DIVERSE
Adapting Forests to Global Change

PROJECT OVERVIEW

Project Overview

DIVERSE is a Pan-Canadian research initiative dedicated to advancing forest management through an innovative approach emphasizing functional diversity and ecological connectivity. The project seeks to enhance forest resilience to global changes while fostering social acceptance and sustainable forest stewardship.

Introduction

In recent decades, human activities have profoundly impacted Earth's ecosystems, leading to unexpected disturbance and mounting socio-economic pressures. These challenges have weakened the resilience of forest ecosystems globally and their capacity to provide essential ecosystem services. The Anthropocene era has led us to rethink traditional forestry practices and conservation strategies. DIVERSE integrates innovative forest management approaches that emphasize ecological functionality and connectivity to navigate the growing uncertainties posed by accelerating and cumulative global changes.

Project Research Footprint: 22 sites across six provinces covering >18,000,000 hectares represented by public, private, and Indigenous forests.

Project Goal

To harmonize forestry practices with the need to enhance the adaptation of Canadian forests to the stressors of global changes. By integrating resilience-focused methods into industry and provincial policies, we seek to reinforce forest adaptability. This transformation will ensure that forests continue to provide essential ecosystem services, supporting a sustainable and resilient future.

Project Value

The DIVERSE Project offers a significant opportunity to advance the resilience and adaptability of Canada's forests in response to global changes, ensuring the continued provision of vital ecosystem services. The DIVERSE Project aims to:

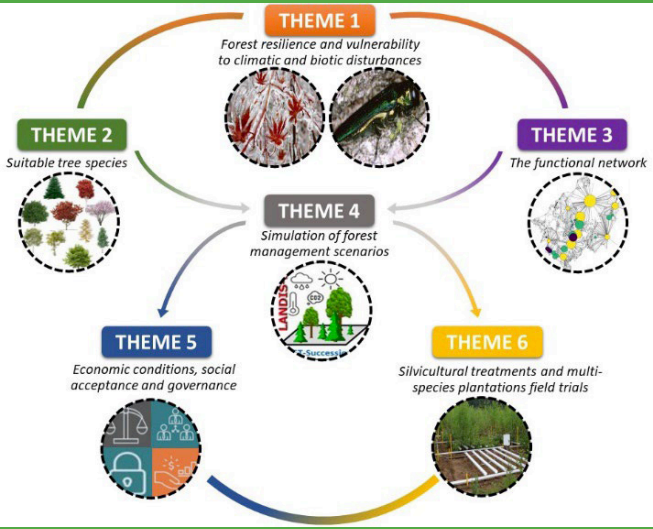
- **Implement Innovative Strategies:** Test novel approaches to enhance the adaptability and resilience of forests against global threats;
- **Improve Uncertainty Management:** Develop better methods to navigate increasing social and environmental uncertainties.

Project Team

To achieve this, a group of 8 Master and 11 Doctoral students, 8 post-docs, and 5 research professionals will be distributed across seven universities (Université du Québec en Outaouais, University of Alberta, Université Laval, University of Toronto, Université TÉLUQ, University of British Columbia, and Dalhousie University) in Canada to conduct research under the supervision of a group of >50 researchers from Canada and the world (12 co-applicants and >40 collaborators) in close partnerships with 24 project partners from Indigenous, industry, government and non-government organizations located across Canada.

Research/Communication Strategy

Research results and findings will aim to be published in the best scientific journals and made available to partners and the public through seminars, field visits, and short written, audio, and video reports. The media will also be invited to report on the main findings of this research program. The program will be overseen by science and a steering committee composed of both partners and researchers. The DIVERSE Project is being supported through contributions from partners, Natural Sciences and Engineering Research Council of Canada (NSERC), and MITACS, totaling $7,444,500.



Six Integrated Research Themes

Through six fully integrated research themes, this 5-year project (2023-2028) aims to develop and test innovative forest management approaches across Canada to mitigate and adapt to current and future global changes.

Theme 1: Assessing the Current Resilience and Vulnerability of Canada's Forests

Evaluate the vulnerability of Canadian forests to climatic and biotic disturbances, with a focus on drought and regeneration failure, by analyzing tree species functional traits over the past 40 years. This period corresponds to the time scale of the permanent forest sample plots in Canada. Specifically, assess how vulnerability to dominant stressors has evolved over time.

Deliverable: Provide project partners with a comprehensive overview of Canada's forests' recent historical and current state regarding their vulnerability and potential resilience to global change stressors.

Theme 2: Identifying and Selecting Suitable Tree Species for the Future

Determine a pool of current and potential tree species (to be introduced via assisted migration) that are likely better adapted to current and future global environmental conditions.

Deliverable: Spatially explicit guides to help forest managers determine which tree species to plant and where and provide options regarding how they could be managed to minimize vulnerability to biotic and abiotic stressors.

Theme 3: Testing the Functional Complex Network Approach for Forest Management

Forest resilience will be quantified using network theory at the stand and landscape scales for each of the 22 sites. Resilience will be assessed based on five complementary properties: (1) functional diversity of forest stands (node level); (2) functional redundancy (node level); (3) connectivity among forest stands (based on tree seed dispersal capacity; link level); (4) highly connected forest stands; and (5) landscape modularity that limit the spread of disturbances.

Deliverable: Resilience maps based on those properties for each site to prioritize solutions to improve resilience (e.g., diversifying tree species composition to increase functional diversity at the stand level and improving spatial configurations to maintain connectivity or not).

Theme 4: Evaluating Various Forest Management Approaches under Global Stressors

The forest landscape simulation model LANDIS-II will be used to test three forest management strategies on each site: (i) Business-As-Usual (BAU), the current or historic forest management approach; (ii) Climate-Smart Forestry (CSF), which uses silviculture to promote climate-adapted species and maximize carbon storage in forests; and (iii) Functional Complex Network (FCN), which promotes forest resilience through functional diversity of species and enhances connectivity and modularity of forest stands. These strategies will be compared for their ability to maintain biodiversity and essential ecosystem services, including wildlife habitat (e.g., woodland caribou), forest productivity, carbon storage and sequestration, and ecological resilience under various global change scenarios over the next 200 years (to reflect the typical length of a provincial forest management agreement).

Deliverable: Simulation outputs for each site will compare the performance of the three management strategies at maintaining essential ecosystem services under global change scenarios.

Theme 5: Assessing the Socio-economic Conditions and Governance Necessary for New Approaches

We will evaluate the feasibility of implementing the CSF and FCN approaches described in Theme 4 based on financial implications, type, and degree of social acceptance, and required modifications to the current provincial forest tenure and management policy.

Deliverable: This information will inform the simulated management scenarios that will offer insight into the relative importance of the various socio-economic factors (forest products, non-market values, public priorities) as well as where forest management regulations and standards may be constraining. This will allow us to consider how and where the local context may shape these two approaches' economic and social feasibility.

Theme 6: Testing Alternative Silvicultural Treatments and Multi-species Plantations

We will design and test treatments and plantations following the analyses conducted in Themes 1 to 5, as well as an evaluation of existing silvicultural treatments and plantations across Canada. These boots-on-the-ground tests will be established in a subset of the 22 DIVERSE Project sites to become demonstration sites across Canada for all to see, learn from, and engage with forest practitioners.

Deliverable: The sites will showcase various silvicultural approaches to adapt forests to climate change while increasing their functional diversity through natural regeneration and underplanting different tree species.