Climate Change Projections for the Canadian Prairie Provinces

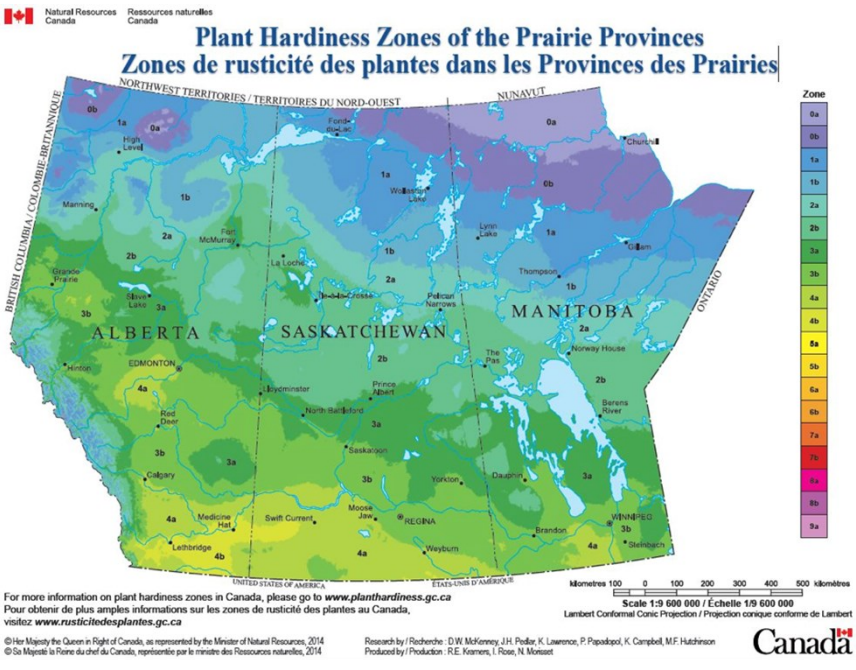
Joshua Palmer, Daniel A. Herms and Scott E. Maco

The Davey Climate Change Fact Sheet Series projects the future impacts of climate change on the tree care industry over the next 30-70 years, with emphasis on changes in temperature, precipitation, storm intensity, tree health, pest pressure, wildfire, and worker stress. Temperatures across Canada have risen 1.7°C since 1948, which is twice the global average. By the end of the century, temperatures are expected to increase between 1.8-6.0°C, with the future trajectory of greenhouse gas emissions providing the largest source of uncertainty. The Intergovernmental Panel on Climate Change (IPCC) projects future climates by modeling different emissions scenarios called "Representative Concentration Pathways (RCP)." This fact sheet focuses on changes expected to occur in the Canadian Prairie Provinces, including Alberta, Saskatchewan, and Manitoba based on lower (RCP2.6), intermediate (4.5RCP), and higher (RCP8.5) emissions scenarios. Currently, global patterns of fossil fuel consumption correspond most closely with the high emissions scenario, while the lower and intermediate emission scenarios will require significant mitigation measures yet to be implemented.

The climate is warming The average annual temperature throughout the Canadian Prairie Provinces has increased 1.9°C since the mid-20th century, ranging from 1-2.5°C in the southern cities of Calgary, Regina, and Winnipeg to beyond 3°C in the northernmost reaches of the provinces. As early as mid-century, air temperature will increase another 1.5°C-2.3°C across the region, and by late-century, temperatures could increase by as much as 6.5°C if the high emission scenario is realized.

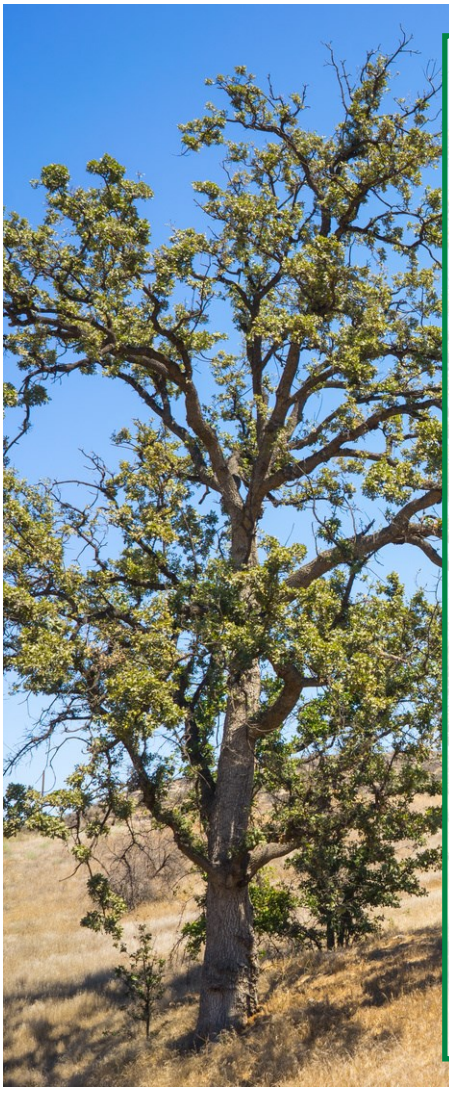
Between 2021 and 2050, the number of extreme heat days (above 30°C) is expected to increase by 5.4 and 6.6 over the 1976*-2005 baseline under the intermediate and higher emissions scenarios, respectively. By 2080, the Prairie Provinces could experience 10-18 additional very hot days, while there are projected to be approximately 25-37 fewer days with frost, greatly extending the growing season.

Hardiness zones in Canada differ slightly from USDA plant hardiness zones. While the USDA zones range from 0a to 13b and are based on the average lowest temperatures experienced in a region each year, Canadian hardiness zones range from 0a to 9b, integrating seven different climate conditions including rainfall, frost-free periods, maximum snow depth, average temperatures, and wind, among others.



Hardiness zones in the Prairie region shifted northward during the second half of the 20th century, most notably in the southern regions where most of the population resides. For example, Calgary and Winnipeg have experienced hardiness zone shifts of 2b to 4a and 3a to 3b, respectively. Hardiness zones will continue to shift northward as temperatures rise, increasing the number of growing degree days for agricultural operations and greatly impacting the phenology, distribution, and abundance of a variety of plant and insect species.

Changing precipitation Average annual precipitation increased 7% across the Prairie Provinces between 1948 and 2012 and is projected to continue rising by another 6-15% by the end of this century, depending on the magnitude of future emissions. Patterns will vary by season with precipitation projected to increase in spring while summer drought and soil water deficits become more frequent. A higher proportion of precipitation is projected to fall as rain as opposed to snow, snowmelt in the mountains will occur earlier, and evapotranspiration will increase. Collectively, these trends will exacerbate low water availability during hotter, drier periods, leading to more frequent and intense droughts and wildfire. In contrast, the combination of increased air temperature and precipitation during the winter and spring is projected to result in more frequent extreme precipitation events and flooding.



Changing climate, changing ecosystems Grasslands dominate the southern regions of the Prairie Provinces, with the northern half covered largely by boreal forest composed primarily of coniferous trees such as pine, spruce, and fir with some broadleaf species such as poplars and birch. Between the two lies the transitional biome of the aspen parkland zone, home to an eclectic array of grassland and coniferous forests, as well as some deciduous tree species such as trembling aspen, which is the main tree species in the parkland zone.

The northern forests of the Prairie Provinces receive significantly less precipitation than do those in eastern Canada and to the west in British Columbia. As summers become dryer and droughts more frequent, especially in northern Alberta, the forests are projected to shift to more of a prairie grassland ecosystem, even under the lower emission scenario. Trembling aspen has experienced widespread decline and mortality in this region in response to recent severe droughts. Such a shift may compound the effects of climate change given that the boreal forest is one of the great global carbon sinks, working to sequester and store atmospheric greenhouse gasses. It's important to note, however, that grasslands can also be important carbon sinks.

Ecosystem migration is a slow and unpredictable process, but evidence indicates that the boreal forest is shifting northward, as trees and shrubs expand their range into Arctic and alpine tundra. As the boreal forest contracts along its southern boundary, warming will expand zones that are suitable for pines, at least in the short term. Ultimately, losses of forest habitat are expected to overshadow any short-term gains, with mature, coniferous forests experiencing greatest decline. The western boreal forest is projected to transition to prairie grassland, as pine and spruce forests contract in response to drier, warmer summers. Southern regions of the Prairie provinces will remain as grassland ecosystems, but they may increasingly resemble grassland communities of Montana and North Dakota, with changes in species composition and an influx of species not currently native to Canada.

Emerald ash borer damage

Increased forest vulnerability to insect outbreaks

In response to warmer winters, the geographic range of the destructive mountain pine beetle, which had expanded northward in British Columbia, breached the Rocky Mountains and spread into central Alberta in 2006 where it now threatens lodgepole and jack pine populations. Factors such as forest composition and cold winters may limit the rate of mountain pine beetle spread in forests of the Prairie Provinces. Still, these forests are projected to become more suitable for mountain pine beetle populations over time. The spruce and fir forests of the Prairie Provinces are also projected to become more vulnerable to periodic outbreaks of eastern spruce budworm, especially at northern latitudes.

The invasive emerald ash borer, which has killed millions of ash trees in North America, may spread farther north as winters warm. First discovered in Canada in Ontario in 2002, emerald ash borer has spread east to Quebec and west to Manitoba where it threatens more than 350,000 ash trees in Winnipeg, alone. Emerald ash borer experiences nearly 100% mortality at temperatures below -34°C. As winters warm, the distribution of this destructive insect is projected to spread northward, threatening millions of ash trees across the Prairie Provinces .

Melting glaciers threaten tourism

In the Canadian Rockies, climate warming threatens Alberta's $8 billion tourism industry connected to glaciers. In Banff National Park, the Peyto Glacier has experienced unprecedented melting over the past century, retreating 3.5 kilometers since the early 1900s and by roughly 20 meters per year in recent decades. Athabasca Glacier, the most-visited glacier in North America, is also melting rapidly, and the total volume of glacier ice in western Canada is projected to shrink by approximately 70 percent by 2100. Downstream consequences of rapid glacial melt include increased flooding and disrupted freshwater ecosystems.

Health impacts

A changing climate increases threats to human health from heat-related illnesses, air pollution, and vector-borne diseases such as West Nile virus. Flooding and runoff caused by extreme precipitation events can increase concentrations of pathogens and toxins in water supplies leading to outbreaks of water-borne diseases. Even perceived benefits of climate change can bring long-term consequences. Warmer temperatures decrease the number of cold-related deaths but increase the number of deaths caused by heat stress, while higher levels of air pollution including ground level ozone and smoke from more frequent wildfires increases the incidence and severity of respiratory illnesses. The elderly, people with underlying health conditions, Aboriginal peoples and those underserved are most at risk from climate-related threats to health. These risks are projected to magnify as the climate continues to warm.

Sources:

Alberta WaterPortal Society. (2022, February 22). *Climate change across the Canadian Prairies*. Alberta WaterPortal. Retrieved from https://albertawater.com/climate-change-across-the-Prairies/

Alladin, E. (2022, January 30). *The differences between us and Canadian Plant Hardiness Zones*. Earth Undaunted. Retrieved from https://earthundaunted.com/the-differences-between-us-and-canadian-plant-hardiness-zones/

Bernard, S.M., Samet, J.M., Grambsch, A., Ebi, K.L. and Romieu, I. (2001): The potential impacts of climate variability and change on air pollution-related health effects in the United States; Environmental Health Perspectives, v. 109 (supp. 2), p. 199–209.

Bonsal, B., Shrestha, R. R., Dibike, Y., Peters, D. L., Spence C., Mudryk L., and Yang D. (August 2020). Western Canadian freshwater availability: current and future vulnerabilities. *Environmental Reviews*. 28(4): 528-545. https://doi.org/10.1139/er-2020-0040

Bowman, D.M.J.S. and Johnston, F.H. (2005): Wildfire smoke, fire management, and human health; EcoHealth, v. 2, no. 1, p. 76–80.

Bush, E. and Lemmen, D.S., editors (2019): Canada's Changing Climate Report; Government of Canada, Ottawa, ON. 444 p.

Canadian Broadcasting Corporation. (2017, December 7). *Invasive Emerald Ash Borer could kill more than 350,000 Winnipeg trees*. CBCnews. Retrieved from https://www.cbc.ca/news/canada/manitoba/winnipeg-emerald-ash-borer-1.4438061

Charron, D.F., Waltner-Toews, D., Maarouf, A. and Stalker, M. (2003): A synopsis of the known and potential diseases and parasites of humans and animals associated with climate change in Ontario; *in* A Synopsis of the Known and Potential Diseases and Parasites of Humans and Animals Associated with Climate Change, (ed.) S. Griefenhagen and T. Noland; Ontario Ministry of Natural Resources, Forest Research Information Report No. 154, p. 7–89.

Clark, C., & Kienzle, S. W. (2019). *Alberta Climate Records*. Retrieved from http://www.albertaclimaterecords.com/#

Clarke, G. K., Jarosch, A. H., Anslow, F. S., Radić, V., & Menounos, B. (2015). Projected deglaciation of Western Canada in the twenty-first century. *Nature Geoscience*, *8*(5), 372–377. https://doi.org/10.1038/ngeo2407

Climate Atlas of Canada. version 2 (July 10, 2019). using BCCAQv2 climate model data.

Climate impacts on health and productivity of aspen. Retrieved from https://natural-resources.canada.ca/climate-change/climate-change-impacts-forests/impacts/climate-impacts-health-productivity-aspen/13119.

Climenhaga, C. (2022, August 2). *Climate change is warming Canada's great expanse of boreal forest, bringing greater risk of fire and disease.* CBCnews. Retrieved from https://www.cbc.ca/news/canada/edmonton/boreal-forest-canada-climate-change-alberta-saskatchewan-1.6518223

Doll, J. (2021, August 31). *Scientists warn glacier in Canadian Rockies is slipping away before their eyes at unprecedented rate*. Global News. Retrieved from https://globalnews.ca/news/8154343/canadian-rockies-glacier-melt/

Johnston, M., Vulnerability of Canada's tree species to climate change and management options for adaptation: An overview for policy makers and Practitioners (2009). Canadian Council of Forest Ministers.

McKenney D. W., Pedlar J. H. (2014, April). Lawrence K, Papadopol P, Campbell K, Hutchinson M. F., Change and Evolution in the Plant Hardiness Zones of Canada, *BioScience*, Volume 64, Issue 4, Pages 341–350, https://doi.org/10.1093/biosci/biu016

Pfeifer, A. (2022, March 30). *Melting glaciers will increase risk of floods in Alberta Mountains, experts warn*. Calgary Journal. Retrieved from https://calgaryjournal.ca/2022/03/30/melting-glaciers-will-increase-risk-of-floods-in-alberta-mountains-experts-warn%EF%BF%BC/

Sauchyn, D., Davidson, D., and Johnston, M. (2020): Prairie Provinces; Chapter 4 in Canada in a Changing Climate: Regional Perspectives Report, (ed.) F.J. Warren, N. Lulham and D.S. Lemmen; Government of Canada, Ottawa, Ontario

Venette, R. C., & Abrahamson, M. (2010). *Cold hardiness of emerald ash borer, Agrilus planipennis: A new perspective*. Retrieved February 8, 2023, from https://www.nrs.fs.usda.gov/pubs/45307

WaterSMART Solutions. (2020). *Appendix B: Hydrology Baseline Summary Report*, prepared for Western Economic Diversification Canada/ Diversification de l'economie de l'Ouest Canada.