wells_gray_pk_mp_19860201_4c_b7dced9a.pdf
- Government of British Columbia. (1996). *Park Act*. [Www.bclaws.gov.bc.ca. https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/96344_01](https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/96344_01)
- Government of British Columbia. (2011). *Ecosections - Ecoregion Ecosystem Classification of British Columbia - Open Government Portal*. [Open.canada.ca. https://open.canada.ca/data/en/dataset/cc01f43-860d-4583-8ba4-e72d8379441e](https://open.canada.ca/data/en/dataset/cc01f43-860d-4583-8ba4-e72d8379441e)
- Government of British Columbia. (2025). *Data Catalogue: BEC Map*. [Catalogue.data.gov.bc.ca. https://catalogue.data.gov.bc.ca/dataset/bec-map/resource/46ceb84a-3f6d-436c-b4c1-c89beb72d11a](https://catalogue.data.gov.bc.ca/dataset/bec-map/resource/46ceb84a-3f6d-436c-b4c1-c89beb72d11a)
- Hausfather, Z. (2018). *Explainer: How “Shared Socioeconomic Pathways” explore future climate change*. Carbon Brief. <https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change/>
- Isbell, F., Tilman, D., Polasky, S., & Loreau, M. (2015). The biodiversity-dependent ecosystem service debt. *Ecology Letters*, 18(2), 119–134. <https://doi.org/10.1111/ele.12393>

- IPCC. (2023). *AR6 Synthesis Report: Climate Change 2023*. Wwww.ipcc.ch; IPCC. <https://www.ipcc.ch/report/ar6/syr/>
- IUCN Global Ecosystem Typology. (2022). *Global Ecosystem Typology*. Global-Ecosystems.org. <https://global-ecosystems.org/>
- Keith, D. A., Ferrer-Paris, J. R., Nicholson, E., Bishop, M. J., Polidoro, B. A., Ramirez-Llodra, E., Tozer, M. G., Nel, J. L., Mac Nally, R., Gregr, E. J., Watermeyer, K. E., Essl, F., Faber-Langendoen, D., Franklin, J., Lehmann, C. E. R., Etter, A., Roux, D. J., Stark, J. S., Rowland, J. A., ... Kingsford, R. T. (2022). A function-based typology for Earth's ecosystems. *Nature*, 610(7932), 513–518. <https://doi.org/10.1038/s41586-022-05318-4>
- k.LAB. (2021). *k.Hub*. Integratedmodelling.org; The SEEA Ecosystem Accounting standard on the ARIES platform. A collaboration between UNSD, UNEP and BC3. <https://integratedmodelling.org/hub/#/home>
- MacKenzie, W. H., & Mahony, C. R. (2021). An ecological approach to climate change-informed tree species selection for reforestation. *Forest Ecology and Management*, 481, 118705. <https://doi.org/10.1016/j.foreco.2020.118705>
- Mahony, C. R., Wang, T., Hamann, A., & Cannon, A. J. (2022). A global climate model ensemble for downscaled monthly climate normals over North America. *International Journal of Climatology*, 42(11), 5871–5891. <https://doi.org/10.1002/joc.7566>
- Ministry of Forest Lands and Natural Resource Operations. (2016). *Biogeoclimatic Zones of British Columbia* [Map]. Forest Analysis and Inventory Branch. <https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/ecosystems/bec/maps/bgcmmap201608.pdf>
- Ministry of Forest Lands and Natural Resource Operations. (2021). *How BEC Works*. Wwww.for.gov.bc.ca; Research, Innovation and Knowledge Management Branch. <https://www.for.gov.bc.ca/hre/becweb/system/how/index.html>
- Mitchell, M. G. E., Suarez-Castro, A. F., Martinez-Harms, M., Maron, M., McAlpine, C., Gaston, K. J., Johansen, K., & Rhodes, J. R. (2015). Reframing landscape fragmentation's effects on ecosystem services. *Trends in Ecology & Evolution*, 30(4), 190–198. <https://doi.org/10.1016/j.tree.2015.01.011>
- Mitchell, M. G. E., Schuster, R., Jacob, A. L., Hanna, D. E. L., Dallaire, C. O., Raudsepp-Hearne, C., Bennett, E. M., Lehner, B., & Chan, K. M. A. (2021). Identifying key ecosystem service providing areas to inform

- national-scale conservation planning. *Environmental Research Letters*, 16(1), 014038. <https://doi.org/10.1088/1748-9326/abc121>
- Natural Resources Canada. (2025a). *Land Cover - Natural Resources Canada*. Canada.ca. <https://natural-resources.canada.ca/maps-tools-publications/satellite-elevation-air-photos/satellite-imagery/land-cover>
- Natural Resources Canada. (2025b). *8 facts about Canada's boreal forest - Natural Resources Canada*. Canada.ca. <https://natural-resources.canada.ca/forest-forestry/sustainable-forest-management/8-facts-about-canada-s-boreal-forest>
- Parks Canada. (2024). *Old Growth Inland Rainforest*. Canada.ca. <https://parks.canada.ca/pn-np/bc/revelstoke/nature/chaine-columbia-range/pluviale-rainforest>
- Partidário MR. (2012). *Strategic Environmental Assessment Better Practice Guide Methodological guidance for strategic thinking in SEA*. Portuguese Environment Agency and Redes Energéticas Nacionais (REN), SA. <https://www.iaia.org/pdf/special-publications/SEA%20Guidance%20Portugal.pdf>
- Partidario, M. R., & Gomes, R. C. (2013). Ecosystem services inclusive strategic environmental assessment. *Environmental Impact Assessment Review*, 40, 36–46. <https://doi.org/10.1016/j.eiar.2013.01.001>
- Sleeter, B., Loveland, T. R., Domke, G. M., Herold, N., Wickham, J., & Wood, N. J. (2018). Land Cover and Land-Use Change. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*. U.S. Global Change Research Program, Washington, DC, USA, pp. 202–231. <https://doi.org/10.7930/nca4.2018.ch5>
- Spangenberg, J. H., Von Haaren, C., & Settele, J. (2014). The ecosystem service cascade: Further developing the metaphor. Integrating societal processes to accommodate social processes and planning, and the case of bioenergy. *Ecological Economics*, 104, 22–32. <https://doi.org/10.1016/j.ecolecon.2014.04.025>
- United Nations. (2021a). *Ecosystem Accounting | System of Environmental Economic Accounting*. Seea.un.org. <https://seea.un.org/ecosystem-accounting>
- United Nations. (2021b). *ARIES for SEEA | System of Environmental Economic Accounting*. Seea.un.org. <https://seea.un.org/content/aries-for-seea>

University of British Columbia, & Centre for Forest Conservation Genetics.
(2023). *ClimateBC_Map*. Climatebc.ca. <https://climatebc.ca/mapVersion>

Wang, T., Hamann, A., Spittlehouse, D., & Carroll, C. (2016). Locally Downscaled and Spatially Customizable Climate Data for Historical and Future Periods for North America. *PLOS ONE*, 11(6), e0156720. <https://doi.org/10.1371/journal.pone.0156720>

Weiskopf, S. R., Isbell, F., Arce-Plata, M. I., Di Marco, M., Harfoot, M., Johnson, J., Lerman, S. B., Miller, B. W., Morelli, T. L., Mori, A. S., Weng, E., & Ferrier, S. (2024). Biodiversity loss reduces global terrestrial carbon storage. *Nature Communications*, 15(1), 4354. <https://doi.org/10.1038/s41467-024-47872-7>

Woods, A. J., Heppner, D., Kope, H. H., Burleigh, J., & MacLauchlan, L. (2010). Forest health and climate change: A British Columbia perspective. *The Forestry Chronicle*, 86(4), 412–422. <https://doi.org/10.5558/tfc86412-4>

CHAPTER 5

Reshaping Green: Ecosystem Principles for Sustainability Transitions

During this research, several gaps appear to be major obstacles not only to achieve conservation goals but also to maintain the stability and vitality of existing protected natural areas. The literature review in chapter 1 explained how policy has failed to recognize the links between ecosystem functions and the ecosystem services (ES). Without a proper balance of these, the ES that ecosystems themselves need to function properly, are not adequately protected. Likewise, the services that people derive from nature are also at risk. As ecosystems represent different values for society, the establishment of ecosystem principles can bring together diverse perspectives on these values. This, in turn, supports the recognition of the benefits ecosystems provide, both for their intrinsic ecological functions and human well-being.

As illustrated in the different chapters of this research, climate change plays a key role in shaping ecosystems and their services, yet decisions driven by economic development often conflict with conservation priorities. Protected areas (PA) confront compounding risks from climate change, resource extraction, and shifting political agendas, which accelerate biodiversity loss and block conservation efforts. While federal, provincial, and territorial governments have taken steps to protect biodiversity, coordinated action across authorities is essential for Canada to overcome fragmentation and meet its 30-by-30 conservation target.

The challenges facing PA, and the biodiversity they represent, demand urgent mitigation and compensation measures. The impacts of different land uses, such as recreation, tourism and resource extraction, must be examined and addressed. The perceived uncertainty of how climate change will affect ecosystems is a powerful reason to consider a new model for decision-making in the short, medium, and long terms. There is also a growing need to incorporate educational programs to promote public appreciation and educate agencies involved in PA planning and expansion.

The purpose of this research was to deliver ecosystem principles that help PA achieve planning opportunities to better balance conservation and recreation priorities while addressing climate change challenges. Given the current global context, these ecosystem principles can be applied to other planning processes, such as regional or provincial planning. Ecosystem principles emerge as a disruptive thinking strategy to consider ecosystems as core values for land management and decision-making. This way, ecological carrying capacities from ecosystems are being consciously incorporated to maintain and enhance them.

British Columbia Contribution to the Canada's 2030 Nature Strategy

With 19.7% of its territory under conservation status, British Columbia (BC) is the second province, surpassed only by the Yukon territory, for percentage of its land in the PAs network of Canada. The provincial government has a commitment to conserve biodiversity and improve the health and integrity of the ecosystems that it encompasses. However, the BC Biodiversity and Ecosystem Health Framework strategy under development still lacks clear actions on how land will be conserved and how the 30-by-30 goal will be achieved.

Decisions to preserve lands from resource extraction industries are not clearly defined, and strategies to create connectivity within ecosystems are at times contradictory. Despite the inclusion of First Nations in decision-making for some PAs, BC has not been able to fully support new park designations such as Indigenous Protected and Conserved Areas (IPCAs). The inclusion of these designations will not only increase the network of PAs, but it will also enhance millennial knowledge and practices that are established through a deep connection with the land. To align with Canada's 2030 Nature Strategy, the provincial government must make a legal commitment to protect 30% of the land, establish connected PA networks, support IPCAs led by First Nations, and develop policies that reflect Indigenous-led conservation goals (West Coast Environmental Law, 2024). This final point acknowledges that environmental policies to date have been dominated by extractive industry perspectives, which

assume that nature is at the service of humanity. This has been to the detriment of the ancestral knowledge of Indigenous communities, which fosters a relationship of coexistence with natural resources (Morgan et al., 2021; Gordon et al., 2023). Therefore, aligning current policies with the vision of Indigenous peoples enables more effective territorial planning by respecting and working with the ecosystems that have long supported human life.

The Politics of Nature

This thesis explored how PAs have been managed and identified key gaps that are barriers to achieve the 30-by-30 target of COP15⁴⁹. Interviewees shared valuable insights on how to address these challenges, which highlighted the significance of planning and managing PAs based on their current ecological characteristics as well as anticipated future changes. The latter is especially important, as considerations of size and boundaries are crucial to address the impacts of rapid ecological shifts driven by climate change.

The implementation of legal frameworks that prioritize biodiversity and ecosystems is essential. Ecosystem-based approaches must be considered in combination with other strategies and measures that include ecological integrity, adaptive management, climate change resilience, and the precautionary principle. Current governmental frameworks lack strong objectives for incorporating biodiversity and ecosystems into management strategies. These aspects are fundamental to address the root causes of biodiversity loss.

Decision-making processes must combine multiple sectors and knowledge systems for the successful restoration and conservation of PAs. Traditional Ecological Knowledge (TEK) and Western science must both be used to develop policies that support the ecological integrity of Canada's extensive network of PAs. Such an approach will support the creation of actions and efforts that will contribute to the maintenance of healthy ecosystems.

⁴⁹ COP15: Final text of Kunming-Montreal Global Biodiversity Framework (CBD, 2022)

The ecosystem principles established in this research are the adaptation strategies needed to maintain and enhance ecological characteristics that federal, provincial, and territorial governments want to preserve. By applying these principles, land management and decision-making can mirror national priorities rather than the individual interests of regions, provinces or territories.

Ecosystem-Based Approach for Wells Gray Provincial Park

The development of an ecosystem-based approach for Wells Gray, focused on creating interconnection of ecosystems, land cover features and Biogeoclimatic Ecosystem Classification (BEC) zones. The exercise indicated the ecological complexity and diversity within Wells Gray Provincial Park. This emphasized the importance of recognizing how different land cover types correspond with specific ecosystems and BEC zones. This insight illustrates the need for more informed, ecosystem-based planning and conservation strategies within the park. It also underlines how imperative it is to incorporate ecosystem classifications to improve the representation of relevant ecosystems that are not well described in the BEC zone series, like aquatic environments. Together, these efforts can contribute to a more holistic and comprehensive understanding of ecosystem distribution in Wells Gray.

Projected changes in BEC zones under climate change scenarios highlighted the significance of including actions in the master plan to enhance the park's resilience. This is especially crucial under more adverse scenarios, where the park remains a vital refuge for flora and fauna. Planning opportunities can emerge from identifying the ecosystems, ES, and their links to land cover features, BEC zones and associated changes. This strategy places ecosystems at the center of the planning process. Potential impacts of proposed land use actions or decisions can be evaluated to guide decision-making and protect ecosystems and the services they provide (Gohr et al., 2022; Kuemmerle, 2024).

Applications of Research Findings

This research presented four ecosystem principles to emphasize a holistic, ecosystem-based approach to PAs planning and management. The main objective of these is to maintain ecological integrity while also recognizing human needs, long-term sustainability, and the inclusion of Indigenous knowledge and co-management. The purpose of the ecosystem principles is to guide decision-making to create, expand or update the plans of PAs to support the 30-by-30 target. This guidance becomes even more relevant as attention shifts toward sustaining and improving existing areas.

For this research, sustainability transitions refer to the maintenance and improvement of natural resources and ecosystems within ecological systems. It also involves strengthening their stability while allowing for the development of recreational, conservation, and other human activities. If the ecosystem principles that were identified in this research were consolidated into the core of PAs management, new planning opportunities would emerge. These opportunities would help sustain and strengthen ecosystems within the PA network, while also guiding actions to tackle complex challenges like climate change.

The ecosystem principles identified by stakeholders in this study can be applied to management decisions within the network of PAs of BC but can also be used for strategic regional planning actions that are broader than parks. If actions are designed with ecosystems in mind, the ES they provide can be preserved, helping to support ecological balance. The purpose of applying these principles is to guide interventions in areas with ecosystem service potential, so that ecosystems are managed and planned to support both human well-being and ecosystem functions.

Limitations of the Study and Future Research

One of the main challenges of this research was to deliver the ecosystem-based approach for Wells Gray Provincial Park. The information used to establish the ecosystems came from ARIES for SEEA, which is a recognized tool for

compiling natural capital for any location on earth. However, the scale of analysis is global, and the land cover features and BEC zones have a regional applicability. This was a limitation to make the links between the ecosystems, the land covers, and BEC zones was a significant task. For the research and the case study, the approach to establish which ecosystems inform the Critical Decision Factors (CDF) for management decisions, especially in the climate scenarios generated by ClimateBC_Map⁵⁰, was a foundational step. While detailed ecosystem mapping is needed to update and improve the Wells Gray master plan, applying the ecosystem principles defined in this project can help PA management balance conservation, recreation, and climate resilience goals.

Although this thesis uses the CDF approach to identify key ecosystems in the planning process of Wells Gray, it is crucial to understand that this strategy does not capture the wider ideas suggested in the research. Delivering a decision-making process that focuses only on CDFs might prioritize certain ecological functions or land features while ignoring the important social and ecological values found in Indigenous and local knowledge. Future studies could explore the potential to redefine CDFs to align with these values. For instance, a collaboration with Indigenous communities to develop indicators or implement planning strategies that do not separate ecological, cultural, and governance functions would lead to a more inclusive and effective conservation outcomes.

Another significant aspect that emerged during this project is the need to form networks of PAs. Establishing buffer zones, ecological corridors and restoring degraded ecosystems, especially in the context of climate change, can support the preservation of ecosystems at provincial, regional, national, and global levels. Because habitats, species, and landscapes are interconnected, their conservation contributes to restoring ecological integrity and the relationships between key regions. Through restoration efforts that support ecosystem stability and natural resources, sustainable recreational values can also thrive. Future research is needed to explore how these strategies can be

⁵⁰ ClimateBC_Map (University of British Columbia & Centre for Forest Conservation Genetics, 2023)

effectively implemented, adapted to local conditions, and scaled to support broader conservation and sustainability goals.

Finally, the absence of Indigenous knowledge in the model scenarios used to project BEC zone changes in Wells Gray reveals a clear gap in how TEK can offer new perspectives on environmental resilience and climate adaptation. In an era of unprecedented environmental change in BC, TEK draws on Indigenous worldviews that emphasize the connections between peoples, ecosystems, and communities (Grenz, 2024). It has the ability to engage local communities, promote collective strategies based on ancestral knowledge that have enabled the resilience of the ecosystems they have contributed to and existed within for generations (Ignace & Ignace, 2017). Innovative research approaches should examine ways to include TEK into climate change models. This is particularly significant as Canadians work to expand the network of PAs by establishing IPCAs, as these new PA designations have been planned with consideration of the deep interrelationships between humans and ecosystems (Zurba et al., 2019; Mason et al., 2022; Vandermale & Mason, 2024). However, it is important to recognize other limiting factors. TEK is often approached only as a set of data added to Western scientific frameworks, rather than as an independent knowledge system that has its own laws, languages, governance, and worldviews. This perspective reinforces colonial dynamics, especially if TEK is not incorporated into the decision-making processes (Walker, 2013). To advance towards a truly transformative management of PA, future research must focus on the co-production of knowledge and the recognition of Indigenous peoples as rights holders, and not just as stakeholders.

To promote public participation in environmental protection, increasing educational resources and establishing a robust biological monitoring system can support ecosystem functions and sustain ES. More innovative research, stakeholder perspectives, and especially regional scenario planning are needed to structure detailed steps to define the values that nature represents for the communities and leaders involved in decision-making. This potential shift could

result in clearer goals and actions on how to accomplish this transformative change.

References

- Convention on Biological Diversity. (2022). *COP15: Final text of Kunming-Montreal Global Biodiversity Framework available in all UN languages*. Convention on Biological Diversity. <https://www.cbd.int/article/cop15-final-text-kunming-montreal-gbf-221222>
- Gohr, C., Von Wehrden, H., May, F., & Ibisch, P. L. (2022). Remotely sensed effectiveness assessments of protected areas lack a common framework: A review. *Ecosphere*, 13(4), e4053. <https://doi.org/10.1002/ecs2.4053>
- Gordon (Iñupiaq), H. S. J., Ross, J. A., Cheryl Bauer-Armstrong, Moreno, M., Byington (Choctaw), R., & Bowman (Lunaape/Mohican), N. (2023). Integrating Indigenous Traditional Ecological Knowledge of land into land management through Indigenous-academic partnerships. *Land Use Policy*, 125, 106469. <https://doi.org/10.1016/j.landusepol.2022.106469>
- Grenz, J. (2024). *Medicine wheel for the planet: a journey toward personal and ecological healing*. Knopf Canada.
- Ignace, M., & Ignace, R. E. (2017). *Secwépemc people, land, and laws =: Yerí7 re Stsqéy's-kucw*. McGill-Queen's University Press.
- Kuemmerle, T. (2024). Moving beyond simplistic representations of land use in conservation. *Conservation Letters*, 17(5), e13055. <https://doi.org/10.1111/conl.13055>
- Mason, C. W., Carr, A., Vandermale, E., Snow, B., & Philipp, L. (2022). Rethinking the Role of Indigenous Knowledge in Sustainable Mountain Development and Protected Area Management in Canada and Aotearoa/New Zealand. *Mountain Research and Development*, 42(4). <https://doi.org/10.1659/mrd.2022.00016>
- Morgan, T. K. K. B., Reid, J., McMillan, O. W. T., Kingi, T., White, T. T., Young, B., Snow, V., & Laurenson, S. (2021). Towards best-practice inclusion of cultural indicators in decision making by Indigenous peoples. *AlterNative: An International Journal of Indigenous Peoples*, 17(2), 202–214. <https://doi.org/10.1177/11771801211015686>
- University of British Columbia, & Centre for Forest Conservation Genetics. (2023). *ClimateBC_Map*. Climatebc.ca. <https://climatebc.ca/mapVersion>
- Vandermale, E. A., & Mason, C. W. (2024). Sustainable tourism development and Indigenous protected and conserved areas in sub-arctic Canada. *Frontiers in Sustainable Tourism*, 3, 1397589. <https://doi.org/10.3389/frsut.2024.1397589>

Walker, R. (2013). *Reclaiming Indigenous Planning*. McGill-Queen's University Press.

West Coast Environmental Law. (2024). *WCEL Submissions on the Draft BC Biodiversity and Ecosystem Health Framework | West Coast Environmental Law*. Wcel.org. https://www.wcel.org/publication/wcel-submissions-draft-bc-biodiversity-and-ecosystem-health-framework?gad_source=1&gclid=Cj0KCQiA-aK8BhCDARIsAL-H9nkYsJiZYWdfVQ_oF6fJ2fLHf497eHePhZ4NU8ZhjZIGJgiMiO0wKYaAhfmEALw_wcB

Zurba, M., Beazley, K., English, E., & Buchmann-Duck, J. (2019). Indigenous Protected and Conserved Areas (IPCAs), Aichi Target 11 and Canada's Pathway to Target 1: Focusing Conservation on Reconciliation. *Land*, 8(1), 10. <https://doi.org/10.3390/land8010010>

APPENDICES

Appendix A

1. What do you do in relation to parks or protected areas?
2. Have you ever participated in the development of protected area policies?
3. Are you aware of the legislation and guidelines that exist to conserve and plan protected areas? What is your opinion regarding these?
4. When considering a "park or protected area in good condition," which elements of the system do you associate with it?
5. What do you think are the most important ecosystem services provided by parks or protected areas?
6. Do you know what ecosystem services are associated with a particular land cover classification?
7. What do you think would happen to park management if stakeholders involved in decision-making and planning were aware of the ecosystem services present in these areas?
8. Can you describe any changes you have noticed in BC parks or protected areas over time?
9. Are there specific aspects that should be done to manage the land cover and ecosystem services associated with BC parks and protected areas?
10. Do you believe that certain sectors require different management approaches?
11. Is adaptation to climate change a part of your current responsibilities at work?
12. In response to climate change issues, what adaptation strategies do you think park or protected area management currently employs or could develop?
13. What role do you think protected and conserved areas can play in addressing the challenges posed by climate change?
14. What are the main activities that could have the greatest impact on protected areas' land cover?
15. What do you think are the main threats to protected areas?

Appendix B

Informed Consent Form

Project Title: Sustainable Management of BC Protected Areas: Ecosystem Principles for strategic land planning and decision-making.

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This consent form is for a research project being conducted by Andrea Patino, a Masters of Environmental Science student at Thompson Rivers University (TRU). The goal of this study is to explore how connecting ecosystem services and land cover features to make an ecosystem-based approach could help manage land better and potentially create new frameworks that support the current goals of protected areas, policy development, and management. The research will take place from the fall of 2024 to the spring of 2025. The semi-structured interview will be conducted individually or by videoconference with Andrea Patino and will last between 60 and 90 minutes, depending on the depth of the discussion and the complexity of the topics addressed.

Participation is completely voluntary, and you may withdraw from the study at any time without penalty. You may choose to remain anonymous by circling the correct area below. By choosing this option your name and organization will be coded and never disclosed. If you choose to not remain anonymous, your name and other details including your occupation or organization may be disclosed alongside your views and opinions in the final report. This could put you at risk of violating corporate or employment policies. You may also choose to let the researcher know during the interview if you wish to keep only some identifying details anonymous. Please be aware that complete anonymity may not be possible due to the qualitative nature of the study. Potential limits to confidentiality include the possibility that others overhear the interview or identify you through specific quotes. You will receive a transcription of your interview to review for accuracy. You will have two weeks to review and provide any feedback or corrections. If we do not receive a response within two weeks, we will use the transcript as-is. Additionally, you will have the opportunity to change your decision on anonymity after reviewing the transcript.

By participating in the study, you can contribute your expertise, insights, and perspectives to a broader research endeavor that focuses on park and protected area management decision-making in British Columbia. This could enhance the collective understanding of complex issues and inform evidence-based policy and management strategies. By sharing your experiences, concerns, and priorities during the interview, specific issues or initiatives within the park management domain will potentially influence decision-making processes and outcomes.

Interviews will be recorded. The recordings will be accessible only by the researcher, Andrea Patino, and by her research supervisor, Dr. Courtney Mason. The storage and disposal of records/data will be as follows:

- Initial interview recordings will be stored and encrypted in a password-protected file on a password-secured computer.
- Recordings encrypted will be backed up to a password-protected folder on a password-protected desktop computer at TRU.
- Recordings will be transcribed to written files, which will be stored the same way as in steps 1 and 2.
- Recordings will be deleted once the transcribed files are stored and backed up.
- You will be sent the transcription of your interview to whichever contact information you provide to review for accuracy. You are responsible for storing or deleting your copy of the transcription.
- Researcher copies of the transcriptions and any research data will be deleted 2 years after the completion of the project, or immediately if you choose to withdraw.

There is a low likelihood of discomfort and/or inconvenience associated with your participation in the project. It is possible that the research will be published. There is a possibility if you choose not to remain anonymous that opinions you express as part of your participation in this research could violate your employment policies or otherwise lead to social discomfort. If you would like to receive a copy of the executive summary of the completed project, please circle the appropriate area below.

While the risks associated with this study are minimal, discussing work-related activities could potentially impact your employment or workplace relationships. Please consider these factors carefully when deciding whether to participate. You may skip any questions you are uncomfortable answering.

Any comments, questions, or concerns should be directed towards Andrea Patino who can be contacted by e-mail at patinogracesm22@mytru.ca or by phone at 1-604-603-5147 or to his research supervisor Dr. Courtney Mason who can be reached by e-mail at cmason@tru.ca or you may contact Dr. Greg Anderson, the Dean of Science, at ganderson@tru.ca.

If you have any concerns or complaints about your rights as a research participant, please contact the Chair of the Research Ethics Board at Thompson Rivers University, 805 TRU Way, Kamloops, BC.V2C 0C8. Email: TRU-REB@tru.ca; Phone: 250-828-5000.

Please initial or circle:

- I am 19 years of age or older _____
- I have received, read, and understand this consent form _____
- I agree to allow my name, position and organization to be published in the final document or used in presentations regarding the final document: YES ___ / NO ___
- I wish to remain anonymous: YES ___ / NO ___
- I permit the interviewer to audiotape/record the interview: YES ___ / NO ___
- I would like to receive a copy of the executive summary of the completed project: YES ___ / NO ___

My signature on this form indicates that I understand the information regarding this research project including all procedures and the personal risks involved. I have had the opportunity to ask questions and am satisfied with the answers. I have received a copy of this consent form for my records. I voluntarily agree to participate in this project.

By signing this consent form, I _____ agree to participate in this project.

Participant's signature _____ Date _____

Project research's name _____

Project research's signature _____ Date _____

Appendix C

ACT	DESCRIPTION
Fisheries Act 1985	Regulates fishing activities to conserve and manage fish habitats, prevent pollution, and ensure sustainable fisheries
Canada Wildlife Act 1985	Provides for the creation, management, and protection of wildlife areas for the conservation of wildlife and their habitats
Historic Sites and Monuments Act 1985	Protects and preserves sites of national historic significance and promotes public awareness of Canada's heritage.
Heritage Railway Stations Protection Act 1985	Ensures the preservation and protection of heritage railway stations that have historical and architectural significance.
Department of Transport Act 1985	Establishes the Department of Transport and outlines its responsibilities, including the development and regulation of transportation systems in Canada.
Dominion Water Power Act 1985	Governs the use of water resources for power generation, ensuring sustainable and regulated development.
Federal Real Property and Federal Immovables Act 1991	Manages the acquisition, administration, and disposal of federal real property and immovables to ensure efficient and effective use.
Department of Natural Resources Act 1994	Establishes the Department of Natural Resources and outlines its mandate to manage and promote sustainable development of natural resources.
Migratory Birds Convention Act 1994	Implements the Migratory Birds Convention between Canada and the United States, protecting migratory birds and their habitats.
Oceans Act 1996	Provides a framework for the management and protection of Canada's marine and coastal areas, promoting sustainable ocean use.
Parks Canada Agency Act 1998	Establishes Parks Canada Agency to manage national parks, national historic sites, and related protected areas.
Canadian Environmental Protection Act 1999	Provides the legal framework for protecting the environment and human health by regulating pollutants and managing waste.
Canada National Parks Act 2000	Governs the creation, management, and protection of national parks to preserve natural landscapes and biodiversity.
Species at Risk Act (SARA) 2002	Protects species at risk of extinction and their habitats, promoting recovery and preventing further decline.
Canada National Marine Conservation Areas Act 2002	Provides for the establishment and management of marine conservation areas to protect marine ecosystems and heritage.

ACT	DESCRIPTION
Antarctic Environmental Protection Act 2003	Implements measures to protect the Antarctic environment in line with international agreements.
Heritage Lighthouse Protection Act 2008	Ensures the protection and preservation of heritage lighthouses of historical and architectural value.
Service Fees Act 2017	Regulates the setting and management of service fees charged by federal departments and agencies, ensuring transparency and accountability.
Impact Assessment Act (IAA) 2019	Law designed to assess the potential environmental, economic, and social impacts of proposed projects. The IAA broadens the scope of assessments to include not only environmental effects but also health, social, and economic impacts. This means that the potential effects of a project on Indigenous rights, community well-being, and economic conditions are considered.
Nature Accountability Act 2024	Aims to ensure transparency and accountability regarding Canada's commitments under the Convention on Biological Diversity. This legislation, alongside the 2030 Nature Strategy, forms a comprehensive plan to protect and restore nature across Canada.

Table 9 Federal Legislation on Conservation and Protected Areas in Canada (Parks Canada Agency, 2014; CanLII, 2025 & ECCC, 2024b)

Appendix D

PROVINCES AND TERRITORIES	ACT
Nunavut (NU)	Consolidation of Territorial Parks Act 1988
	Consolidation of Wildlife Act 2003
Northwest Territories (NT)	Territorial Parks Act 1988
	Protected Areas Act 2019
	Wildlife Act 2013
Yukon (YT)	Parks and Land Certainty Act 2002
	Wildlife Act 2002
	Environment Act 2002
Newfoundland and Labrador (NL)	Provincial Parks Act 1990
	Wildlife Act 1990
	Wilderness and Ecological Reserves Act 1990
Prince Edward Island (PE)	Recreation Development Act 1988
	Planning Act 1988
	Natural Areas Protection Act 1988
	Wildlife Conservation Act 1988
	Parks Development Act 1989
Nova Scotia (NS)	Provincial Parks Act 1989
	Wildlife Act 1989
	Special Places Protection Act 1989
	Trails Act 1989
	Wilderness Areas Protection Act 1998
	Biodiversity Act 2021
	Parks Act 2011
New Brunswick (NB)	Protected Natural Areas Act 2003
	Fish and Wildlife Act 1980
	Sustainable Development Act 2006
Québec (QC)	Parks Act 2006
	Natural Heritage Conservation Act 2004
	Act respecting the conservation and development of wildlife 2002
Ontario (ON)	Wilderness Areas 1990
	Provincial Parks and Conservation Reserves Act 2006
	Far North Act 2010
Manitoba (MB)	The Ecological Reserves Act 1987
	Wildlife Act 1988
	The Provincial Parks Act 1993
Saskatchewan (SK)	The East Side Traditional Lands Planning and Special Protected Areas Act 2009
	The Ecological Reserves Act 1980
	The Wildlife Habitat Protection Act 1983
	Parks Act 1986
	The Wildlife Act 1998
	The Conservation Easements Act 1996
	The Regional Parks Act 2013
Alberta (AB)	The Provincial Lands Act 2016
	Provincial Parks Act 2000

PROVINCES AND TERRITORIES	ACT
	Wilderness Areas, Ecological Reserves, Natural Areas and Heritage Rangelands Act 2000
	Wildlife Act 2000
	Trails Act 2021
British Columbia (BC)	Park Act 1996
	Environment and Land Use Act 1996
	Wildlife Act 1996
	Land Act 1996
	Ecological Reserve Act 1996
	Land Title Act 1996
	Protected Areas of British Columbia Act 2000
	Local Government Act 2015

Table 10 Provincial and Territorial Protected Areas Acts (CanLII, 2025)

Appendix E

PROVINCES AND TERRITORIES	GUIDELINES AND STRATEGIES	LINK
Nunavut (NU)	Nunavut Parks Program 2020	Nunavut Parks Program 2020
Northwest Territories (NT)	Northwest Territories Biodiversity Action Plan 2004	Northwest Territories Biodiversity Action Plan 2004
	Nominating and Establishing Protected Areas	Nominating and Establishing Protected Areas
	Wildlife Management and Monitoring Plan 2019	Wildlife Management and Monitoring Plan 2019
	Protected Areas Strategy 1999	Protected Areas Strategy 1999
Yukon (YT)	Yukon Parks Strategy 2020 - 2030	Yukon Parks Strategy 2020 - 2030
	Parks and outdoor recreation policy 1991	Parks and outdoor recreation policy 1991
Newfoundland and Labrador (NL)	Newfoundland and Labrador Protected Areas Strategy 2004	Newfoundland and Labrador Protected Areas Strategy 2004
Prince Edward Island (PE)	Land Conservation	Land Conservation
Nova Scotia (NS)	Our Parks and Protected Areas 2013	Our Parks and Protected Areas 2013
New Brunswick (NB)	Socio-Economic Analysis for the Protected Areas Strategy 2000	Socio-Economic Analysis for the Protected Areas Strategy 2000
	Provincial Parks Planning Policy for Québec National Parks 2018	Provincial Parks Planning Policy for Québec National Parks 2018
Québec (QC)	The Ecological Reference Framework	Protected Areas in Québec (English) The Ecological Reference Framework (French)
	Ontario's Protected Areas Planning Manual 2014	Ontario's Protected Areas Planning Manual 2014
Ontario (ON)	Guideline to Management Planning for Protected Areas in the Context of Ecological Integrity 2019	Guideline to Management Planning for Protected Areas in the Context of Ecological Integrity 2019
	A System Plan for Manitoba's Provincial Parks 2023	A System Plan for Manitoba's Provincial Parks 2023
Saskatchewan (SK)	Saskatchewan Protected and Conserved Areas Network	Saskatchewan Protected and Conserved Areas Network
	Conservation and Stewardship	Conservation and Stewardship
Alberta (AB)	Management Planning	Management Planning
	Alberta Parks Management Planning Process	Alberta Parks Management Planning Process
British Columbia (BC)	Management planning process	Management planning process
	Strategic Policy for Management Planning 2013	Strategic Policy for Management Planning 2013
	BC Parks management planning manual 2016	BC Parks management planning manual 2016
	BC Parks guide to writing management plans 2013	BC Parks guide to writing management plans 2013

PROVINCES AND TERRITORIES	GUIDELINES AND STRATEGIES	LINK
	Zoning framework 2012	BC Parks Zoning Framework (gov.bc.ca)
	Wildlife Guidelines for Backcountry Tourism/Commercial Recreation in British Columbia 2006	Wildlife Guidelines for Backcountry Tourism/Commercial Recreation in British Columbia 2006
	B.C.'s draft Biodiversity and Ecosystem Health Framework	B.C.'s draft Biodiversity and Ecosystem Health Framework
	Wildlife Management Areas	Wildlife Management Areas

Table 11 Guidelines and strategies for Provincial and Territorial Protected Areas

Appendix F

ECOSYSTEM TYPE (SEEA EA)	GLOBAL ECOSYSTEM TYPOLOGY (IUCN)	OTHER POSSIBLE ECOSYSTEM TYPOLOGY PRESENT IN WELLS GRAY	ECOSYSTEM SERVICES (SEEA EA)	
Boreal Temperate Montane Forest Woodland	T2.1 Boreal and temperate high montane forests and woodlands T4.4 Temperate woodlands		Provisioning	Wood Wild animals, plants and other biomass Genetic material
			Regulating	Global climate regulation Rainfall pattern regulation Air filtration Soil and sediment retention Soil quality regulation Pollination Nursery population and habitat maintenance
Temperate Forest	T2.1 Boreal and temperate high montane forests and woodlands		Provisioning	Wood Wild animals, plants and other biomass Genetic material
			Regulating	Global climate regulation Rainfall pattern regulation Air filtration Soil and sediment retention

ECOSYSTEM TYPE (SEEA EA)	GLOBAL ECOSYSTEM TYPOLOGY (IUCN)	OTHER POSSIBLE ECOSYSTEM TYPOLOGY PRESENT IN WELLS GRAY	ECOSYSTEM SERVICES (SEEA EA)	
				Soil quality regulation Pollination Nursery population and habitat maintenance
Rocky Pavement Lavaflow Screes	T6.2 Polar/alpine cliffs, screes, outcrops and lava flows		Provisioning	Wild animals, plants and other biomass Genetic material
			Regulating	Soil and sediment retention Soil quality regulation Nursery population and habitat maintenance
Cool Temperate Heathland	T6.3 Polar tundra and deserts		Provisioning	Wild animals, plants and other biomass Genetic material
			Regulating	Soil and sediment retention Soil quality regulation Nursery population and habitat maintenance
Aquatic	F1.3 Freeze-thaw rivers and streams. F2.4 Freeze-thaw freshwater lakes F2.1 Large permanent freshwater lakes	F2.9 Geothermal pools and wetlands	Provisioning	Wild fish and other natural aquatic biomass Water supply Genetic material
			Regulating	Global climate regulation

ECOSYSTEM TYPE (SEEA EA)	GLOBAL ECOSYSTEM TYPOLOGY (IUCN)	OTHER POSSIBLE ECOSYSTEM TYPOLOGY PRESENT IN WELLS GRAY	ECOSYSTEM SERVICES (SEEA EA)	
				Rainfall pattern regulation Water purification Water flow regulation River flood mitigation Nursery population and habitat maintenance
Boreal Cool Temperate Palustrine Wetland	T6.3 Polar tundra and deserts		Provisioning	Wild animals, plants and other biomass Genetic material
			Regulating	Global climate regulation Water purification River flood mitigation Nursery population and habitat maintenance
Cropland⁵¹	T7.1 Annual croplands		Provisioning	Crop
			Regulating	Pollination Nursery population and habitat maintenance
Ice Sheet Glacier Permanent Snowfield	T6.1 Ice sheets, glaciers and perennial snowfields	S1.1 Aerobic caves	Provisioning	Wild animals, plants and other biomass
	T6.3 Polar tundra and deserts			Water supply Genetic material

⁵¹ This ecosystem type represents only 0.18% of the total area of Wells Gray. Additionally, it is based on a model developed by ARIES for the SEEA platform, where the analysis is conducted at a global scale. As a result, the probability of cropland occurring within Wells Gray is effectively zero. Since the park prohibits agricultural activities, this ecosystem type is not considered relevant for the ecosystem services analysis.

ECOSYSTEM TYPE (SEEA EA)	GLOBAL ECOSYSTEM TYPOLOGY (IUCN)	OTHER POSSIBLE ECOSYSTEM TYPOLOGY PRESENT IN WELLS GRAY	ECOSYSTEM SERVICES (SEEA EA)	
			Regulating	Soil and sediment retention Soil quality regulation Water flow regulation River flood mitigation Nursery population and habitat maintenance
Polar Alpine Rocky Outcrop	T6.2 Polar/alpine cliffs, screes, outcrops and lava flows	S1.1 Aerobic caves	Provisioning	Wild animals, plants and other biomass Genetic material
			Regulating	Soil and sediment retention Soil quality regulation Nursery population and habitat maintenance
Alpine Grassland Shrubland	T6.4 Temperate alpine grasslands and shrublands		Provisioning	Wild animals, plants and other biomass Genetic material
			Regulating	Global climate regulation Air filtration Pollination Nursery population and habitat maintenance

Table 12 Wells Gray Ecosystem Services base on Global Ecosystem Typology IUCN (IUCN Global Ecosystem Typology, 2022) and Reference list of selected ecosystem services SEEA EA (United Nations, 2021a)

Appendix G

GLOBAL ECOSYSTEM TYPOLOGY (IUCN)	ECOSYSTEM PROPERTIES	LINK
T2.1 Boreal and temperate high montane forests and woodlands	Moderate productivity Simple tree canopy and layered substrata Seasonal growth and reproduction Winter dormancy, hibernation and migration Frost tolerance Seed physiological dormancy	<u>Group: Boreal and temperate high montane forests and woodlands - T2.1 Boreal and temperate high montane forests and woodlands</u>
T4.4 Temperate woodlands	Temporally and spatially variables C3-C4 (photosynthetic pathways) grass mixture High diversity and low endemism Seasonally high productivity Extended trophic structure Fine-scale heterogeneity Seasonal drought tolerance Fire tolerance Frost tolerance Wide dispersal and vegetative reproduction	<u>Group: Temperate woodlands - T4.4 Temperate woodlands</u>
T6.1 Ice sheets, glaciers and perennial snowfields	Very low productivity, diversity and endemism Slow decomposition Truncated trophic networks. Microbe dominance Seasonal metabolic activity Migratory and itinerant birds and mammals	<u>Group: Ice sheets, glaciers and perennial snowfields - T6.1 Ice sheets, glaciers and perennial snowfields</u>
T6.2 Polar/alpine cliffs, screes, outcrops and lava flows	Very low productivity, diversity and endemism Slow decomposition Truncated trophic networks. Lichen and bryophyte dominance. Seasonal metabolic activity Nesting birds	<u>Group: Polar/alpine cliffs, screes, outcrops and lava flows - T6.2 Polar/alpine cliffs, screes, outcrops and lava flows</u>
T6.3 Polar tundra and deserts	Low productivity Slow decomposition Simple trophic networks Low diversity Freeze tolerance Dormancy and hibernation Sparse nomadic predators Migratory birds and mammals	<u>Group: Polar tundra and deserts - T6.3 Polar tundra and deserts</u>
T6.4 Temperate alpine grasslands and shrublands	Low productivity Slow decomposition Simple trophic networks Low vegetation stature Frost tolerance Ruderal and stress tolerator life histories	<u>Group: Temperate alpine grasslands and shrublands - T6.4 Temperate alpine grasslands and shrublands</u>

GLOBAL ECOSYSTEM TYPOLOGY (IUCN)	ECOSYSTEM PROPERTIES	LINK
	Dormancy and hibernation Migratory birds and mammals	
F1.3 Freeze-thaw rivers and streams	Low-moderate seasonal productivity Allochthonous energy Simple trophic structure Cold-insulation tissues Low-temperature metabolism Dormant life stage Dispersal to winter refuges	<u>Group: Freeze-thaw rivers and streams - F1.3Freeze-thaw rivers and streams</u>
F2.1 Large permanent freshwater lakes	High productivity Autochthous and allochthonous energy High diversity and trophic complexity Local endemism Buffered trophic states. Biotic zonation Specialised life history and feeding traits	<u>Group: Large permanent freshwater lakes - F2.1Large permanent freshwater lakes</u>
F2.4 Freeze-thaw freshwater lakes	High seasonal productivity Trophic complexity related to lake size. Oligotrophic-eutrophic state dynamics Oxygen capture traits Dormancy and resisting traits. Biotic zonation	<u>Group: Freeze-thaw freshwater lakes - F2.4Freeze-thaw freshwater lakes</u>
F2.9 Geothermal pools and wetlands	Low productivity and diversity Simple trophic structure Chemoautotrophic and photoautotrophic energy Successional gradients Thermophilic and metallophilic biota Invertebrate detritivores Heat tolerance	<u>Group: Geothermal pools and wetlands - F2.9Geothermal pools and wetlands</u>
S1.1 Aerobic caves	Very low productivity Aphotic energy synthesis Slow decomposition Low diversity and high endemism Truncated trophic network (heterotrophic) Dominated by micro-organism and invertebrate detritivores	<u>Group: Aerobic caves - S1.1Aerobic caves</u>

Table 13 Wells Gray Global Ecosystem Typology IUCN (IUCN Global Ecosystem Typology, 2022)

Appendix H

LAND COVER	ECOSYSTEM TYPE	%
Barren Lands	Alpine Grassland Shrubland	1.9709%
	Aquatic	0.0087%
	Boreal Cool Temperate Palustrine Wetland	0.0337%
	Boreal Temperate Montane Forest Woodland	3.3074%
	Cool Temperate Heathland	1.6295%
	Cropland	0.0025%
	Ice Sheet Glacier Permanent Snowfield	0.7490%
	Polar Alpine Rocky Outcrop	3.3694%
	Rocky Pavement Lavaflow Scree	2.2357%
	Temperate Forest	0.0050%
Cropland	Boreal Temperate Montane Forest Woodland	0.0062%
	Cool Temperate Heathland	0.0017%
	Rocky Pavement Lavaflow Scree	0.0006%
	Cropland	0.0001%
	Boreal Cool Temperate Palustrine Wetland	0.0001%
Mixed Forest	Boreal Temperate Montane Forest Woodland	0.0002%
Snow and Ice	Alpine Grassland Shrubland	0.4302%
	Aquatic	0.0032%
	Boreal Temperate Montane Forest Woodland	0.2138%
	Cool Temperate Heathland	0.0869%
	Ice Sheet Glacier Permanent Snowfield	2.1090%
	Polar Alpine Rocky Outcrop	1.7653%
	Rocky Pavement Lavaflow Scree	0.3351%
Sub-polar or polar grassland-lichen-moss	Rocky Pavement Lavaflow Scree	0.0006%
	Cool Temperate Heathland	0.0004%
	Boreal Temperate Montane Forest Woodland	0.0004%
	Polar Alpine Rocky Outcrop	0.0002%
Sub-polar taiga needleleaf forest	Alpine Grassland Shrubland	0.0021%
	Boreal Temperate Montane Forest Woodland	0.0096%
	Cool Temperate Heathland	0.0029%
	Ice Sheet Glacier Permanent Snowfield	0.0001%
	Polar Alpine Rocky Outcrop	0.0035%
	Rocky Pavement Lavaflow Scree	0.0034%
Temperate or sub-polar broadleaf deciduous forest	Boreal Temperate Montane Forest Woodland	0.0013%
	Cool Temperate Heathland	0.0002%
	Cropland	0.0004%
	Rocky Pavement Lavaflow Scree	0.0012%
	Alpine Grassland Shrubland	0.3005%
	Aquatic	0.0185%

LAND COVER	ECOSYSTEM TYPE	%
Temperate or sub-polar grassland	Boreal Cool Temperate Palustrine Wetland	0.0648%
	Boreal Temperate Montane Forest Woodland	3.5345%
	Cool Temperate Heathland	1.0845%
	Cropland	0.0249%
	Ice Sheet Glacier Permanent Snow field	0.0093%
	Polar Alpine Rocky Outcrop	0.3709%
	Rocky Pavement Lavaflow Scree	0.6026%
	Temperate Forest	0.0809%
Temperate or sub-polar needleleaf forest	Alpine Grassland Shrubland	0.3726%
	Aquatic	1.3871%
	Boreal Cool Temperate Palustrine Wetland	0.1207%
	Boreal Temperate Montane Forest Woodland	52.4269%
	Cool Temperate Heathland	1.3568%
	Cropland	0.0861%
	Ice Sheet Glacier Permanent Snow field	0.0044%
	Polar Alpine Rocky Outcrop	0.5906%
	Rocky Pavement Lavaflow Scree	0.5219%
	Temperate Forest	1.2882%
Temperate or sub-polar shrubland	Alpine Grassland Shrubland	0.2514%
	Aquatic	0.0958%
	Boreal Cool Temperate Palustrine Wetland	0.1741%
	Boreal Temperate Montane Forest Woodland	9.2434%
	Cool Temperate Heathland	1.6963%
	Cropland	0.0492%
	Ice Sheet Glacier Permanent Snow field	0.0046%
	Polar Alpine Rocky Outcrop	0.2640%
	Rocky Pavement Lavaflow Scree	0.2419%
	Temperate Forest	0.1138%
Urban	Boreal Temperate Montane Forest Woodland	0.0497%
	Aquatic	0.0021%
	Temperate Forest	0.0009%
Water	Alpine Grassland Shrubland	0.0570%
	Aquatic	3.0683%
	Boreal Cool Temperate Palustrine Wetland	0.0006%
	Boreal Temperate Montane Forest Woodland	1.3634%
	Cool Temperate Heathland	0.0917%
	Cropland	0.0134%
	Ice Sheet Glacier Permanent Snow field	0.0195%
	Polar Alpine Rocky Outcrop	0.0862%
	Rocky Pavement Lavaflow Scree	0.0946%
	Temperate Forest	0.4761%
Wetland	Alpine Grassland Shrubland	0.0003%

LAND COVER	ECOSYSTEM TYPE	%
	Aquatic	0.0001%
	Boreal Temperate Montane Forest Woodland	0.0023%
	Cool Temperate Heathland	0.0011%
	Polar Alpine Rocky Outcrop	0.0007%
	Rocky Pavement Lavaflow Screes	0.0004%
TOTAL		100%

Table 14 Wells Gray Land Covers and Ecosystems Type Intersection

Appendix I

LAND COVER	BEC ZONE	ECOSYSTEM TYPE (ARIES for SEEA EA)	ECOSYSTEM SERVICE
Temperate or sub-polar needleleaf forest Temperate or sub-polar shrubland	ICH	Boreal Temperate Montane Forest Woodland	Wood; Wild animals, plants and other biomass; Genetic material; Global climate regulation; Rainfall pattern regulation; Air filtration; Soil and sediment retention; Soil quality regulation; Pollination; Nursery population and habitat maintenance
Temperate or sub-polar shrubland Temperate or sub-polar needleleaf forest		Cool Temperate Heathland	Wild animals, plants and other biomass; Genetic material; Soil and sediment retention; Soil quality regulation; Nursery population and habitat maintenance
Temperate or sub-polar needleleaf forest Temperate or sub-polar shrubland		Temperate Forest	Wood; Wild animals, plants and other biomass; Genetic material; Global climate regulation; Rainfall pattern regulation; Air filtration; Soil and sediment retention; Soil quality regulation; Pollination; Nursery population and habitat maintenance
Water		Aquatic	Wild fish and other natural aquatic biomass; Genetic material; Water supply; Global climate regulation; Rainfall pattern regulation; Water purification; Water flow regulation; River flood

LAND COVER	BEC ZONE	ECOSYSTEM TYPE (ARIES for SEEA EA)	ECOSYSTEM SERVICE
			mitigation; Nursery population and habitat maintenance
Temperate or sub-polar needleleaf forest	ESSF	Boreal Temperate Montane Forest Woodland	Wood; Wild animals, plants and other biomass; Genetic material; Global climate regulation; Rainfall pattern regulation; Air filtration; Soil and sediment retention; Soil quality regulation; Pollination; Nursery population and habitat maintenance
Temperate or sub-polar shrubland			
Temperate or sub-polar grassland			
Barren Lands			
Temperate or sub-polar shrubland		Boreal Cool Temperate Palustrine Wetland	Wild animals, plants and other biomass; Genetic material; Global climate regulation; Water purification; River flood mitigation; Nursery population and habitat maintenance
Temperate or sub-polar needleleaf forest			
Barren lands		Cool Temperate Heathland	Wild animals, plants and other biomass; Genetic material; Soil and sediment retention; Soil quality regulation; Nursery population and habitat maintenance
Temperate or sub-polar shrubland			
Temperate or sub-polar needleleaf forest			
Temperate or sub-polar grassland			
Barren lands		Alpine Grassland Shrubland	Wild animals, plants and other biomass; Genetic material; Global climate regulation; Air filtration; Pollination; Nursery population and habitat maintenance
Temperate or sub-polar needleleaf forest			
Temperate or sub-polar grassland			

LAND COVER	BEC ZONE	ECOSYSTEM TYPE (ARIES for SEEA EA)	ECOSYSTEM SERVICE
Temperate or sub-polar needleleaf forest		Temperate Forest	Wood; Wild animals, plants and other biomass; Genetic material; Global climate regulation; Rainfall pattern regulation; Air filtration; Soil and sediment retention; Soil quality regulation; Pollination; Nursery population and habitat maintenance
Barren lands Temperate or sub-polar needleleaf forest		Polar Alpine Rocky Outcrop	Wild animals, plants and other biomass; Genetic material; Soil and sediment retention; Soil quality regulation; Nursery population and habitat maintenance
Barren lands Temperate or sub-polar grassland		Rocky Pavement Lavaflow Scree	Wild animals, plants and other biomass; Genetic material; Soil and sediment retention; Soil quality regulation; Nursery population and habitat maintenance
Temperate or sub-polar needleleaf forest Temperate or sub-polar shrubland	IDF	Boreal Temperate Montane Forest Woodland	Wood; Wild animals, plants and other biomass; Genetic material; Global climate regulation; Rainfall pattern regulation; Air filtration; Soil and sediment retention; Soil quality regulation; Pollination; Nursery population and habitat maintenance
Temperate or sub-polar needleleaf forest		Temperate Forest	Wood; Wild animals, plants and other biomass; Genetic material; Global climate regulation; Rainfall

LAND COVER	BEC ZONE	ECOSYSTEM TYPE (ARIES for SEEA EA)	ECOSYSTEM SERVICE
Temperate or sub-polar shrubland			pattern regulation; Air filtration; Soil and sediment retention; Soil quality regulation; Pollination; Nursery population and habitat maintenance
Water		Aquatic	Wild fish and other natural aquatic biomass; Genetic material; Water supply; Global climate regulation; Rainfall pattern regulation; Water purification; Water flow regulation; River flood mitigation; Nursery population and habitat maintenance
Barren lands Snow and Ice	IMA	Alpine Grassland Shrubland	Wild animals, plants and other biomass; Genetic material; Global climate regulation; Air filtration; Pollination; Nursery population and habitat maintenance
Snow and Ice Barren lands		Ice Sheet Glacier Permanent Snowfield	Wild animals, plants and other biomass; Water supply; Genetic material; Soil and sediment retention; Soil quality regulation; Water flow regulation; River flood mitigation
Barren lands Snow and Ice		Polar Alpine Rocky Outcrop	Wild animals, plants and other biomass; Genetic material; Soil and sediment retention; Soil quality regulation; Nursery population and habitat maintenance

LAND COVER	BEC ZONE	ECOSYSTEM TYPE (ARIES for SEEA EA)	ECOSYSTEM SERVICE
Barren lands Snow and Ice		Rocky Pavement Lavaflow Screes	Wild animals, plants and other biomass; Genetic material; Soil and sediment retention; Soil quality regulation; Nursery population and habitat maintenance

Table 15 Wells Gray BEC zones, Ecosystems and Ecosystem Services approached.

Appendix J

TYPE OF ES	ECOSYSTEM SERVICES (SEEA EA)	DESCRIPTION
Provisioning	Wood	Wood provisioning services are the ecosystem contributions to the growth of trees and other woody biomass in both cultivated (plantation) and uncultivated production contexts that are harvested by economic units for various uses including timber production and energy. This service excludes contributions to non-wood forest products. This is a final ecosystem service.
	Wild animals, plants and other biomass	Wild animals, plants and other biomass provisioning services are the ecosystem contributions to the growth of wild animals, plants and other biomass that are captured and harvested in uncultivated production contexts by economic units for various uses. The scope includes non-wood forest products (NWFP), and services related to hunting, trapping and bio-prospecting activities; but excludes wild fish and other natural aquatic biomass. This is a final ecosystem service.
	Wild fish and other natural aquatic biomass	Wild fish and other natural aquatic biomass provisioning services are the ecosystem contributions to the growth of fish and other aquatic biomass that are captured in uncultivated production contexts by economic units for various uses, primarily food production. This is a final ecosystem service.
	Water supply	Water supply services reflect the combined ecosystem contributions of water flow regulation, water purification, and other ecosystem services to the supply of water of appropriate quality to users for various uses including household consumption. This is a final ecosystem service.
	Genetic material services	Genetic material services are the ecosystem contributions from all biota (including seed, spore or gamete production) that are used by economic units, for example (i) to develop new animal and plant breeds; (ii) in gene synthesis; or (iii) in product development directly using genetic material. This is most commonly recorded as an intermediate service to biomass provisioning.
Regulating and Maintenance	Global climate regulation	Global climate regulation services are the ecosystem contributions to the regulation of the chemical composition of the atmosphere and oceans that affect global climate through the accumulation and retention of carbon and other GHG (e.g., methane) in ecosystems and the ability of ecosystems to remove (sequester) carbon from the atmosphere. This is a final ecosystem service.
	Rainfall pattern regulation (at sub-continental scale)	Rainfall pattern regulation services are the ecosystem contributions of vegetation, in particular forests, in maintaining rainfall patterns through evapotranspiration at the sub-continental scale. Forests and other vegetation recycle moisture back to the atmosphere where it is available for the generation of rainfall. Rainfall in interior parts of continents fully depends upon this recycling. This may be a final or intermediate service.

TYPE OF ES	ECOSYSTEM SERVICES (SEEA EA)	DESCRIPTION
	Air filtration	Air filtration services are the ecosystem contributions to the filtering of air-borne pollutants through the deposition, uptake, fixing and storage of pollutants by ecosystem components, particularly plants, which mitigates the harmful effects of the pollutants. This is most commonly a final ecosystem service.
	Soil quality regulation	Soil quality regulation services are the ecosystem contributions to the decomposition of organic and inorganic materials and to the fertility and characteristics of soils, e.g., for input to biomass production. This is most commonly recorded as an intermediate service.
	Soil and sediment retention	Soil erosion control services are the ecosystem contributions, particularly the stabilising effects of vegetation, which reduce the loss of soil (and sediment) and support use of the environment (e.g., agricultural activity, water supply). This may be recorded as a final or intermediate service. Landslide mitigation services are the ecosystem contributions, particularly the stabilising effects of vegetation, which mitigates or prevents potential damage to human health and safety and damaging effects to buildings and infrastructure that arise from the mass movement (wasting) of soil, rock and snow. This is a final ecosystem service.
	Water purification	Water purification services are the ecosystem contributions to the restoration and maintenance of the chemical condition of surface water and groundwater bodies through the breakdown or removal of nutrients and other pollutants by ecosystem components that mitigate the harmful effects of the pollutants on human use or health. This may be recorded as a final or intermediate ecosystem service.
	Water flow regulation	Water regulation services are the ecosystem contributions to the regulation of river flows and groundwater and lake water tables. They are derived from the ability of ecosystems to absorb and store water and gradually release water during dry seasons or periods through evapotranspiration and hence secure a regular flow of water. This may be recorded as a final or intermediate ecosystem service. They are also derived from the ability of ecosystems to absorb and store water and hence mitigate the effects of flood and other extreme water-related events. Peak flow mitigation services will be supplied together with river flood mitigation services in providing the benefit of flood protection. This is a final ecosystem service.
	River flood mitigation	River flood mitigation services are the ecosystem contributions of riparian vegetation which provides structure and a physical barrier to high water levels and thus mitigates the impacts of floods on local communities. River flood mitigation services will be supplied together with peak flow mitigation services in providing the benefit of flood protection. This is a final ecosystem service.

TYPE OF ES	ECOSYSTEM SERVICES (SEEA EA)	DESCRIPTION
	Pollination	Pollination services are the ecosystem contributions by wild pollinators to the fertilization of crops that maintains or increases the abundance and/or diversity of other species that economic units use or enjoy. This may be recorded as a final or intermediate service.
	Nursery population and habitat maintenance	Nursery population and habitat maintenance services are the ecosystem contributions necessary for sustaining populations of species that economic units ultimately use or enjoy either through the maintenance of habitats (e.g., for nurseries or migration) or the protection of natural gene pools. This service is an intermediate service and may input to a number of different final ecosystem services including biomass provision and recreation-related services.
Cultural	Recreation	Recreation-related services are the ecosystem contributions, in particular through the biophysical characteristics and qualities of ecosystems, which enable people to use and enjoy the environment through direct, in-situ, physical and experiential interactions with the environment. This includes services to both locals and non-locals (i.e. visitors, including tourists). Recreation-related services may also be supplied to those undertaking recreational fishing and hunting. This is a final ecosystem service.
	Visual amenity	Visual amenity services are the ecosystem contributions to local living conditions, in particular through the biophysical characteristics and qualities of ecosystems that provide sensory benefits, especially visual. This service combines with other ecosystem services, including recreation-related services and noise attenuation services to underpin amenity values. This is a final ecosystem service.
	Education and scientific research	Education, scientific and research services are the ecosystem contributions, in particular through the biophysical characteristics and qualities of ecosystems, which enable people to use the environment through intellectual interactions with the environment. This is a final ecosystem service.
	Spiritual, artistic and symbolic	Spiritual artistic and symbolic services are the ecosystem contributions, in particular through the biophysical characteristics and qualities of ecosystems, which are recognised by people for their cultural, historical, aesthetic, sacred or religious significance. These services may underpin people's cultural identity and may inspire people to express themselves through various artistic media. This is a final ecosystem service.
	Ecosystem and species appreciation	Ecosystem and species appreciation concerns the wellbeing that people derive from the existence and preservation of the environment for current and future generations, irrespective of any direct or indirect use.

Table 16 Wells Gray Ecosystem Services base on Reference list of selected ecosystem services SEEA EA (United Nations, 2021a)