Frontline EXPRESS
Canadian Forest Service, Great Lakes Forestry Centre

Bulletin No. 13

CANADA'S PLANT HARDINESS ZONES

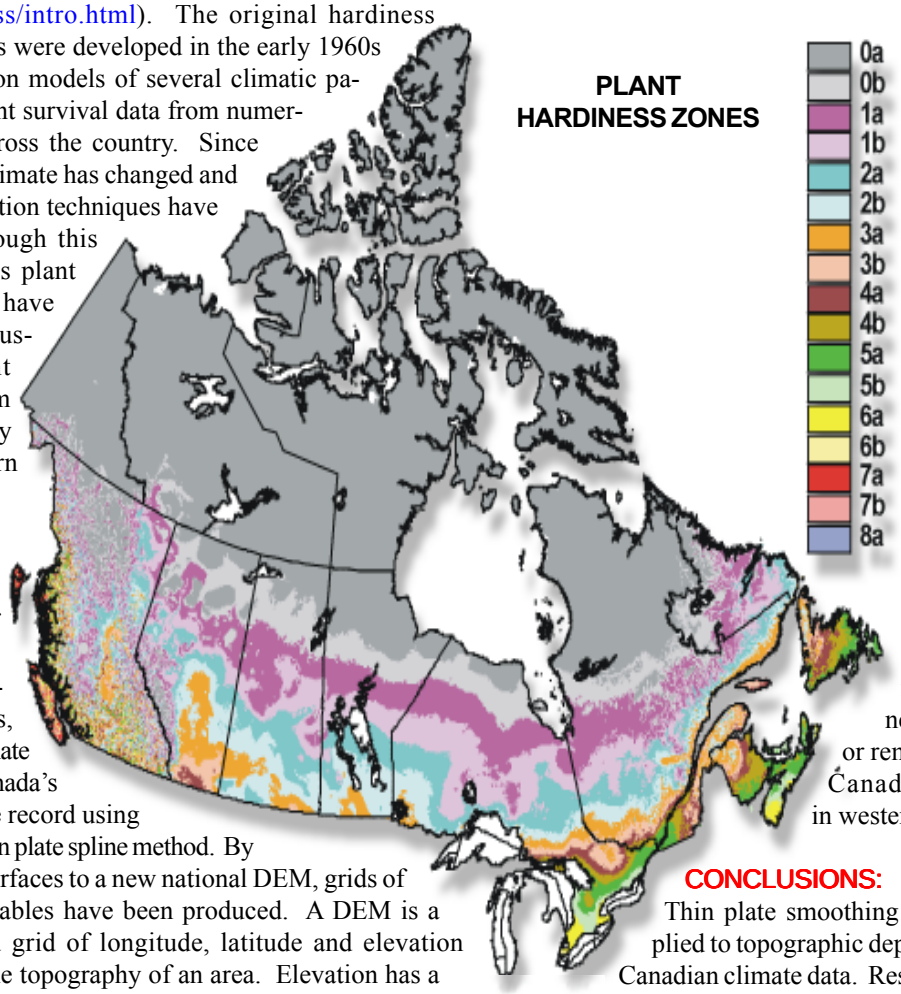
INTRODUCTION:

In 1967, the Canadian Journal of Plant Science published three articles on woody ornamental plant zonation. The third article, "Suitability map for the probable winter survival of ornamental trees and shrubs" has become the standard reference used by gardeners for plant hardiness zones in Canada. It has been published in numerous venues and is well known across Canada. The plant hardiness zones map (PHZ Map) is still a widely requested item at Agriculture Canada's research station in Ottawa (see the Agriculture and Agri-Food Canada web site: http://sis.agr.gc.ca/cansis/nsdb/climate/hardiness/intro.html). The original hardiness indices and zones were developed in the early 1960s through regression models of several climatic parameters and plant survival data from numerous locations across the country. Since then, Canada's climate has changed and climate interpolation techniques have improved. Through this project, Canada's plant hardiness zones have been remapped using more recent climate data from across the country and more modern methods.

This approach involved the development of topographically dependent, spatially continuous, mathematical climate surfaces from Canada's historical climate record using ANUSPLIN, a thin plate spline method. By coupling these surfaces to a new national DEM, grids of the required variables have been produced. A DEM is a regularly spaced grid of longitude, latitude and elevation that represents the topography of an area. Elevation has a major influence on climate.

RESULTS:

Preparation of a new PHZ map was accomplished following three phases of development: climate surface testing, climate surface fitting and map generation, and map comparisons. Trials of different spline models were undertaken and evaluated using withheld data. A tri-variate function of position (longitude and latitude) and elevation performed best. Standard errors of the surfaces were about 0.5°C or less for temperature variables and 5 to 28% for rainfall depending on the month (winter months being the worst). The creation of a new DEM of Canada has enabled the mapping of each variable required for the plant hardiness formula at spatial resolutions of 1km to 10km. The figure is from an approximate 2km resolution DEM. These models better capture the spatial variation in climate than was previously possible and hence should provide a stronger basis for applications such as the determination of plant hardiness zones. Comparisons of the zones between the two time periods are consistent with what is known about climate in Canada. The hardiness index has declined or remained stable in eastern Canada and has increased in western areas.



CONCLUSIONS:

Thin plate smoothing splines have been applied to topographic dependent interpolation of Canadian climate data. Results are consistent with applications of these techniques in other parts of the

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world, with standard errors of less than 0.5°C for monthly mean minimum and maximum temperature. However, the results do suggest that more data are required to improve the precipitation surfaces. This is important given the current interest in climate change research and reductions in Canada's climate observing network in recent years due to budget constraints. Elevation dependencies are evident for both temperature and precipitation. An implication is that spatial climate models that do not include elevation, or that utilize very coarse resolutions, are likely to miss important information that can be provided by topography.

MANAGEMENT IMPLICATIONS:

Canada's plant hardiness zones appear to have changed in many parts of the country. The changes are most pronounced in western Canada. Perhaps surprisingly, the index value seems to be decreasing in parts of eastern Canada. It is important to remember the plant hardiness formula includes variables other than temperature (e.g., snow depth and rainfall in January). It is also important to be explicit about the exact nature of the hardiness index. The zones are associated with probabilities of plant survival in relation to average, broad scale conditions. Extreme weather variations, local topography and human interventions (e.g., mulching) can have a significant impact on plant survival in any particular location.

SOURCES OF RELEVANT INFORMATION:

McKenney, D.W.; Hutchinson, M.F.; Kesteven, J.L.; Venier, L.A. 2001. Canada's Plant Hardiness Zones Revisited Using Modern Climate Interpolation Techniques. Can. J. Plant Sci. 81:129-143

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