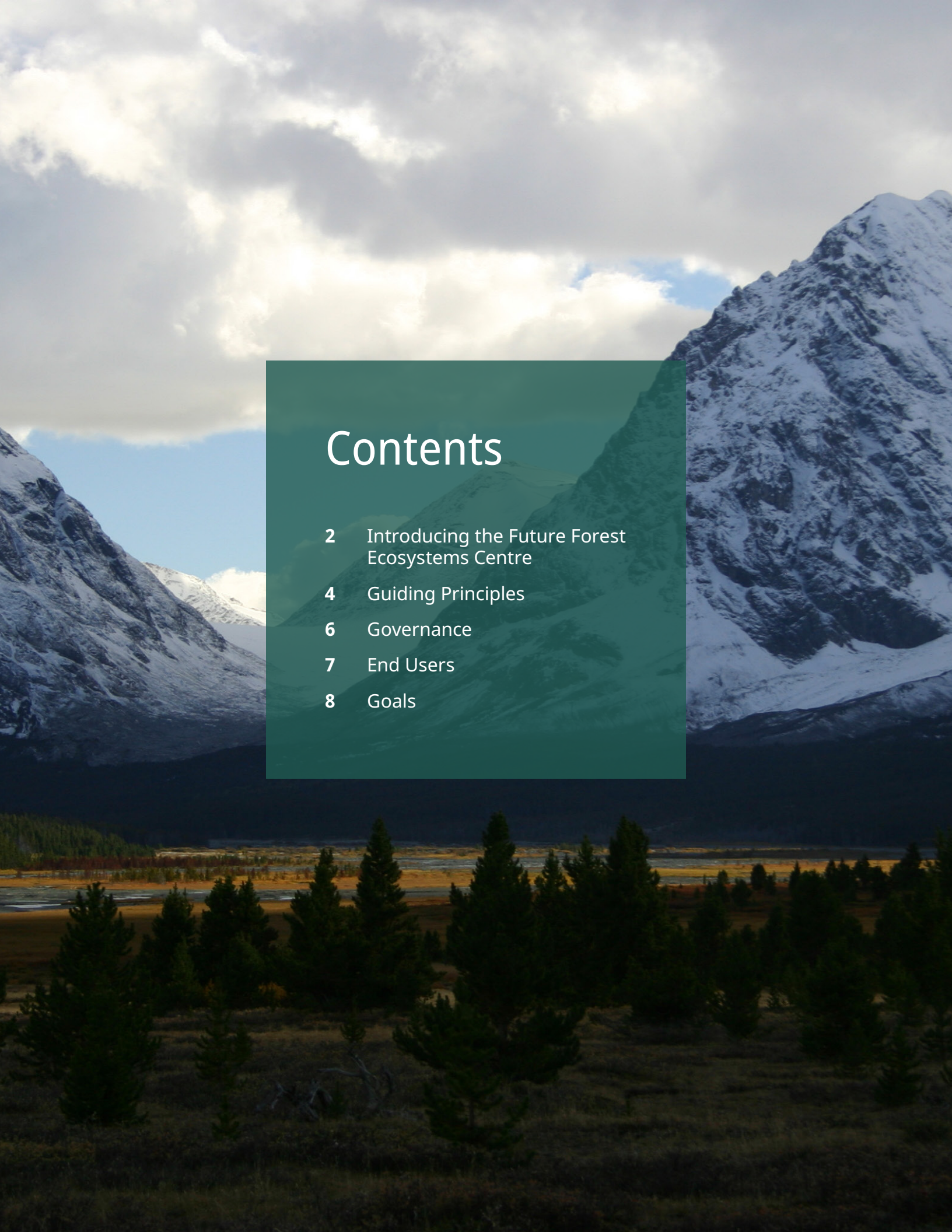
Future Forest Ecosystems Centre

2023-2025 Strategic Plan

October 1, 2023

BRITISH COLUMBIA



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Introducing the Future Forest Ecosystems Centre

Responding to the climate crisis is an urgent priority in British Columbia. Understanding how climatic disruption will affect ecosystems is essential to this response. Ecosystem practitioners, planners, and policymakers require translation of climate change projections into information that is useful for their decisions.

The Ministry of Forests has established the Future Forest Ecosystems Centre (FFEC) to address this need. The FFEC is a scientific team that forecasts climate change impacts to BC's forest ecosystems. The focus of the FFEC is on decision support: data, tools, and guidance that help ecosystem managers account for climate risks. Our purpose is to support climate change adaptation and mitigation by reducing disruptions to ecosystem services.

Origins of the FFEC

The Ministry of Forests identified the need for an *Ecosystem Forecast Centre* in 2019 as part of its submissions to the Climate Preparedness and Adaptation Strategy Discussion Paper. The ministry expanded this concept as part of the 2021 Climate Preparedness and Adaptation Strategy. In 2022, the name "Future Forest Ecosystems Centre" was adopted in recognition that one team could not address all elements of BC's ecosystems. This name emphasizes a holistic concept of forest ecosystems while leaving room for other ecological forecasting centres to emerge in the natural resource ministries.

Scope

Thematic scope – Our concept of forest ecosystems encompasses the abiotic and biotic components of the forest as well as the mosaic of biomes—alpine, aquatic, wetland, and grassland—that support and depend on the condition of the forest. Within this inclusive concept we have a strategic focus on vegetation and its role in providing ecosystem services.

Geographical scope – The FFEC aims to deliver datasets and tools that cover all of British Columbia. Where feasible, our data and tools include adjacent jurisdictions across northwestern North America. This large geographic scope provides essential context for climate change in BC, is the basis for the cross-border collaborations that are necessary for climate change adaptation, and advances BC's leadership in climate action.

Temporal scope – The FFEC provides decadal-scale forecasts of ecological drivers and climate risks. Our focus is on timescales that are relevant to long-term strategic decision-making: the 2020-2050 period, with outlooks to 2100 for longer-term context. The potential to provide seasonal forecasts will be considered in future strategic plans.

Strategic Alignment

This strategic plan supports the Ministry of Forests Service Plan Objective 3.2 to "Generate new scientific knowledge on forest carbon and climate change to support decision-making and support changes in behaviour and practices through education, outreach, and the development of decision support tools."

This strategic plan also supports the ministry's legal obligations to account for climate change risks under the *Forest Statutes Amendment Act*: "The chief forester, in preparing a forest landscape plan, must consider... preventing, mitigating and adapting to impacts caused by significant disturbances to forests and forest health, including wildfire, insects, disease and drought."

Aftermath of the 2017 Hanceville Fire on the Chilcotin Plateau.
Photo by Colin Mahony

Guiding Principles

The work of the FFEC is guided by the following principles.

- **Transparency** – The FFEC practices open science by providing free public access to all datasets, source code, and publications.
- **Policy-neutrality** – While FFEC products may be designed to inform policy and planning, the FFEC does not make policy prescriptions.
- **Public service** – We support policymakers, planners, ecosystem practitioners, and Indigenous knowledge-keepers in the public, private, and academic sectors.

Principles of service to First Nations

Respect for Indigenous knowledge systems and the unique place-based relationship of First Nations peoples with the ecosystems of BC is a guiding principle of the FFEC. We seek to support self-determined climate resilience of First Nations by:

- Recognizing that Indigenous knowledge systems are inseparable from Indigenous knowledge-keepers and cannot be meaningfully or ethically incorporated into FFEC products without the explicit direction and oversight of Indigenous knowledge-keepers.
- When responding to information requests from First Nations leaders and organizations, recognizing that FFEC products are a supplement to Indigenous knowledge in Indigenous decisions.
- When invited to support First Nations, doing so with humility, recognizing both the profound relationship of First Nations peoples with their traditional territories and the continuing legacies of colonial harm.
- Collaborating with First Nations directly and through established government-to-government processes such as Forest Landscape Planning and Modernized Landscape Planning.

Forecasting principles

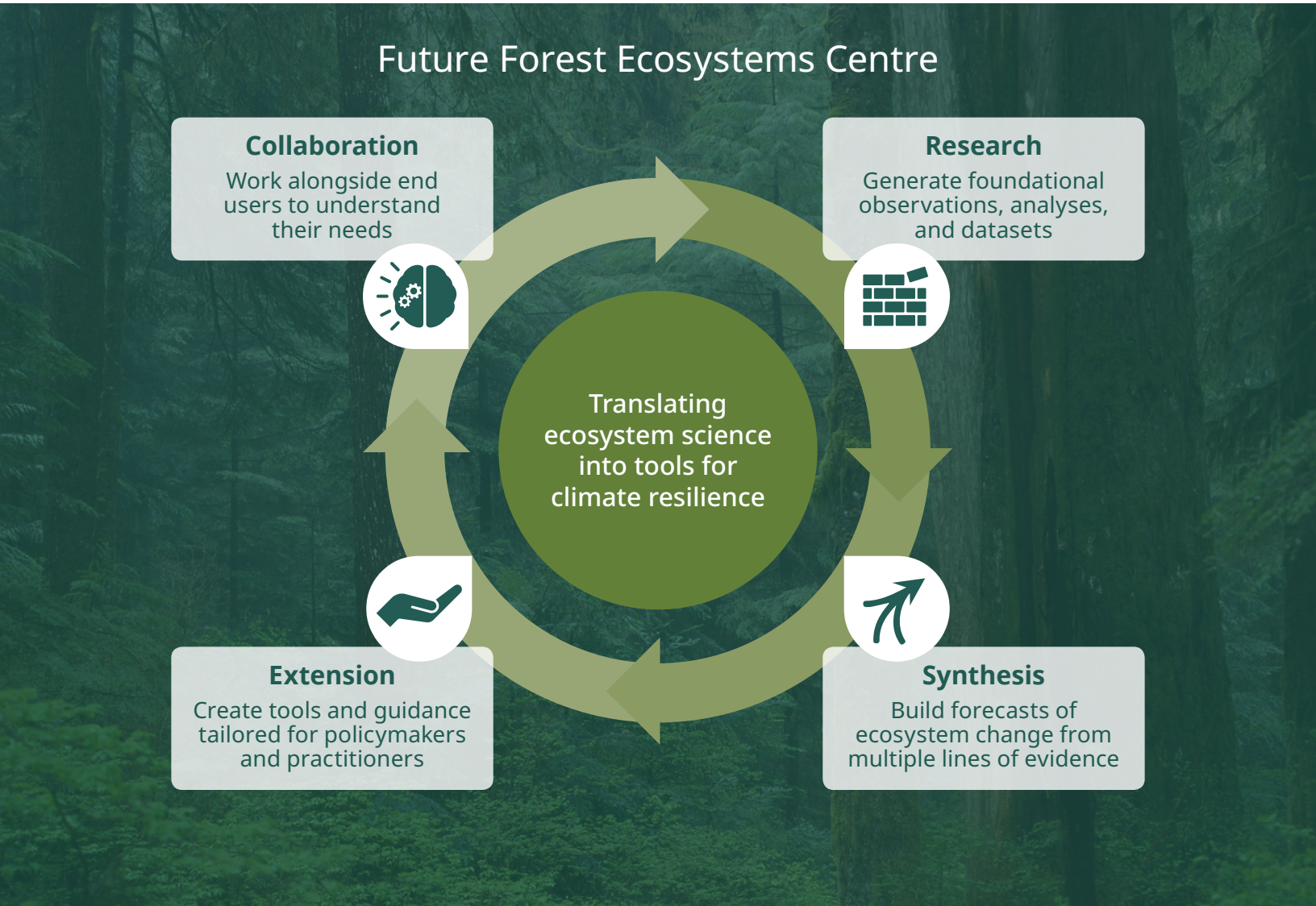
The FFEC recognizes the following principles specifically related to the technical development of its forecasts and forecasting tools.

- **Transferability/Reusability** – FFEC forecasting tools will be developed within integrated and continuous workflows to facilitate i) transferability to different geographical areas, ii) repeating forecasts, and iii) comparing and evaluating different tool designs.
- **Integrated uncertainty and validation** – The FFEC forecasting workflows will integrate uncertainty and model adequacy (validation) estimates, to facilitate their communication to end users and promote literacy in forecast interpretation.
- **Repeated/iterative forecasting** – The FFEC will have an iterative perspective on its forecasts and repeat them as new data, new science, and new end-user needs arise.

The FFEC Decision Support Cycle

The core role of the FFEC is to translate ecological knowledge into decision support tools. Doing so involves co-production with end users, involving a project cycle with four phases:

1. **Collaboration** – Data, tools, and guidance must work within the decision space of policymakers, planners, practitioners, and Indigenous knowledge-keepers. The FFEC works with end users to understand the nature of their decisions and what tools will be useful.
2. **Research** – Based on end-user needs, the FFEC conducts or funds research to fill gaps in the information required for the decision. The observations, analyses, and datasets produced in this phase are designed to have value for many ecosystem management activities.
3. **Synthesis** – Ecosystem management decisions shouldn't be made based on a single source of information. Multiple lines of evidence from modelling, observations, expert opinion, and local knowledge need to be brought together to provide an assessment of trends, dynamics, and uncertainties.
4. **Extension** – FFEC decision support tools can be in many formats, and generally are a combination of interactive web tools, curated data layers, guidance documents, training materials, and expert advice. Extension is a conversation; feedback on FFEC products is key to their usefulness and begins a new cycle of decision support.



Governance

The **FFEC Implementation Working Group (IWG)** advises on and endorses the development of the FFEC strategic plans and annual workplans. The IWG includes subject matter experts and policymakers from the Ministry of Forests and other natural resource ministries. The composition of the IWG will evolve in response to changes in the strategic priorities, so that the IWG contains the relevant expertise. Oversight of the IWG follows an **Executive Sponsor model**, in which the Forest Carbon and Climate Services Branch director and executive director provide strategic direction to the IWG, approve IWG decisions, and liaise with natural resource ministry senior leaders on the confirmation of strategic direction.

A wetland from the dry interior grasslands of British Columbia. Many such wetlands and the plant communities and species associated with them are vulnerable to loss in a warmer climate. Photo by Kurt Williams, BC Parks

End Users

FFEC activities are designed to serve a broad range of end users in the public, private, and academic sectors. The following are examples of applications of FFEC products in the BC Government and how they relate to the goals described in the following pages.

End user	Linkage to FFEC Goals and Actions
Forest Landscape Planning	FLP is a primary end user of FFEC products. We are designing our products to be delivered at the management unit scale for incorporation into FLP. Examples of uses of FFEC products in FLP include translation of tree species outlooks (Goal 3) into landscape-level stocking standards and landscape modelling (Goal 4) for risk and resilience mapping.
Modernized Land Use Planning	MLUP is an important avenue for FFEC to support the integration of climate change risks into strategic-level planning across multiple values. FFEC will work with MLUP tables to identify the information and formats that are most useful to them.
Timber Supply Review	Biogeoclimatic projections (Goal 2) and the Drought Tool (Goal 3) can be used to estimate changes in site productivity due to climate change. ClimatEx (Goal 1) will improve workflows and variables for Forest Analysis and Inventory Branch's fire modelling initiatives. Landscape disturbance modelling (Goal 4) and ecological forecasting (Goal 5) add capacity for integrating climate change risks into TSR.
Species at Risk	The FFEC-funded collaboration with the BC Conservation Data Centre to establish and implement standards for species habitat modelling (Goal 5) will contribute to assessments of climate pressures on species at risk.
Provincial Old Growth Team	Landscape disturbance and resilience modelling (Goal 4) and climate change outlooks for tree species (Goal 3) can improve the outcomes of old growth planning and protection.
Climate Based Seed Transfer	Outlooks for tree species (Goal 3) indicate likely changes in seed sowing demands. The CCISS tool (Goal 3) and CBST tool can be harmonized to inform reforestation decisions. ClimatEx (Goal 1) provides extremes indices for the CBST and tree breeding programs.
Climate-Informed Conservation	Biogeoclimatic projections (Goal 2) are an input for the identification of climate change refugia. Species habitat modelling standards and output (Goal 5) can standardize the inputs to the assessment of species climate velocity.
Inter-Ministry Invasive Species Working Group	Species habitat modelling standards and workflows (Goal 5) can be applied to model the potential expansion of invasive species.
Interior Broadleaf WG	The CCISS tool (Goal 3) and landscape modelling (Goal 4) can assist with management of risks and opportunities associated with broadleaves.
BC Wildfire Service	ClimatEx (Goal 1) aims to provide decadal projections of fire weather indices which, combined with landscape disturbance modelling (Goal 4), will assist with prioritization of landscape-level fire hazard management.
BC Parks	The FFEC will explore whether delivering its products (Goals 1-4) at the scale of individual parks can be useful for integration of climate change risks into park management plans.
Cumulative Effects Framework	The Cumulative Effects Framework assesses the cumulative impacts of human and natural disturbances on specified values. The data and tools produced under Goals 1-5 will support current condition assessments and integration of climate change impacts into the CEF.

Goals

The FFEC has nine goals grouped into four strategic themes:

Climate Data
Goal 1 – Improve the quality and accessibility of high-resolution climate data
Goal 2 – Provide standardized and accessible biogeoclimatic projections
Ecological Forecasting
Goal 3 – Develop climate change outlooks for tree species
Goal 4 – Develop landscape models to forecast forest resilience and ecosystem services
Building Capacity
Goal 5 – Foster capacity in ecological forecasting across government
Goal 6 – Foster climate and ecological literacy
Program Management
Goal 7 – Excellence in information management
Goal 8 – Communicate on FFEC outcomes and impact

Strategic Theme: Climate Data

Climate data is an essential precursor to accounting for climate risks in ecosystem management. The FFEC aims to provide climate data tailored for ecological analysis. Our goals for the next two years are to (1) provide standardized and accessible biogeoclimatic projections, and (2) improve the quality and accessibility of high-resolution climate data. These initiatives build on and complement the climate data services provided by the Pacific Climate Impacts Consortium and the Canadian Centre for Climate Services.

GOAL 1 | Improve the quality and accessibility of high-resolution climate data

High-resolution climate data is essential for understanding climate impacts in BC's rugged topography. Currently available high-resolution data is limited to monthly averages and doesn't describe weather extremes, ecological drought, fire weather, and many biologically relevant climate indices. The FFEC is leading a new initiative—the ClimatEx project—to improve the availability of this urgently needed information. The outcomes of this project will improve the effectiveness of BC's climate adaptation and preparedness initiatives, particularly with respect to the management of water, wildlife, wildfire, reforestation, and ecosystems.

ACTIONS

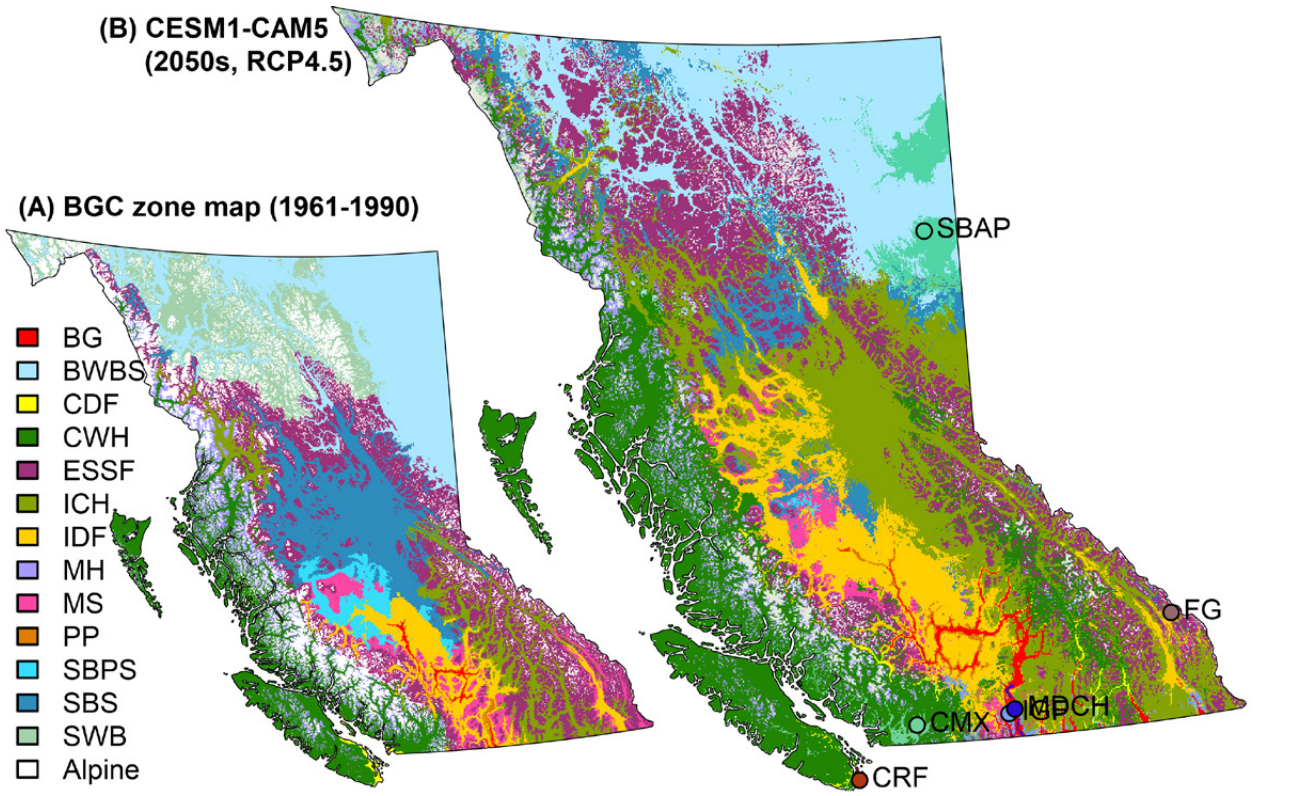
- **WRF Simulations** – Provide 3-year funding to the UBC Weather Forecast Research Team to produce weather research and forecasting model (WRF) simulations of BC's historical and future climates at very high (3km) resolution.
- **WRF Emulator** – Provide 2-year funding to Prof. Adam Monahan (UVic) and Dr. Alex Cannon (Environment and Climate Change Canada) to develop deep learning techniques for downscaling climate extremes and new climate variables such as wind and humidity.
- **PRISM** – Support continual improvement and expansion of the PRISM temperature and precipitation maps that are the basis for climate downscaling in BC.
- **climR** – FFEC is leading the development of an R package and web app that integrates the other components of the ClimatEx project and provides efficient and user-friendly access to climate data.

GOAL 2 | Provide standardized and accessible biogeoclimatic projections

Biogeoclimatic projections are a technique in which recent or projected future climate conditions are classified in terms of the climate units of the Biogeoclimatic Ecosystem Classification. Biogeoclimatic projections are becoming an essential component of forestry, conservation, and land use planning. The FFEC aims to provide authoritative biogeoclimatic projections supported by comprehensive documentation, best practices, and easy access.

ACTIONS

- Publish a peer-reviewed paper on the methods and results of biogeoclimatic projections for the Pacific Northwest.
- Develop a spatial data portal for public access to biogeoclimatic projections.
- Deploy a web application for summarizing and exploring biogeoclimatic projections.
- Publish best practices for using biogeoclimatic projections in ecosystem management.
- Support the finalization of draft biogeoclimatic classification for the western USA.



Example of biogeoclimatic projections for a modelled future climate (B). Adapted from MacKenzie and Mahony (2021). Biogeoclimatic zone codes are: Bunchgrass (BG), Boreal White and Black Spruce (BWBS), Coastal Douglas-Fir (CDF), Coastal Western Hemlock (CWH), Engelmann Spruce-Subalpine Fir (ESSF), Interior Cedar-Hemlock (ICH), Interior Douglas-Fir (IDF), Montane Spruce (MS), Mountain Hemlock (MH), Ponderosa Pine (PP), Sub-Boreal Pine-Spruce (SBPS), Sub-Boreal Spruce (SBS), and Spruce-Willow-Birch (SWB).

Strategic Theme | Ecological Forecasting

Forecasts are essential to decision-making under climate change. Unlike projections, which estimate future conditions based on a specific scenario, and predictions, which provide a "best guess" about future conditions, forecasts estimate the range of possible future conditions. A forecast is not a "crystal ball", but a quantification of uncertainty that enables robust decisions. The FFEC aims to provide ecological forecasts that are immediately useful to BC's ecosystem managers.

GOAL 3 | Develop climate change outlooks for tree species

An initial priority for the FFEC is to provide climate change outlooks for tree species. This priority was selected because trees are foundational to BC's forested ecosystems and developing related outlooks is the first step in understanding and managing threats to a broad suite of ecosystem services. Further, the FFEC can have immediate impact by leveraging the vast knowledge about tree ecology within the Biogeoclimatic Ecosystem Classification (BEC) system, and link tree species-based projections to ecosystem level impacts. Finally, the hundreds of millions of trees planted every year in BC are a large investment and a large ecological intervention that must be informed by an understanding of climate risks.

Many FFEC projects that support this initial priority on trees—such as improvements to climate data, standards for species habitat modelling, ecological drought assessment, and biogeoclimatic projections—also improve knowledge and decision support on other components of ecosystems. For example, our framework for projecting climatic suitability of tree species can be extended to plants of cultural, conservation, and habitat significance.

Multiple streams of work will contribute to this goal. The climate change informed species selection (CCISS) framework provides the core structure for this goal, and the CCISS tool is a primary outcome. However, other lines of evidence must be integrated with CCISS results to provide comprehensive climate change outlooks for tree species. The integration of observations, models, and expert judgement is needed to support decisions such as Forest Landscape Planning and Timber Supply Reviews.

ACTIONS

- Finalize the CCISS Tool in collaboration with the Forest Science Planning and Practices Branch.
- Collect observational evidence on tree species survival and growth within and outside their geographical range limits, for validation and refinement of CCISS results.
- Model changes in the outbreak dynamics of tree pathogens and insect herbivores.
- Support the development of the Forest Drought Risk Assessment tool.
- Model site-specific trends in wildfire severity.
- Develop species-specific synthesis reports on the climate change outlooks for trees (range shifts, disturbance, and productivity) based on multiple lines of evidence.
- Align the CCISS and Climate-Based Seed Transfer (CBST) Frameworks.

GOAL 4 | Develop landscape models to forecast forest resilience and ecosystem services

Managing BC's forests to promote their resilience to climate change and to protect the ecosystem services they provide requires i) understanding the forest ecosystem's resistance, adaptability, and recovery capability to environmental stressors (e.g., climate, fire, and pests) and ii) forecasting where ecosystem services are more/less likely to change. In both cases, we need landscape models that can capture how the vegetation responds and adapts to changes in climate and disturbances, and how these changes influence other components of the forest ecosystem, such as wildlife habitat, timber productivity, and food and medicinal plant availability, amongst others.

Other teams within and beyond the Ministry of Forests have begun valuable work in this direction that can be integrated and expanded within a common modelling framework. The FFEC can have an important role in coordinating and centralizing these efforts. Supporting model improvement and expansion, particularly for ecosystem services forecasting and optimization, is important to protect a wide range of ecosystem services.

ACTIONS

- Combine existing modelling efforts for integration within a flexible and common framework, where model setups can be adapted to end-user needs.
- Evaluate how much BC forests change under different combinations of stressors (e.g., climate, fire, drought, and pests) and their intensity (e.g., climate scenarios).
- Evaluate how current forest management strategies (e.g., assisted migration, retention cutting) can contribute to keep forests stable under these stressors.
- Identify areas of highest and lowest forest resilience in BC and how distinct forest management practices may contribute to enhance forest resilience.
- Start a collaborative research program targeted at forecasting and optimizing a range of ecosystem services across BC.

Burned Douglas-fir near Kamloops BC. Scorching by fire increases susceptibility of Douglas-fir to attack by bark beetles. Photo by Jeanne Robert, Director of Provincial Bark Beetle Response

Strategic Theme | Building Capacity

The FFEC seeks to support ecological forecasting capacity in other BC government agencies. Further, the FFEC can improve the uptake of its products by fostering climatic and ecological literacy across the natural resource ministries and the broader public.

Goal 5 | Foster capacity in ecological forecasting across the natural resource ministries

To complement the initial strategic focus on tree species, FFEC funding and expertise will be used to support the development of ecological forecasting projects with respect to other components of forest ecosystems. Our intent is to build ecological forecasting expertise in the natural resource ministries and cultivate a network of collaborators that can contribute to the future direction of the FFEC.

ACTIONS

- Collaborate with the BC Conservation Data Centre (CDC) to develop standards for climate-sensitive species habitat modelling and to incorporate species habitat models into the CDC Portal.
- Support the Inter-Ministry Invasive Species Working Group to develop forecasts of invasive species risks.
- Support the integration of climate change risks into Timber Supply Reviews.
- Collaborate with external researchers to develop climate change outlooks for wildlife and freshwater fish.

Goal 6 | Foster climate and ecological literacy

FFEC staff have unique expertise at the intersection of climate science, ecosystem dynamics, and forest management. The FFEC will contribute to end users' understanding of climate risks by providing guidance and commentary on foundational knowledge and emerging topics. The FFEC will help its staff to develop the ecological and cultural literacy needed to effectively engage end users.

ACTIONS

- Develop guidance and best practices to assist policymakers, researchers, and natural resource practitioners in considering and applying climate change within their work.
- Actively participate in the provincial BEC program and support its coordination, research, and extension activities.
- Expand the ecological literacy of FFEC staff through continuing education, field work, and collaboration with provincial ecologists.

Strategic Theme | Program Management

Goal 7 | Excellence in information management

The work of the FFEC—ecological forecasting, hosting datasets, and deploying interactive tools—is computationally intensive and requires robust data management. As a public sector scientific organization, we aim to practice Open Science, in keeping with the BC Open Information and Open Data Policy.

ACTIONS

- **Open data** – Publish FFEC datasets as open data in the BC Data Catalogue under the Open Government Licence.
- **Open-source code** – Produce research and products open source via the BCGov GitHub Organization.
- **Integrated workflows** – Use scripted workflows that integrate all steps of a forecasting exercise, from data to visualisation, for streamlined forecasting and reporting.
- **Data stewardship** – Establish robust data and code backup protocols.
- **Innovation** – Work with the Natural Resources Information and Digital Services to improve options for cloud computing, web development, and public data access.

Goal 8 | Communicate FFEC outcomes and impact

In addition to outreach and extension on individual FFEC projects, the FFEC will report on its overall progress through the following communications and reporting activities:

ACTIONS

- **Website** – Engaging and interactive portal for public access to FFEC products and up-to-date project descriptions.
- **Symposium** – Annual symposium to showcase the work of FFEC staff and collaborators.
- **Program report** – Digital document describing progress on FFEC projects and goals.
- **Business report** – Digital document documenting program spending and milestones.

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Photos by Colin Mahony except where noted