DIVERSE
Adapting Forests to Global Change

THEME 4

Evaluating Forest Management Approaches Under Global Stressors

DIVERSE is a Pan-Canadian research initiative dedicated to advancing forest management through innovative approaches that emphasize functional diversity and ecological connectivity. The research encompasses six interconnected themes that aim to enhance forest resilience and sustainable forest stewardship in the face of global changes.

Theme 4 Goals & Objectives

Theme 4 will compare three forest management strategies in DIVERSE Project sites across Canada:

1) **Business-As-Usual (BAU):** Current or historical forest management practices;

2) **Climate-Smart Forestry (CSF):** Silviculture that promotes climate-adapted species, provenances, and maximizes carbon storage in forests;

3) **Functional Complex Network (FCN):** Management emphasizing forest resilience through species functional diversity, spatial connectivity and modularity.

The strategies will be simulated using the landscape forest model LANDIS-II with the PnET-Succession module, comparing outputs every 20 years and final outcomes over a 200-year timeframe. Key comparisons will evaluate forest yield, biodiversity, and essential ecosystem services, including wildlife habitat (e.g., woodland caribou), productivity, carbon storage and sequestration, and ecological resilience.

Value Statement

LANDIS-II has been a cornerstone of forest management modelling for over 30 years, used by both academic and governmental researchers. Through direct collaboration with the forest sector, research under Theme 4 will characterize the current forest management strategies across the DIVERSE sites and compare these with alternative scenarios (BAU, CSF, and FCN) in the context of future forest composition, configuration, and natural disturbances.

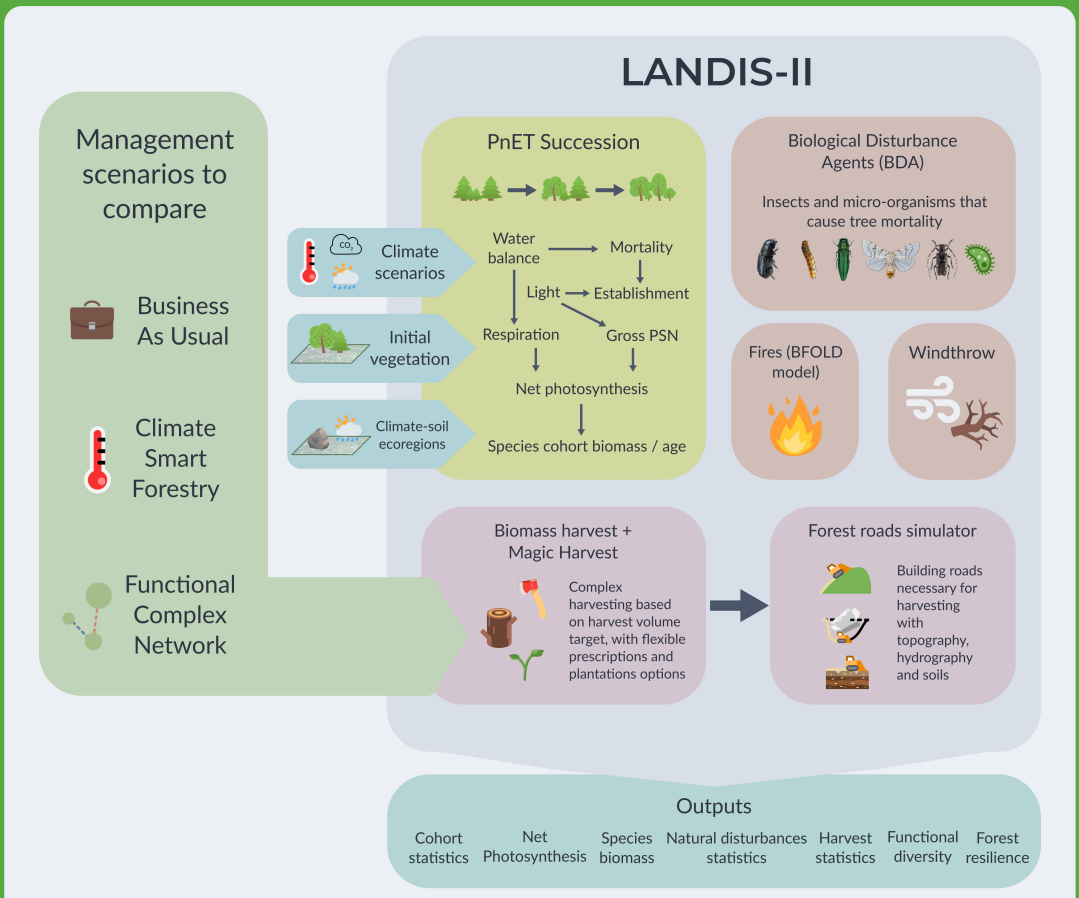
Scientific Background

The PnET-Succession module in LANDIS-II represents a cutting-edge advancement in modeling forest responses to environmental changes. This approach incorporates functional traits identified in DIVERSE Themes 1 and 2, ensuring models reflect critical diversity factors. Theme 4 will integrate fundamental research with practical applications, benefiting both scientific communities and forest management partners.

Methodology

Simulations of BAU, CSF, and FCN will be conducted under mild and severe global change scenarios. Outputs evaluated will include: (1) Wildlife habitat; (2) Tree mortality; (3) Forest productivity (growth & yield); (4) Aboveground biomass carbon accumulation; (5) Tree species composition; (6) Forest stand structure; and (7) Forest resilience indices as those developed in Theme 3.

- **Business-as-Usual Approach:** Forest management practices that are being undertaken within each site;
- **Climate-Smart Forestry Approach:** Modified BAU management approach by integrating silvicultural treatments to adapt the current forest composition to future climate conditions. This will involve regenerating and/or planting tree species (or provenances) that are projected to be better adapted to climate warming and related natural disturbances (e.g., wildfire, insect outbreaks);
- **Functional Complex Network Approach:** Prioritize long-term forest resilience by enhancing functional diversity and connectivity, potentially sacrificing Net-Primary Productivity and other management objectives.



An example of the main direct and indirect interaction(s) between LANDIS-II extensions, their internal components, inputs, and model outputs.

(Adapted from Mina et al. 2022).

Timeline

2024 2025

Incorporating research results associated with species functional traits from Themes 1 and 2 for model parameterization and calibration. Data collection from Project Partners to ensure accurate characterization of model scenarios and simulations.

2025

Parameterization of LANDIS-II with partners' data.

2025 2027

Development of management scenarios (BAU, CSF, and FCN) and simulation of future conditions using LANDIS-II.

Inter-Theme Links

- **Theme 1 and 2:** Key species traits and functional diversity to ensure resilience under future threats;
- **Theme 3:** Incorporates the Functional Complex Network approach into landscape simulations;
- **Theme 5:** Accounts for the socio-economic constraints in implementing management strategies;
- **Theme 6:** Guides field testing of silvicultural practices based on simulation results. The simulated treatments will be developed in conjunction with the experiments under theme 6 to test alternative silvicultural treatments in various FMUs.

Project Personnel

Theme 4 is led by researchers from the University of Toronto, with support from, University of Alberta, Ontario Forest Research Institute, USDA Forest Service, NCASI, Harvard University, and University of Madison-Wisconsin.

Highly-Qualified Personnel (HQP): 3 PhDs and 1 Post-Doctoral Fellow.

Projected Deliverables

- Comparative simulations for DIVERSE Project sites across Canada, assessing the performance of BAU, CSF, and FCN under various climate and disturbance scenarios;
- Detailed guidance for forest managers on adaptive, resilience-focused strategies;
- Series of scientific papers, workshops and webinars fostering knowledge transfer with project partners and collaborators.