**PROJECT TITLE: Making Red Pine Forest Resilient to Climate Change**

**I. PROJECT STATEMENT**

Climate change and changing disturbance events are predicted to threaten the ecology and economic resilience of Minnesota’s forests. The overarching goal of this project is to increase the resistance and resilience of red pine forests to climate change. Specific outcomes include:

(1) A statewide assessment of red pine forest vulnerability to stress that will highlight hot spots for future forest health issues such as mountain pine beetle

(2) Forest management approaches to adapt red pine forests to expected changes,

(3) A learning network for climate change adaptation in red pine forests.

Red pine forests provide enormous benefits to both the economy ($13 million in stumpage not to mention the indirect economic benefit) and ecology (recreation, wildlife habitat for bird species like the chestnut-sided warbler, and cultural significant species including blueberries). Climate change, especially more severe and frequent droughts during the summer, can reduce productivity, increase mortality, and increase susceptibility to other insects and diseases.

While moderate to severe growing season droughts occur every five to ten years, the frequency and severity of drought is expected to increase with a changing climate. The susceptibility of red pine forests to drought and associated health stressors is higher when the forests are overly dense (too many trees per acre), a condition that may be common in red pine forests due to a lack of management and fire.

Models suggest that habitat suitable for current tree species in Minnesota may change. If this happens, we’ll need to know which species can replace the old. Thus, our project helps to ensure that red pine forests remain forests even if other tree species become more common than red pine in the future.

To accomplish our objectives we will use existing data from forest inventories as well as an existing experiment that was developed through start-up investments from the USDA Forest Service and partners.

**II. PROJECT ACTIVITIES AND OUTCOMES**

**Activity 1:** Evaluate the vulnerability of red pine forests to drought and other stressors and develop guidelines to adapt forest management to climate change and future conditions

**Description:**We will assess current vulnerability of red pine in MN to reduced growth and mortality during drought. We will use statewide data on tree density compiled from forest inventory, LIDAR and remote sensing. We will create maps of tree vulnerability to different environmental stresses. These maps will highlight critical regions that could have high tree mortality due to drought and high risk for mountain pine beetle and other forest health problems. Maps will provide guidance to private and public landowners about opportunities to mitigate impacts of future conditions on their lands. Additionally, to develop guidelines to adapt management for climate change we will use an established operational-scale experiment, Adaptive Silviculture for Climate Change (ASCC). ASCC began in 2014 and implemented new approaches to managing red pine forests for climate change adaptation. Climate adaptation treatments included: thinning to reduce tree density and creating gaps to encourage regeneration of diverse species. We will test the effectiveness of these approaches by measuring soil moisture, tree growth and tree water stress.

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| **ENRTF BUDGET: $295,171** |  |

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| **Outcome** | **Completion Date** |
| *1. Statewide database of red pine stand vulnerability* | *July 2022* |
| *2. Statewide map of risk of tree stress and forest health issues* | *July 2022* |
| *3. Guidelines to adapt forest management for maintenance of red pine*  | *June 2023* |

**Activity 2:** Evaluate the potential for red pine forests to adapt to climate change through natural and artificial regeneration of tree species suited to a warmer, drier climate

**Description:** To ensure that red pine forests remain forests even if other tree species become more common than red pine in the future, we will evaluate 4 future climate-adapted tree species planted in the ASCC project: ponderosa pine, white pine, bur oak, and northern red oak. We will assess survival and growth of planted seedings of these tree species. To study response to drought, we will construct shelters that reduce or eliminate rainfall to seedlings. These data will be used to generate guidelines for selecting species for regeneration efforts in red pine forests. Finally, we will evaluate natural regeneration potential of native species that are future climate adapted using data on natural regeneration in ASCC, on FIA plots and in the DNRs monitoring network.

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| **ENRTF BUDGET: $281,597** |  |

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| **Outcome** | **Completion Date** |
| *1. Growth and survival of juvenile trees assessed in climate change adaptation treatments* | *June 2023* |
| *2*. *Juvenile tree stress from drought assessed using 60 rainout shelters (20/species)* | *June 2023* |
| *3. Statewide assessment of natural regeneration potential in red pine forests* | *June 2023* |

**Activity 3:** Create a Forest Adaptation Learning Network to develop a climate adaptation toolbox for red pine

**Description:**We will create a Forest Adaptation Learning Network to promote climate adaptation approaches for red pine. We will survey organizations that manage red pine forests (e.g., Resource Management Divisions of MN Ojibwe bands, Chippewa and Superior National Forests, MN DNR, various county land agencies, Potlatch, Blandin, University of Minnesota) about current approaches, resources, concerns and challenges. We will host workshops and field tours aimed at facilitating knowledge sharing about adaptation approaches among diverse groups including private landowners. We will develop a set of case studies for the online Great Lakes Silviculture Library that managers query for new approaches. This Forest Adaptation Learning Network will promote landowner-landowner learning and information sharing about climate change adaptation.

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| **ENRTF BUDGET: $51,969** |  |

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| **Outcome** | **Completion Date** |
| *1. Survey of current approaches, resources, challenges in red pine forests* | *June 2021* |
| *2. 3 workshops and 5 demonstration tours* | *June 2023* |
| *3. 5 case studies for the Great Lakes Silviculture Library* | *June 2023* |

**III. PROJECT PARTNERS AND COLLABORATORS:**

Receiving funds: Rebecca Montgomery, Marcella Windmuller-Campione and Matthew Russell, University of Minnesota; Brian J. Palik, USDA Forest Service (ASCC project lead for MN). Not receiving funds: Rob Slesak, MN Forest Resources Council; MN DNR; USDA Forest Service FIA program.

**IV. LONG-TERM IMPLEMENTATION AND FUNDING:** Field sites are maintained by cooperators such as USDA Forest Service.Great Lake Silviculture Library maintained by University of Minnesota.