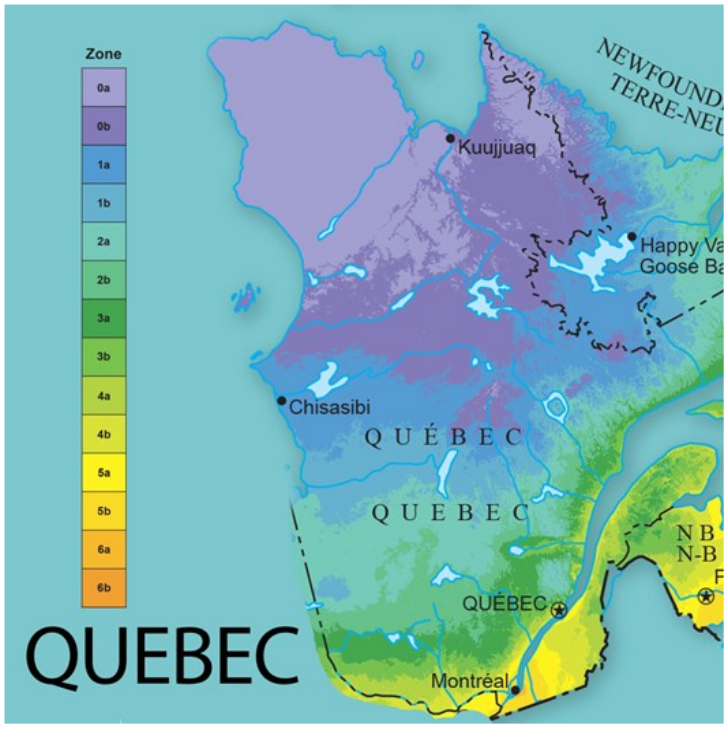
TECHNICAL BULLETIN *Prepared by the Davey Institute*

Climate Change Projections for Québec

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 Québec 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.

A warming climate Québec has experienced steady warming over the past 75 years, with the average annual temperature throughout the province increasing 1.1°C since 1948. Because of Québec's immense geography that stretches from the St. Lawrence River in the south to the tundra in the north, the warming has been uneven, ranging from 0.5-1.5°C depending on location, with northern regions warming more quickly than the south. As the climate has warmed, so has Québec's frost-free growing season, which has lengthened by 15 days since the beginning of the 20th century. Québec has experienced a marginal increase in extreme heat since 1948, with 1-3 additional days exceeding 30°C. In Montréal, the number of nights exceeding 22°C has increased by 1-3 since 1948.



The climate in Québec is expected to continue warming, with temperatures projected to increase by 1.5-2.3°C by mid-century, based on the lower and higher emission scenarios, respectively. Warming could exceed 6°C by the end of the century if RCP8.5 is realized. Daily maximum and minimum temperature are projected to increase, as are the number of extreme heat days. By 2050, the growing season is projected to increase by an additional 20 days across the province, while decreases of 20-34 days of the frost season could be experienced in southern parts of Québec and along the Gulf of St. Lawrence. This widespread warming will have significant consequences for the climate system in Québec, exacerbating climate extremes and increasing seasonal variability.

A warming climate cont. 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.

Québec's vast geography ranges from 45°N in Montreal, the equivalent of mid-Michigan, U.S.A, to 62°N at the northern tip of the province, the approximate latitude of Anchorage, Alaska. Hence, the province encompasses diverse climates and ecosystems. Hardiness zones in Québec range from oa in the northern reaches to as high as 5a-6b at the southernmost point. Despite pronounced increases in hardiness zones across Canada, particularly in the west, changes in hardiness zones in Québec have been mixed. In some of the easternmost portions of the province, hardiness zones have decreased by as much as half a zone, while regions in the north and west have increased by a full zone. Montréal experienced a shift from 5a to 5b, or even as high as 6a according to some estimates. As the climate continues to warm, hardiness zones are projected to continue migrating north, altering agricultural practices and the species composition of forests.

Increased precipitation

Precipitation in Québec has increased significantly in the past 75 years, and this trend is projected to continue throughout the 21st century. Between 1948 and 2012, annual precipitation in Québec increased 10.5%, with future precipitation expected to surge by an additional 9% by 2050, and as much as 22% by the end of the century, based on the high emissions scenario. Climate change will also affect seasonal patterns of precipitation. During the winter months, a higher proportion of precipitation will fall as rain rather than snow, decreasing snowpack accumulation.

Between 1948 and 2012, the number of days with heavy rainfall in southern Québec increased by 2-3 days. The frequency, duration, and intensity of heavy precipitation events are projected to continue increasing in winter and spring across the province, as is the frequency of flooding. During summer, however, the frequency of prolonged dry periods is projected to increase throughout the century. Decreased soil moisture levels, combined with warmer temperatures and increased evaporation rates, will increase the likelihood of drought.

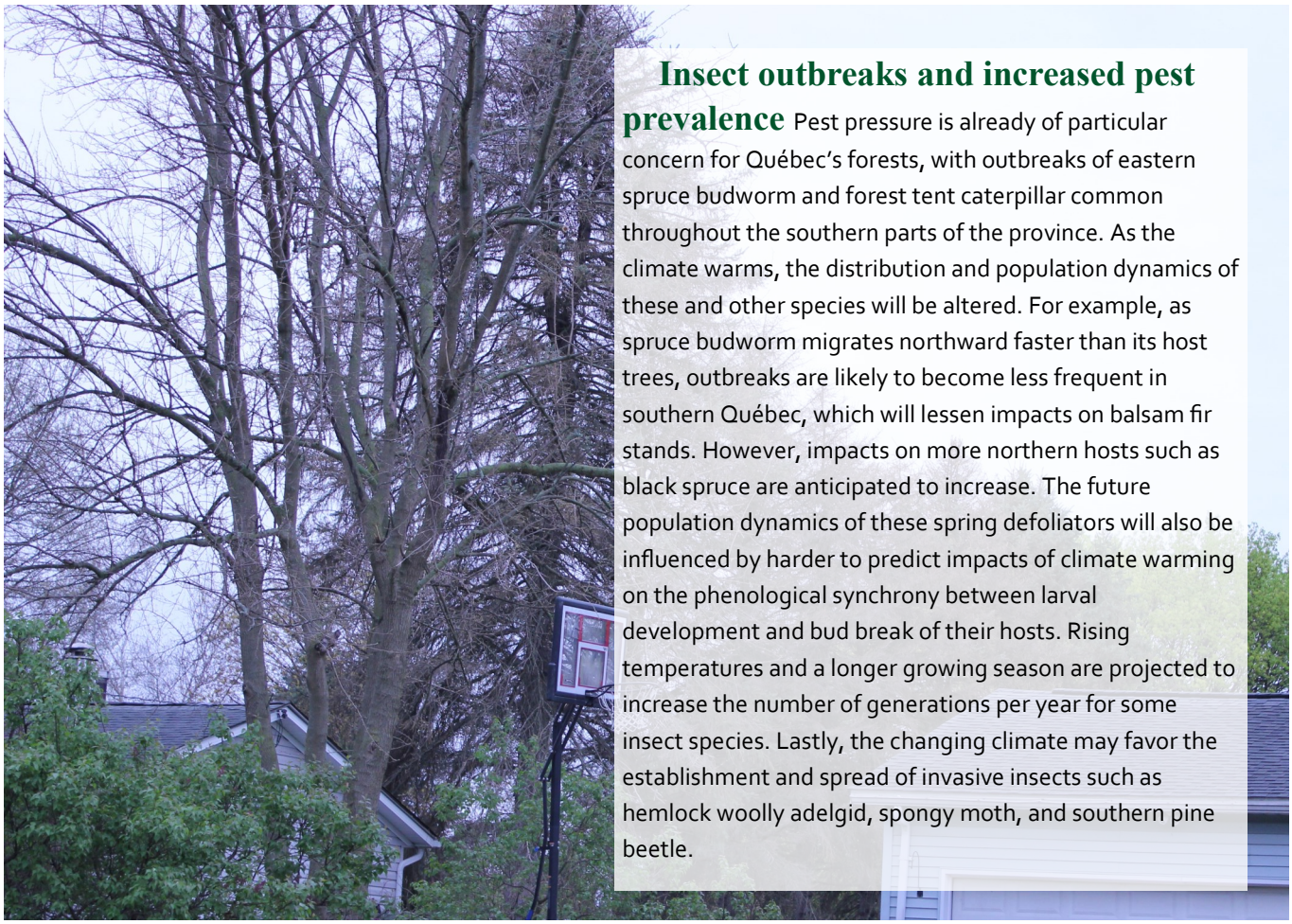
Shifts and contractions of forest ecozones

Québec's rich biodiversity occurs across three main vegetation zones. an Arctic area characterized by low-lying and upright shrubs; the boreal zone comprised of forest tundra, spruce-lichen, spruce-moss, and paper birch-fir stands; and the northern temperate zone dominated by fir and mixed hardwood including yellow birch, basswood, sugar maple, and bitternut hickory. The effects of climate change will vary across these zones but are already apparent. Increased temperatures and precipitation are accelerating budbreak and increasing tree growth.

In the long term, the warming climate will result in northward migration of tree species, which is currently occurring at a rate of 45 km per decade. The climate zone suitable for yellow birch, for example, is projected to shift northeastward from its current range in southern Québec into central Québec. Species that historically have occurred south of the border with the United States will continue to become more common in Québec as the climate warms.

Still, the pace at which the climate is changing may be faster than the ability of many species to migrate or adapt, which may affect their long-term survival. For example, as the climate continues to warm, temperatures will increasingly exceed the tolerance threshold for species such as black spruce, balsam fir, and paper birch. By the end of the century, between 5 and 20% of forest ecosystems will no longer be suitable habitat for their current tree species.

Forest ecosystems will also be affected as the frequency of wildfire is projected to increase by 50% by 2050, while total area burned is anticipated to double. Rising temperatures will increase the wildfire season by 10-20 days by mid-century, lasting from early spring to late fall. Warmer temperatures will also lead to increased evapotranspiration and drought, which will contribute to more frequent, expansive, and intense forest fires. Finally, the flammability of woodland areas is likely to increase as the range and abundance of insect pests and pathogens expands and tree mortality increases in response to changing climate.



Insect outbreaks and increased pest prevalence

Pest pressure is already of particular concern for Québec's forests, with outbreaks of eastern spruce budworm and forest tent caterpillar common throughout the southern parts of the province. As the climate warms, the distribution and population dynamics of these and other species will be altered. For example, as spruce budworm migrates northward faster than its host trees, outbreaks are likely to become less frequent in southern Québec, which will lessen impacts on balsam fir stands. However, impacts on more northern hosts such as black spruce are anticipated to increase. The future population dynamics of these spring defoliators will also be influenced by harder to predict impacts of climate warming on the phenological synchrony between larval development and bud break of their hosts. Rising temperatures and a longer growing season are projected to increase the number of generations per year for some insect species. Lastly, the changing climate may favor the establishment and spread of invasive insects such as hemlock woolly adelgid, spongy moth, and southern pine beetle.

Defoliation caused by spongy moth

Human health vulnerabilities and worker risks

Climate warming is likely to have some detrimental effects on the health and safety of the citizens of Québec. Heightened temperatures and increased frequency of heat waves can cause an array of health problems, ranging from discomfort and dehydration to heat stroke, particularly for vulnerable populations such as children and the elderly. The effects of climate change can also worsen chronic diseases, while hotter temperatures increase mortality from cardiovascular and respiratory conditions among older populations. People that work outdoors are also prone to physical ailments during extremely hot days.

An increase in the number of extreme weather events due to climate change poses significant risks to people throughout the province. Heat waves, drought, heavy rainfall, floods, tornadoes, and forest fires and associated smoke lead to various physical and mental health problems. Severe weather events had a greater economic impact in 2021 than any year in Canadian history, and the frequency of severe weather events is projected to increase. In 2022, just before eastern Québec was struck by inland reaches of Hurricane Fiona, the province experienced an unprecedented derecho windstorm with speeds up to 195 km/hr that tragically claimed 11 lives and caused more than $1 billion in damages. While derecho is a rare event in Canada, the changing climate could make them more likely in the future.

Other climate-related factors are also impacting human health in Québec. Air pollution from ground-level ozone and wildfire smoke cause respiratory illness, while increased pollen loads trigger allergic reactions. A changing climate is increasing the prevalence of zoonotic diseases in southern Canada including West Nile Virus and Lyme disease vectored by ticks, which is increasing the risk to those that work and recreate outdoors. The probability of these and similar events will continue to increase as the climate continues to warm.

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