PAPER 5

RESEARCH ON BIODIVERSITY AND PLANT HARDINESS ZONES ACROSS A SOUTHERN ONTARIO TRANSECT

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ABSTRACT: This research paper will compare expected species lists for the new plant hardiness zones with species lists collected by volunteers in SI/MAB plots along a longitudinal gradient in the Niagara Escarpment from Long Point to Wiarton. Scientists have currently documented 12 families at Long Point and nine families at Wiarton. The expected loss in the number of families in Long Point, as predicted by the new plant hardiness zones, could result in a potential biodiversity crisis for Ontario. Our native species diversity could be threatened, especially species growing in the Carolinian Region of Ontario, one of the most diverse areas in Canada. Native species may potentially be lost that have been naturally adapted to Canadian climates. Detailed examples of biodiversity data will be discussed using a Southern Ontario case study. In addition, recommendations will be presented for future paired SI/MAB plots. Ongoing monitoring on these paired 1 ha SI/MAB sites by the volunteer sector and ACER (Association for Canadian Education Resources) can provide scientists with early detection of changes in the landscape, especially in high impact areas.

1. Introduction

A new plant hardiness zone map of Canada is now available on the web from Agriculture Canada (**http://sis.agr.gc.ca/cansis/nsdb/climate/hardiness**). The original plant hardiness map was based on 1931-1960 climate data (Ouellet and Sherk, 1967). The new hardiness map, based on the same formula is for the 1961-1990 data period (McKenney *et al.*, 2001).

The plant hardiness map outlines different zones in Canada where various types of trees will most likely survive. In 1967, Ouellet and Sherk created a plant hardiness map using Canadian plant survival data and seven climate variables, including minimum winter temperatures of the coldest month, length of frost-free period, rainfall of the frost free months, maximum temperatures, January rainfall, snow cover and maximum wind gust. In 2001, McKenney *et al.* produced a new plant hardiness zone map using the same variables and climate data from 1961-1990, applying automated computerized climate mapping techniques.

A large number of SI/MAB biodiversity observation plots (>25) exist across a southern Ontario transect along and adjacent to the Niagara Escarpment from Wiarton at Georgian Bay to Long Point along Lake Erie. The ability to interrogate and field validate the results of existing and new plant hardiness zone maps is now possible by comparing actual with predicted indicator species that flourish

in areas within this transect. The plant hardiness zone map is perhaps the most widely used climate-based map by gardeners as they select their plant varieties at nurseries depending on their respective hardiness zones.

2. Climate, Agricultural and Ecological Relationships of the Southern Ontario Transect

Distinct climate differences exist between Wiarton and Long Point. The observations at Wiarton and Long Point will be used for illustration purposes only; the comments and conclusions in this paper apply throughout southern Ontario and elsewhere in Canada. The average annual temperature at Wiarton is 6°C and 7.8°C at Delhi, the closest long term Bioclimatic station to Long Point (Figures 1a, b). Corn Heat Units and Growing Degree Days also differ significantly between the two stations. There are 947 available growing degree days above 10°C at Wiarton compared to 1,268 growing degree days above 10°C at Delhi (Figures 1c, d).

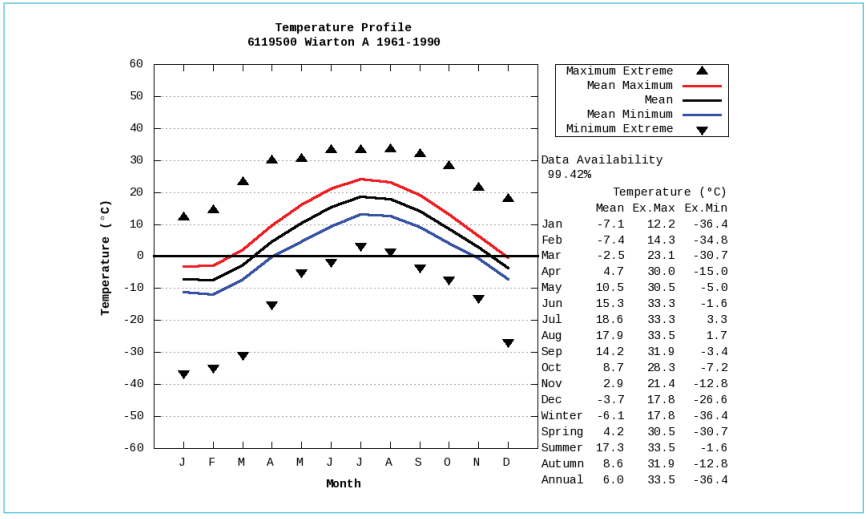

FIGURE 1a

Temperature Bioclimate Profiles for Wiarton.

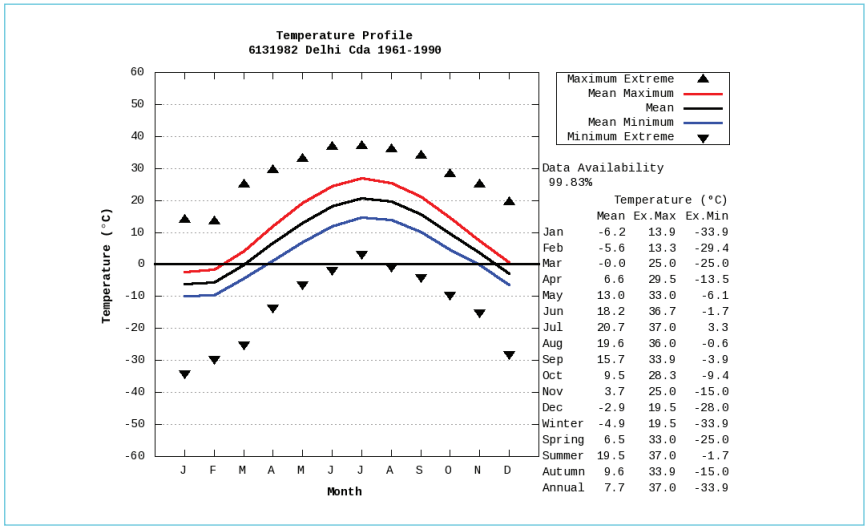

FIGURE 1b

Temperature Bioclimate Profiles for Delhi CDA.

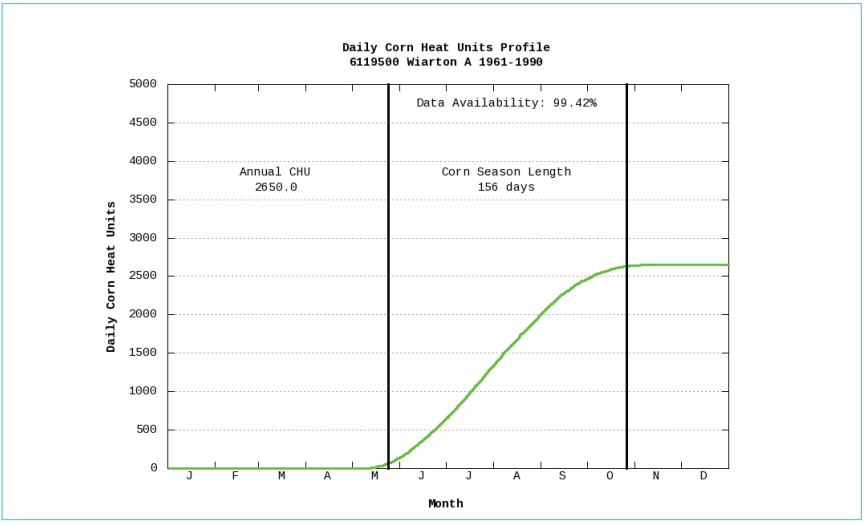

FIGURE 1c

Corn Heats and Growing Degree Days for Wiarton.

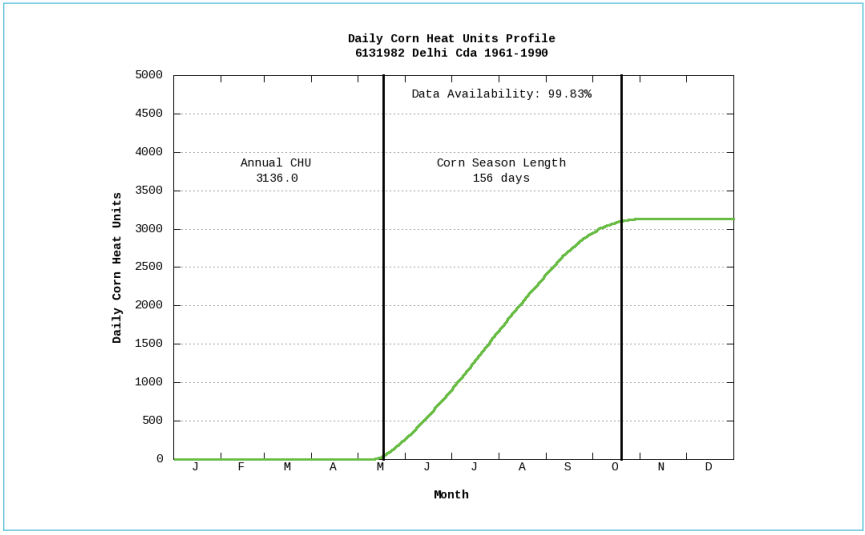

FIGURE 1d
Corn Heats and Growing Degree Days for Delhi CDA.

This difference of 321 in growing degree-days impacts significantly the agricultural crop potential in each region. According to Dumanski and Stewart (1981), cash crops such as soybean are moderately suitable for growing in Long Point (Class 3) but have no potential in Wiarton (Class 6). Likewise, seed or grain corn have low potential in the Wiarton region, different than Long Point.

One of the most distinct forestry transition zones in southern Ontario is the Carolinian Zone in the Lake Erie Lowland Ecoregion (**www.on.ec.gc.ca/glirnr/images/maps/carolinian.git**). Above this zone is the Great Lakes-St. Lawrence Forest Region with a very different forest biodiversity at the ecosystem, species and genetic levels. This major ecological zone occurs along the transect between Wiarton and Long Point. To show some of the tree species differences across this transect we can interrogate the relatively large number of Climate-Based Biodiversity Mapping and Global (SI/MAB) Sites in southern Ontario (Figure 2a).

3. SI/MAB Program

The Smithsonian Institution and the UNESCO Man and the Biosphere Biological Diversity Program (now the Monitoring and Assessment program) tested procedures for establishing permanent forest inventory plots in world biosphere reserves. The purpose of this program was to 1) document plant diversity, 2) provide long term data on the growth, mortality, regeneration and dynamics of forest trees and 3) create a research and education base that will foster the conservation and management of biosphere reserves.

One of the very fortunate aspects of having this data available and analyzed is the ability to compare sites across Canada and globally. For the purpose of illustration, the global versus Long Point families by proportional abundance classes show greater biodiversity at Long Point with 12 families compared to 9 families in Wiarton and relatively few families compared to a site in Asia with over 50 families (Figure 2b).

For the first time a globally standardized plot design has been adopted that is flexible and accommodating to different forest environments. This standardized design allows compatibility and comparable reliability in data collected at different sites around the world. The design is a square, one-hectare size (subdivided into 25 individual 20 x 20 m quadrants).

The use of a one-hectare plot gives a relatively large sample and has been shown to be robust enough to capture the biodiversity of a site in the tropics and also in some of the most biologically diverse areas in the Carolinian Zone of southern Ontario. The globally agreed upon protocol requires that all trees above a certain diameter (10 cm dbh in the tropics and 4 cm dbh in southern Ontario) are mapped, identified for species and measured for diameter at breast height (dbh) and total height (m). Parameters such as tree health, understory vegetation and other species may also be monitored in these plots using standardized protocols.

This long term mapping of tree species and vegetation in urban impacted areas makes these sites ideal for interrogating existing and previous plant hardiness zone maps. The Canadian Biodiversity SI/MAB sites continue to expand at an unprecedented rate. It is an extremely successful program and the first comparative results of the data from sites right across Canada have been documented (EMAN 2001).

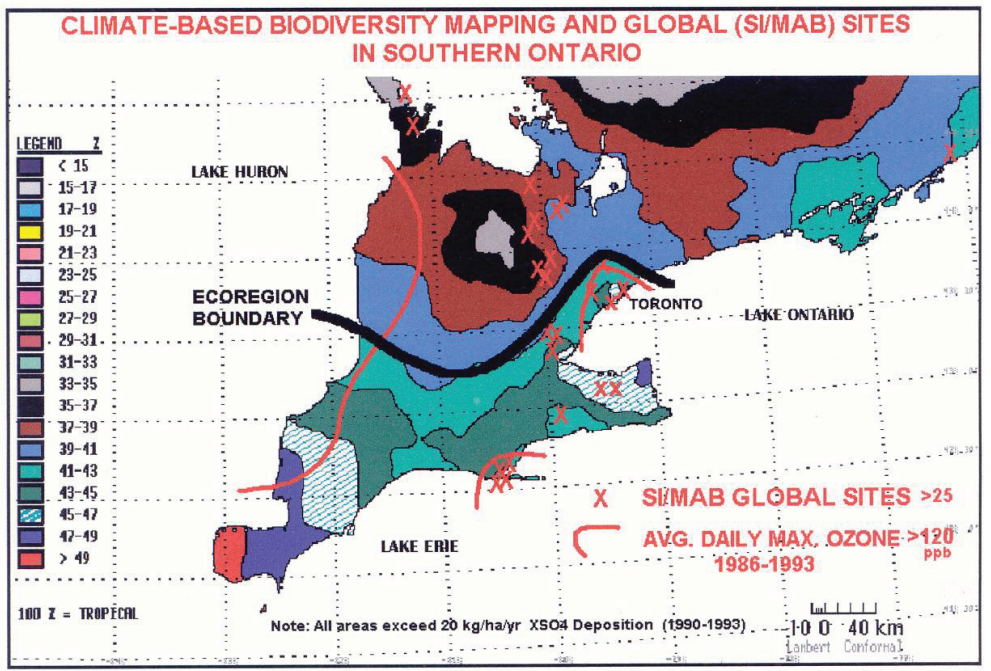

FIGURE 2a

Climate-Based Biodiversity Mapping and Global (SI/MAB) Sites in southern Ontario.

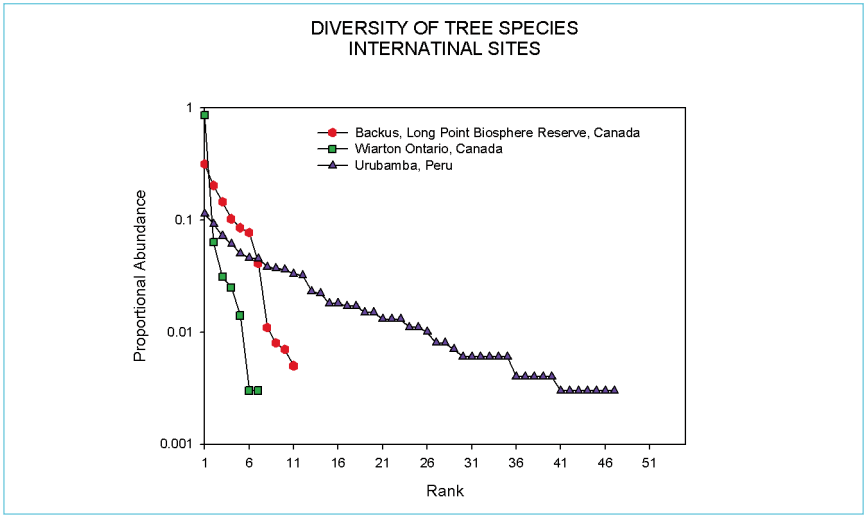

FIGURE 2b

Global Versus Long Point Families by Proportional Abundance Classes.

4. Plant Hardiness Zone Map Changes

The original map by Oueuet and Sherk (1967) shows two zones removed between Wiarton and Long Point. On this map Wiarton is in zone 5b and Long Point is in zone 6b (Figure 3a). The first noticeable difference between the maps is the classification of the old versus new hardiness zones. The new map shows cooler species zones by one or two classes for southern Ontario. Toronto shows a cooler species zone by one class and the region of Long Point along the Lake Erie shoreline shows a cooler species zone by two classes (6b to 5b). The original 7b zone south of Windsor in the 1967 publication is not reproduced in the 1967 map. The two warmest species zones on the 1967 map, namely 8b and 9a, are entirely omitted in the 2000 map (Figure 3b).

The second important difference between the old and new maps is the spatial mapping of, for example, the Long Point area along Lake Erie. A noticeable difference is the joining of Long Point with Wiarton and Owen Sound in the Bruce Peninsula (now all in 5b). The former 6b zone (now 6a) is no longer joined across Lake Erie. There is a separation around the region of Long Point, and Long Point has dropped from 6b into 5b. This means that Wiarton, Owen Sound, Collingwood, Kincardine, Stratford, Woodstock, Brantford, Richmond Hill, Long Point, Oshawa, Coburg, Kingston and Ganonoque are all in this cooler species 5b zone.

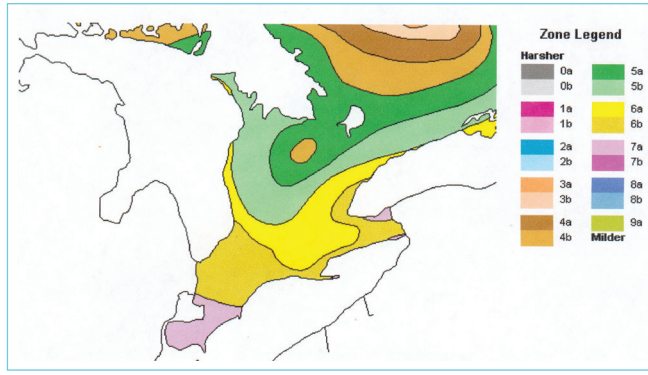

FIGURE 3a
Plant Hardiness Zones of Canada for 1967 (Ouellet and Shark 1967).

FIGURE 3b
Plant Hardiness Zones of Canada for 2000 (McKenney *et al.*).

5. Predicted Indicator Species and Species Lists on SI/MAB Sites

For the purpose of illustration, one of the main indicator species for zone 6b, which formally included Long Point in the 1967 map, is Eastern Flowering Dogwood (*Cornus florida*). The indicator species associated with the 6b zone in the 2000 map is still Eastern Flowering Dogwood (for the most part the indicator species remain unchanged between the old and new maps). Similarly, the indicator species in the USDA Plant Hardiness Zone Map

(**www.usna.usda.gov/Hardzone/html.hzm-ne**) for the Long Point region is *Cornus florida*. Field data show that *Cornus florida* flourishes at Long Point, comprising 4 percent to 6.5 percent of the total number of stems per hectare in two SI/MAB mixed-wood plots at Long Point. Eastern Flowering Dogwood continues to be found in significant proportion in 2000 after the fifth year remeasurement (EMAN 2001).

Today, based on this new 2000 plant hardiness zone map, colder species are recommended throughout southern Ontario. Current and future temperature scenarios illustrate a "less cold" environment within the rotation life span of any tree species selected for planting today. Equally important is the lack of agreement between the new plant hardiness zone and current tree species. Likewise, the mapping algorithms are suspect when the spatial patterns are generated that link together locations such as, Long Point, Kitchener, Wiarton and many other areas that cross distinct ecological, agricultural and climate regions. If this new plant hardiness map continues to be used by Canadians as the fundamental basis for selecting and planting species, then the validity of the map raises serious concerns for future biodiversity.

6. Conclusions and Recommendations

We have a tremendous database available to us in the SI/MAB plots across southern Ontario and in other parts of Canada as well. These SI/MAB plots, using standard global protocols, provide an essential ground-truthing knowledge base for the evaluation of new climate-based products, including remote sensing.

7. References

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