ADAPTING FORESTS

ADAPTING FORESTS TO CLIMATE CHANGE

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Forest managers and owners need good, practical information to make decisions in order to adapt their forests to climate change. To address this need, Natural Resources Canada is implementing a large adaptive silviculture research study at the Petawawa Research Forest (PRF). This study, called the Adaptive Silviculture for Climate Change (ASCC) Study, is the first of its kind in Canada. The study incorporates the latest research and methods for adapting forests to climate change. It is led by Dr. Trevor Jones (Research Scientist), Dr. Nelson Thiffault (Research Scientist), Michael Hoepting (Silviculture Research Forester), Jeff Fera (Forest Research Officer), and Liz Cobb (PRF Operations Manager). The outcomes will provide insight into how forests can be managed in the face of climate change.

The Petawawa Research Forest (PRF), located in Chalk River, Ontario, is a 10,000-hectare (24,711 acre) research forest. Operated by Natural Resources Canada's Canadian Forest Service, the PRF aims to be a living laboratory for innovative forest research as well as a hub for forestry knowledge transfer. The PRF was established in 1918 and has continued to build upon a rich history of data and observations to help researchers develop solutions for the challenges facing the forests of today.

ADAPTIVE SILVICULTURE FOR CLIMATE CHANGE NETWORK

This research project is part of the Adaptive Silviculture for Climate Change Network and is the first research site outside of the United States. The network is led by Linda Nagel from Colorado State University and Maria Janowiak and Chris Swanston from the United States Forest Service. The project consists of eleven research sites (nine in the United States and two in Canada — the first at PRF and a second in Northern British Columbia at the John Prince Research Forest). These sites have been established to investigate how forests can be adapted to climate change. Each site represents a different forest type. Site specific treatments are developed and implemented based on local conditions and knowledge. All sites maintain a consistent research and data collection structure so results can be compared between research sites.

An Adaptive Silviculture for Climate Change project research site has been established at the PRF. Part of an international network of research installations, it is one of two sites in Canada, the other located at the John Prince Research Forest in Northern British Columbia. These photos are from the harvest that started in November 2021 at the Petawawa Research Forest.

Photo Credits: Petawawa Research Forest — Natural Resources Canada.

Each site implements at least four different treatments: control; resistance; resilience; and transition (see Table 1). The PRF will have a fifth treatment type called business as usual that will act as a second type of control. Resistance and business as usual treatments aim to return the forest to its present condition after a disturbance, such as harvesting. Resilience has the same goal but accommodates some differing methods and successional pathways to achieve that goal. Transition allows the forest to move to a new a new condition that is not historically typical of that region but is adapted to climate change.

Table 1 Adaptation Treatment Definitions and Goals

	Adaptation Treatment Definition	Adaptation Treatment Goal
Treatment 1: Control	Since climate change impacts all forests globally, a true "control" or "do nothing" treatment cannot be maintained. An approach is taken where forests are allowed to respond to climate change in the absence of direct silvicultural interventions.	Allow forests to respond to climate change without direct management intervention.
Treatment 2: Business as Usual	The implementation of best practice silvicultural systems and methods typically used in the area to achieve forest management goals.	Maintain desired forest conditions using existing techniques.
Treatment 3: Resistance	Actions that improve the defences of the forest against anticipated changes or directly defend the forest against disturbance to maintain relatively unchanged conditions.	Maintain relatively unchanged forest conditions over time in relation to a reference condition.
Treatment 4: Resilience	Actions that accommodate some degree of change but encourage a return to prior condition or desired reference conditions following disturbance.	Allow some change in current conditions but encourage an eventual return to reference conditions.
Treatment 5: Transition	Actions that intentionally accommodate change and enable ecosystems to adaptively response to changing and new conditions.	Actively facilitate change to encourage adaptive responses.

CLIMATE CHANGE IMPACTS AT THE PETAWAWA RESEARCH FOREST

Framing the study required understanding some of the climate change impacts anticipated at the PRF. These impacts are similar to those expected elsewhere in southern and central Ontario and include:

- Continued snow and ice storms leading to tree crown damage and snow loading on seedlings;
- Warmer winter temperatures and increased evapotranspiration;
- Rain on snow events leading to rapid snow melt and fluctuating water tables; and
- Increasing summer moisture stress due to drought and the increased potential for wildfire concerns.

Climate change will present challenges and opportunities for accomplishing the management objectives of the Petawawa Research Forest and include:

- Increased drought stress leading to slower growth of established trees and increase mortality in regeneration;
- Shorter, milder winters could lead to challenges with the timing of vegetation management and harvest, but may also enable the establishment and growth of new, high-value species;
- Infrastructure on the PRF could be taxed by large storm events and heavy rains; and
- Changes in precipitation patterns and increased drought could increase stress and lead to increases in forest insects and diseases.

RESEARCH DESIGN

The ASCC research site at the PRF covers 189 hectares of land situated in stands with major components of white and red pine, and mid-canopy components of aspen, white birch, red maple, balsam fir, and white spruce. The control treatment will be situated in stands representing a future desired condition. These stands will serve as a benchmark of natural succession in the absence of management.

The business as usual treatment will use the standard uniform shelterwood silvicultural system used in pine forests in the Great Lakes-St Lawrence Forest. The goal is to regenerate a well-stocked productive, pine-dominated stand. Growing sawlogs and maintaining high-quality habitat will be key priorities in this treatment. A first harvest will reduce the basal area down to 12-14 m2/ha. Planting of white pine from local seed sources will occur after the first harvest and natural regeneration of pine will be encouraged. A second harvest will occur when the regeneration is six meters tall.

The resistance treatment has the same goals and treatment method as the business as usual treatment but includes the planting of white pine from within the local seed zone as well as seedlings from seed zones further south that are anticipated to be optimized for a future climate.

The resilience treatment will use an irregular shelterwood system with expanding gaps. Goals include: creating a well-stocked, multi-aged stand that is white pine dominated but with components of

red oak, aspen, and red pine; promoting low susceptibility to disturbance and fire; growing sawlogs; enhancing species and genetic diversity; and maintaining high-quality habitat. Natural regeneration will be encouraged, and planting will occur in the gaps using white pine, red oak, and white oak, all from sources optimized for future conditions. White oak will be a new addition to the area as its natural northern range ends just north of Ottawa.

The transition treatment will use a clearcut with seed tree system, leaving 16 to 35 stems per hectare after harvest. The goals include providing wood products, promoting a species mix that is adapted to drought, wildfire, storm, insects, and diseases, and maintaining wildlife habitat. Planting will occur after the harvest and will include local red pine stock as well as pitch pine, red oak, and white oak from sources optimized for future conditions. Pitch pine will be a new addition to the area as its natural northern range ends along the St. Lawrence River near Kingston and the Quebec-Ontario-New York border.

This transition treatment is a clearcut with seed trees. It will be planted with red pine, pitch pine, red oak, and white oak.

Photo Credits: Petawawa Research Forest — Natural Resources Canada.

IMPLEMENTATION

The study is currently underway with harvests starting in November 2021. Preparatory work was undertaken through 2020 and 2021. The researchers hope the site becomes a hub for other researchers who want to answer questions about climate change and its impacts on ecosystems and wildlife. This article is brief description of what is a complex, leading-edge, and exciting project. Those who wish to know more can contact Dr. Trevor Jones (trevor.jones@canada.ca) project Lead Scientist at the Canadian Forest Service.

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