

A Climate Change Risk Index for Tree Species of the Wabanaki– Acadian Forest

Version One
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Forestry &
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TABLE 1. Climate Change Risk Index for **Softwood** Species of the Wabanaki–Acadian Forest

Species	Risk Factor				
	Warming	Drought	Wind	Wildfire	Pests *
Balsam fir (<i>Abies balsamea</i>)	High	High	High	High	Moderate
Black spruce (<i>Picea mariana</i>)	Moderate	Moderate	High	Moderate	Moderate
Eastern hemlock (<i>Tsuga canadensis</i>)	Low	Moderate	Moderate	Moderate	High
Jack pine (<i>Pinus banksiana</i>)	Low	Low	Moderate	Moderate	Low
Larch (<i>Larix laricina</i>)	Moderate	High	Moderate	Moderate	Low
Red pine (<i>Pinus resinosa</i>)	Low	Low	Low	Moderate	Low
Red spruce (<i>Picea rubens</i>)	Moderate	Moderate	High	High	Moderate
White cedar (<i>Thuja occidentalis</i>)	Low	Moderate	Moderate	High	Low
White pine (<i>Pinus strobus</i>)	Low	Low	Low	Moderate	Moderate
White spruce (<i>Picea glauca</i>)	Moderate	Moderate	High	High	Moderate

* The risk factor 'Pests' in Tables 1 and 2 includes both pests and diseases.

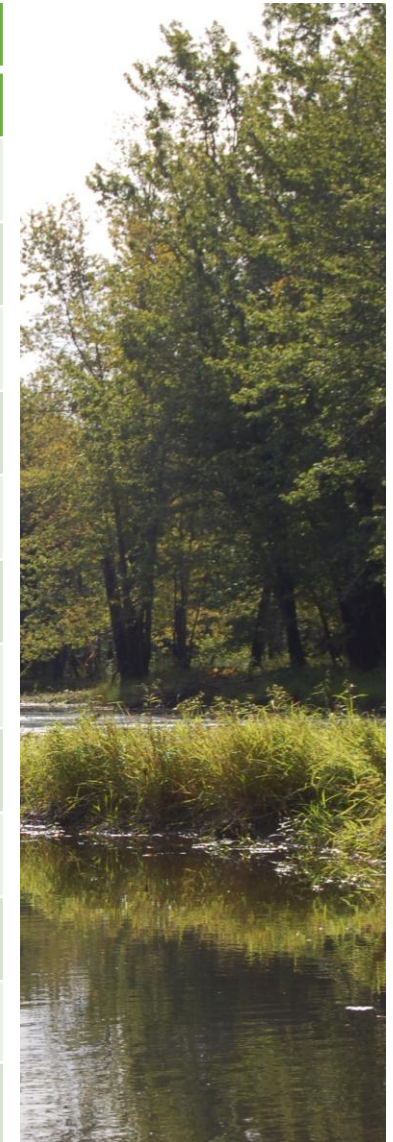


TABLE 2. Climate Change Risk Index for **Hardwood** Species of the Wabanaki–Acadian Forest

Species ¹	Risk Factor				
	Warming	Drought	Wind	Wildfire	Pests
American beech ² (<i>Fagus grandifolia</i>)	Low	Low	Low	Moderate	Low
Ash species ³ (<i>Fraxinus spp.</i>)	Low	Moderate	Low	Low	Low
Basswood (<i>Tilia americana</i>)	Low	Moderate	Moderate	Low	Low
Black cherry (<i>Prunus serotina</i>)	Low	Low	Moderate	Moderate	Low
Bur oak (<i>Quercus macrocarpa</i>)	Low	Low	Low	Low	Moderate
Ironwood (<i>Ostrya virginiana</i>)	Low	Low	Low	Moderate	Low
Manitoba maple (<i>Acer negundo</i>)	Low	Low	Low	Low	Low
Poplar species ⁴ (<i>Populus spp.</i>)	Moderate	High	High	Low	Low
Red maple (<i>Acer rubrum</i>)	Low	Low	Low	Low	Low
Red oak (<i>Quercus rubra</i>)	Low	Low	Low	Low	Moderate
Silver maple (<i>Acer saccharinum</i>)	Low	Moderate	Low	Low	Low
Sugar maple (<i>Acer saccharum</i>)	Low	Moderate	Low	Low	Low
White birch (<i>Betula papyrifera</i>)	Moderate	High	Moderate	Moderate	Moderate
White elm ⁵ (<i>Ulmus americana</i>)	Low	Low	Low	Low	Low
Yellow birch (<i>Betula alleghaniensis</i>)	Low	Moderate	Low	Moderate	Moderate

TABLE 3. Combined Climate Change Risk for Tree Species of the Wabanaki–Acadian Forest

Combined Risk Assessment *			
Species	Risk	Species	Risk
Balsam fir (<i>Abies balsamea</i>)	High	Black cherry (<i>Prunus serotina</i>)	Low
Black spruce (<i>Picea mariana</i>)	Moderate	Bur oak (<i>Quercus macrocarpa</i>)	Low
Eastern hemlock (<i>Tsuga canadensis</i>)	Moderate	Ironwood (<i>Ostrya virginiana</i>)	Low
Jack pine (<i>Pinus banksiana</i>)	Low	Manitoba maple (<i>Acer negundo</i>)	Low
Larch (<i>Larix laricina</i>)	Moderate	Poplar species (<i>Populus spp.</i>)	Moderate
Red pine (<i>Pinus resinosa</i>)	Low	Red maple (<i>Acer rubrum</i>)	Low
Red spruce (<i>Picea rubens</i>)	Moderate	Red oak (<i>Quercus rubra</i>)	Low
White cedar (<i>Thuja occidentalis</i>)	Low–Moderate	Silver maple (<i>Acer saccharinum</i>)	Low
White pine (<i>Pinus strobus</i>)	Low	Sugar maple (<i>Acer saccharum</i>)	Low
White spruce (<i>Picea glauca</i>)	Moderate	White birch (<i>Betula papyrifera</i>)	Moderate
American beech (<i>Fagus grandifolia</i>)	Low	White elm (<i>Ulmus americana</i>)	Low
Ash species (<i>Fraxinus spp.</i>)	Low	Yellow birch (<i>Betula alleghaniensis</i>)	Moderate
Basswood (<i>Tilia americana</i>)	Low		



* The combined risk score presented above for each species is calculated based on the most frequent risk score assigned to that species in Tables 1 and 2. In cases of a tie, both levels are denoted to indicate an intermediate score.

Notes from Table 2

1. Some native hardwood trees are missing from this list due to lack of scientific studies concerning their sensitivity to climate change, but also due to their smaller size as trees (for example, striped maple and mountain ash), or because their current geographic distribution has become significantly reduced due to disease (for example, butternut).
2. American beech once dominated the canopy of many old forest stands across the Wabanaki–Acadian Forest, but Beech Bark Disease has diminished it to a minor component of today’s forest. Despite this, disease–resistant beech is expected to thrive under a warming climate. See: [Ensuring a future for American beech trees | Kejimikujik National Park and National Historic Site](#)
3. Ash species include all three native ash: white ash (*Fraxinus americana*), black ash (*Fraxinus nigra*), and red ash (*Fraxinus pennsylvanica*). They were combined as there is little information available on how climate change is expected to affect each individual species.
4. Poplar species include all three native poplar: trembling aspen (*Populus tremuloides*), largetooth aspen (*Populus grandidentata*), balsam poplar (*Populus balsamifera*). They were combined as there is little information available on how climate change is expected to affect each individual species.
5. White elm once dominated many of the river valley bottoms across the Wabanaki–Acadian Forest, but Dutch Elm Disease has diminished it to a minor component of today’s forest. Despite this, disease–resistant elm is expected to thrive under a warming climate. See: [Elm Recovery Project | The Arboretum](#)



Definitions and supporting information for Tables 1, 2 and 3

Geographical Area: The Wabanaki–Acadian Forest encompasses the Canadian provinces of New Brunswick, Nova Scotia and Prince Edward Island, along with the states of Maine, New Hampshire, and Vermont in the United States.

Time Period: 2040–2060. This risk assessment pertains to the potential negative health consequences to tree species given the predicted magnitude of climate change by this time period. This time period was chosen as it is near-term enough to have practical management planning value, yet not too far into the future as to avoid the unnecessary uncertainties associated with longer forecasts.

Climate Scenario: This risk assessment pertains to the Intergovernmental Panel on Climate Change (www.ipcc.ch) ‘middle-of-the-road’ SSP2–RCP 4.5 climate forcing scenario. This scenario currently represents the most likely climate change outcome given international commitments to greenhouse gas emissions reductions. For New Brunswick, this scenario predicts:

- Mean Annual Temperature will increase approximately 2°C by the 2040–2060 time period, compared with today’s temperatures.
- Annual precipitation will increase by 5-10% by the 2040–2060 time period, compared with today’s precipitation levels.

The above climate projections are derived from www.ClimateData.ca [Accessed on March 13, 2026]. ClimateData.ca was created through a collaboration between the Pacific Climate Impacts Consortium (PCIC), Ouranos Inc., the Prairie Climate Centre (PCC), Environment and Climate Change Canada (ECCC) and Centre de Recherche Informatique de Montréal (CRIM).

Risk: Refers to the potential for negative health consequences to tree species across the Wabanaki–Acadian Forest, including (but not limited to) declines in growth, reproduction, and abundance. Given the complexities and uncertainties involved in assessing future tree population health as affected by climate change, risk is categorized and assigned as one of three levels based on the weight of current scientific evidence and understanding:

- **Low**—meaning there is currently little-to-no evidence that climate change poses a risk to the tree species’ health; and in fact, it may even benefit from climate change.
- **Moderate**—meaning there is evidence and agreement that climate change poses a marginal risk to the tree species’ health.
- **High**—meaning there is evidence and agreement that climate change poses a serious health risk to the tree species.

Definitions and supporting information for Tables 1, 2 and 3

Warming: Refers to risks associated with warming that may negatively affect tree species' health given the magnitude of warming predicted under SSP2–RCP 4.5 by 2040-2060. This risk factor is assessed independently of changes in soil moisture and only considers the direct effects of temperature on tree species' health.

Sample of Supporting Documents: *

1. Taylor, A.R., Boulanger, Y., Price, D.T., Cyr, D., McGarrigle, E., Rammer, W., and Kershaw, J.A. 2017. Rapid 21st century climate change projected to shift composition and growth of Canada's Acadian Forest Region. *Forest Ecology and Management*, 405: 284-294.
2. Natural Resources Canada. 2026. Canada's Plant Hardiness Site: Species-specific Models and Maps. Retrieved from: <https://planthardiness.gc.ca> [Accessed on March 13, 2026].
3. Sheppard, M.M., Taylor, A.R., Vaughn, W.R. 2026. The effects of high temperatures on seedling mortality for seven major conifer species in the Acadian Forest region of eastern Canada. *Forestry*, (IN PRESS, DOI: <https://doi.org/10.1093/forestry/cpag015>).

Drought: Refers to risks associated with drought that may negatively affect tree species' health given the increased frequency of severe droughts expected under SSP2–RCP 4.5 by 2040-2060. Drought tolerance is the ability to survive, and sometimes grow, during periods of water shortage. This risk factor takes into consideration drought avoidance (for example, deep roots or stomatal adjustments); resistance (the ability to withstand drought exposure); and resilience (how quickly a tree can resume normal growth when conditions improve).

Sample of Supporting Documents: *

1. Moran, E., Lauder, J., Musser, C., Stathos, A. and Shu, M., 2017. The genetics of drought tolerance in conifers. *New Phytologist*, 216: 1034-1048.
2. Sánchez-Pinillos, M., D'Orangeville, L., Boulanger, Y., Comeau, P., Wang, J., Taylor, A.R. and Kneeshaw, D., 2022. Sequential droughts: A silent trigger of boreal forest mortality. *Global Change Biology*, 28: 542-556.
3. USDA Natural Resources Conservation Service. 2026. PLANTS Database. Retrieved from: <https://plants.sc.egov.usda.gov/> [Accessed on March 13, 2026].

Definitions and supporting information for Tables 1, 2 and 3

Wind: Refers to the risk of windthrow occurrence, which is the overturning of trees from either uprooting or stem breakage. It takes into consideration tree morphological traits, including rooting depth, stem density and elasticity, crown structure, and leaf form. While future windiness is highly uncertain for the Wabanaki-Acadian Forest, it is considered very unlikely that the number of windstorms or hurricanes will decrease under SSP2–RCP 4.5 by 2040-2060.

Sample of Supporting Documents: *

1. Foster, D.R. and Boose, E.R. 1992. Patterns of forest damage resulting from catastrophic wind in central New England, USA. *Journal of Ecology*, 1: 79-98.
2. Rich, R.L., Frelich, L.E. and Reich, P.B., 2007. Wind-throw mortality in the southern boreal forest: Effects of species, diameter and stand age. *Journal of Ecology*, 95: 1261-1273.
3. Taylor, A.R., Dracup, E., MacLean, D.A., Boulanger, Y., and Endicott, S. 2019. Forest structure more important than topography in determining windthrow during Hurricane Juan in Canada's Acadian Forest. *Forest Ecology and Management*, 434: 255-263.

Wildfire: This risk factor takes into consideration a balance between tree flammability, resistance to fire damage, and recovery following wildfire, such as through root sprouting. For instance, trees which tend to be more flammable and less resistant to wildfire would be considered to have higher wildfire risk. There is strong evidence that weather conditions conducive to wildfire will increase substantially under SSP2–RCP 4.5 by 2040-2060 in the Wabanaki-Acadian Forest.

Sample of Supporting Documents: *

1. Quinby, P.A. 1987. An index to fire incidence. *Canadian Journal of Forest Research*, 17: 731-734.
2. Terrier, A., Girardin, M.P., Périé, C., Legendre, P. and Bergeron, Y. 2013. Potential changes in forest composition could reduce impacts of climate change on boreal wildfires. *Ecological Applications*, 23: 21-35.
3. Varner, J.M., Kane, J.M., Kreye, J.K. and Engber, E., 2015. The flammability of forest and woodland litter: a synthesis. *Current Forestry Reports*, 1: 91-99.

Definitions and supporting information for Tables 1, 2 and 3

Pests: Risk associated with pests refers to the potential negative effects of pests and diseases on tree species' health as the climate changes under SSP2–RCP 4.5 by 2040-2060. It is worth noting that of all five risk factors evaluated in this assessment, 'pests' is the most complex and uncertain as it must consider climate-related behavioral changes to 100s of pests and diseases for which few actual studies exist.

To help account for these uncertainties, this risk factor only considers known emerging threats that may occur under climate change. Species considered high risk are those under threat from existing or new pests and diseases that are expected to intensify under climate change. Low risk suggests there is little-to-no evidence damage from existing or new pests and diseases will intensify under climate change.

Sample of Supporting Documents: *

1. Weed, A.S., Ayres, M.P. and Hicke, J.A., 2013. Consequences of climate change for biotic disturbances in North American forests. *Ecological Monographs*, 83: 441-470.
2. Taylor, A.R., MacLean, D.A., Neily, P.D., Stewart, B., Quigley, E., Basquill, S.P., Boone, C.K., Gilby, D., and Pulsifer, M. 2020. A review of natural disturbances to inform implementation of ecological forestry in Nova Scotia, Canada. *Environmental Reviews*, 28: 387-414.
3. Natural Resources Canada. 2026. Canada's Trees, insects, mites, and diseases of Canada's forests. Retrieved from: www.tidcf.nrcan.gc.ca [Accessed on March 13, 2026]

* Please contact author (anthony.taylor@unb.ca) for a full list of references and the rationale for species rankings to risk factors.

Other important notes about this version of the Climate Change Risk Index

- This is the first version of the Climate Change Risk Index based on current knowledge and available science. It is expected that this risk index will be revised and updated in future versions as new science becomes available.
- This version of the Climate Change Risk Index has been peer-reviewed by:
 1. Dr. Loïc D'Orangeville, Associate Professor of Forest Ecology, Université Laval
 2. Dr. Michael Stastny, Research Scientist, Natural Resources Canada