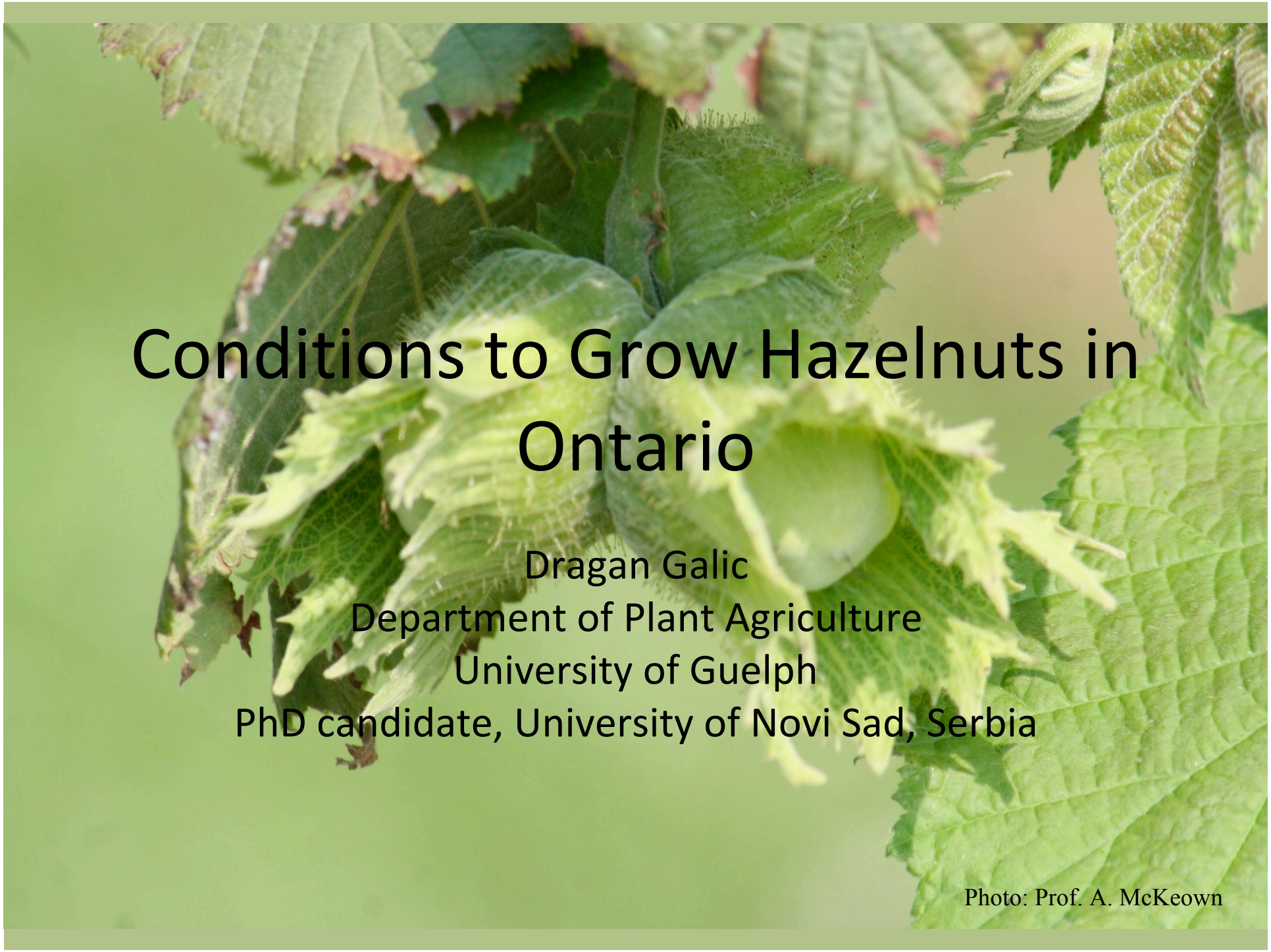

Conditions to Grow Hazelnuts in Ontario

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Photo: Prof. A. McKeown

Winter hardiness

- Ability of commercial varieties to survive “test winters”,
  - origin,
  - conditions to grow,
- Management actions to help the plants to survive subfreezing temperatures.

“ Properly matured and hardened off tree of a tendered variety is more hardy than an immature tree of a hardy cultivar”

Prof. Norman F. Childers, Florida University

Winter hardiness (cont.)

- Ability to survive freezing temperatures,
  - tolerate ice crystals,
  - avoid freezing through supercooling,
    - : survive up to -40°C,
- Cold acclimation.

Cold acclimation

- Prerequisite: apical growth cessation (dormancy)

  1. Photo-periodically induced stage,

     - short days: early warning,
     - leaves are photo-periodic receptors,

       a) increased abscisic acid (ABA),

       b) decreases gibberellic acid, (GA) and cytokinins,

       c) increase carbohydrate concentration.

Cold acclimation (cont.)

2. Low temperatures and frost induced stage,
   - hardiness increases over a period of several weeks,
   - subfreezing temperatures result in maximum hardiness.

Relative cold hardiness for some cultivars

How freezing kills acclimated trees.

As temperature drops below freezing point:

- ice crystals first form outside of the cell in extracellular space,
- more water is pulled from the cell,
    - plant die from desiccation,
    - equivalent to severe summer drought.

The amount of the freezing injury

- Rate at which temperature falls,
  - rapid temperature fall: greater injury,
- Duration of low temperature,
  - longer cold period: more winter injury,
- Cold wind.

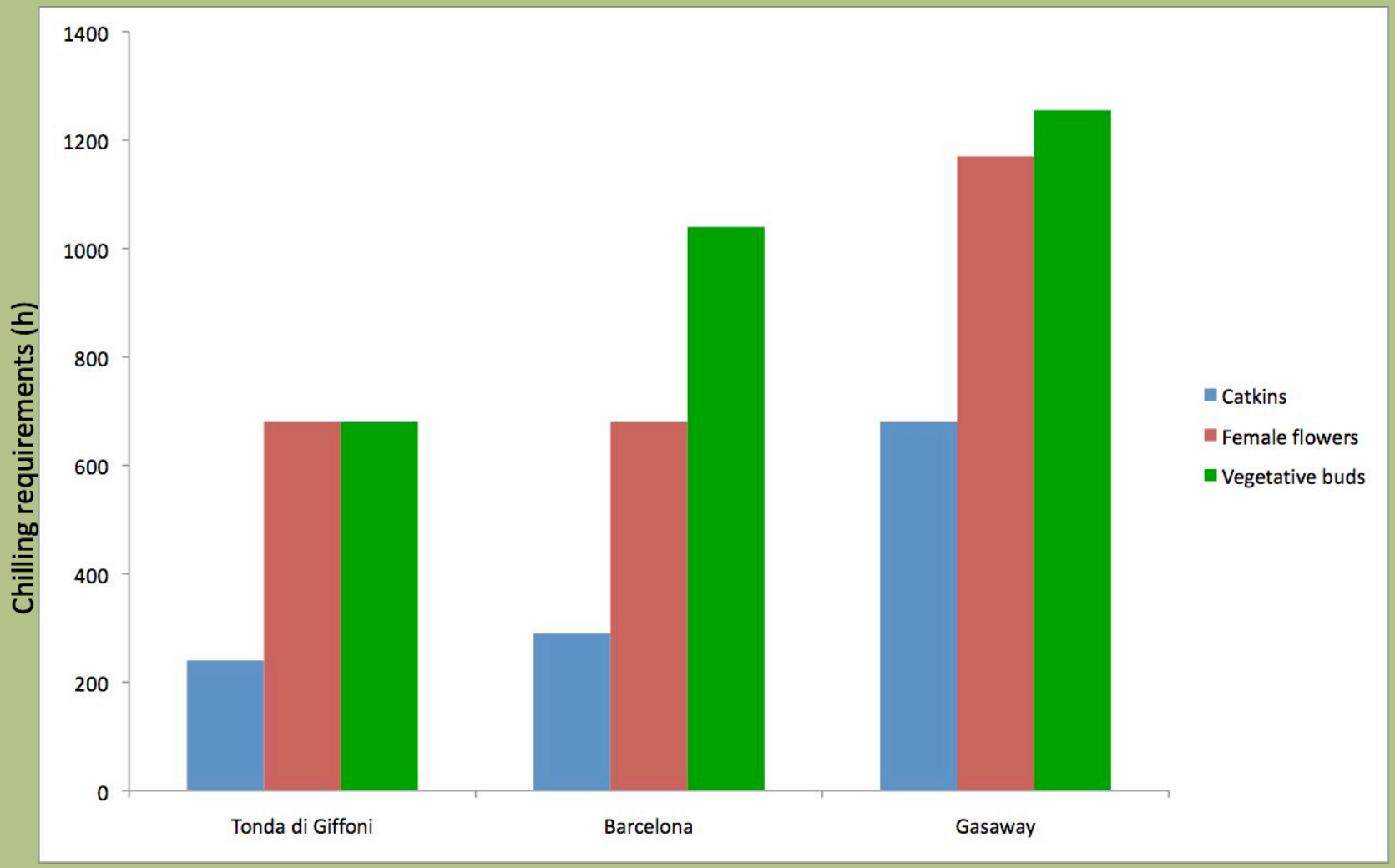
The amount of the freezing injury (cont.)

- Temperature prior to freezing,
  - this temperatures will determine the degree of cold hardiness,
- Rate and frequency of thawing,
  - greater injury: faster and more frequent frozen tissue thaws,
- Tissue type.

Conditions to grow hazelnuts

- Soil type,
  - moist loam to sandy loam soils with good aeration,
  - soil pH 6 to 7,
- Harvesting requirements,
  - wet soils hold machinery at harvest,
- Chilling requirements,
  - below 7°C.

Estimated chilling requirements (h)

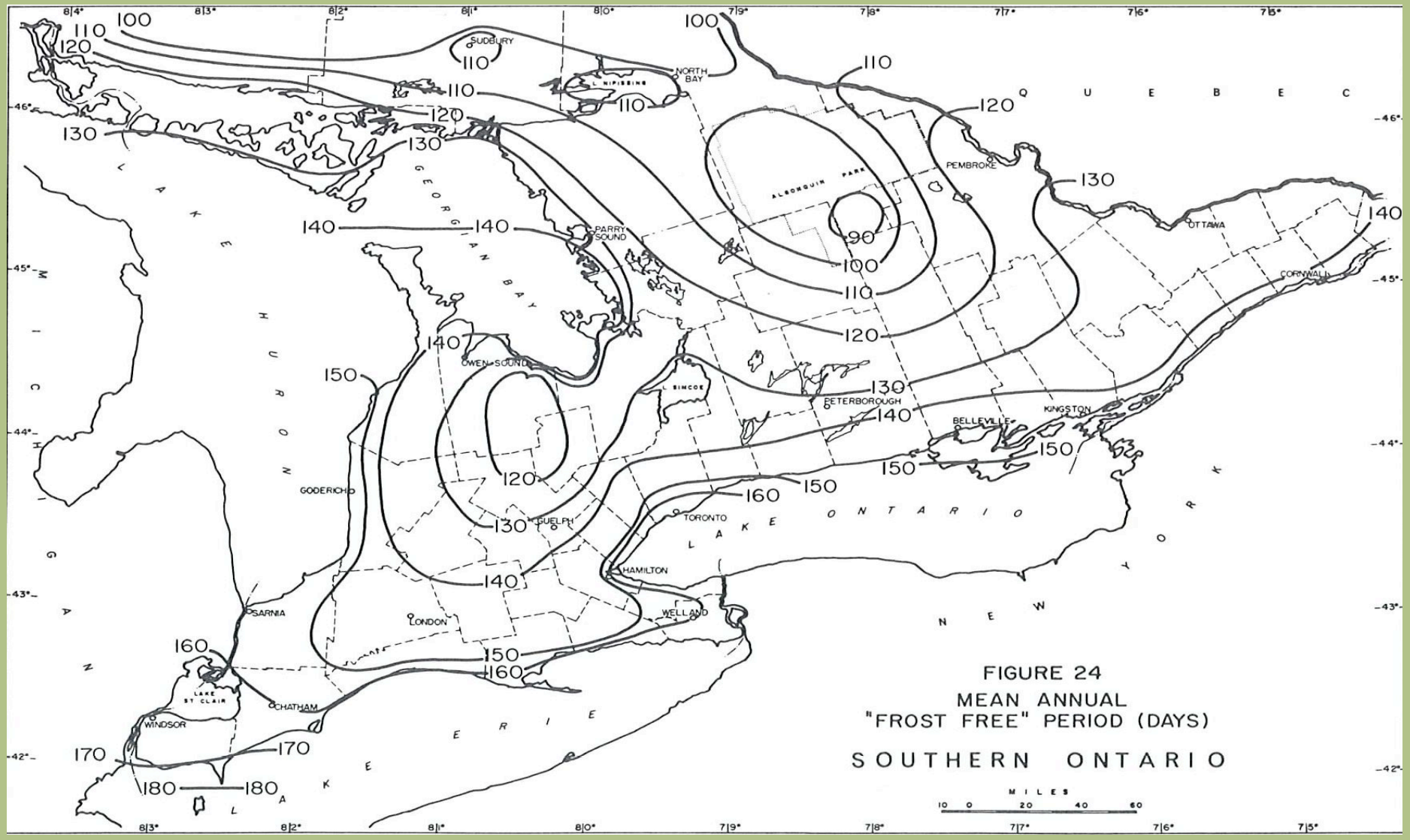


Source: Mehlenbacher, S., 1991

Conditions to grow hazelnuts (cont.)

- Average temperature for growing season 16.7°C,
- Frost-free period 150 days,
- Corn heat units >2500,
- Tissue hardiness.

Frost-free period (1930-1960)



Conditions to grow hazelnuts (cont.)

- Average temperature for growing season 16.7°C,
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Corn heat units (1930-1960)

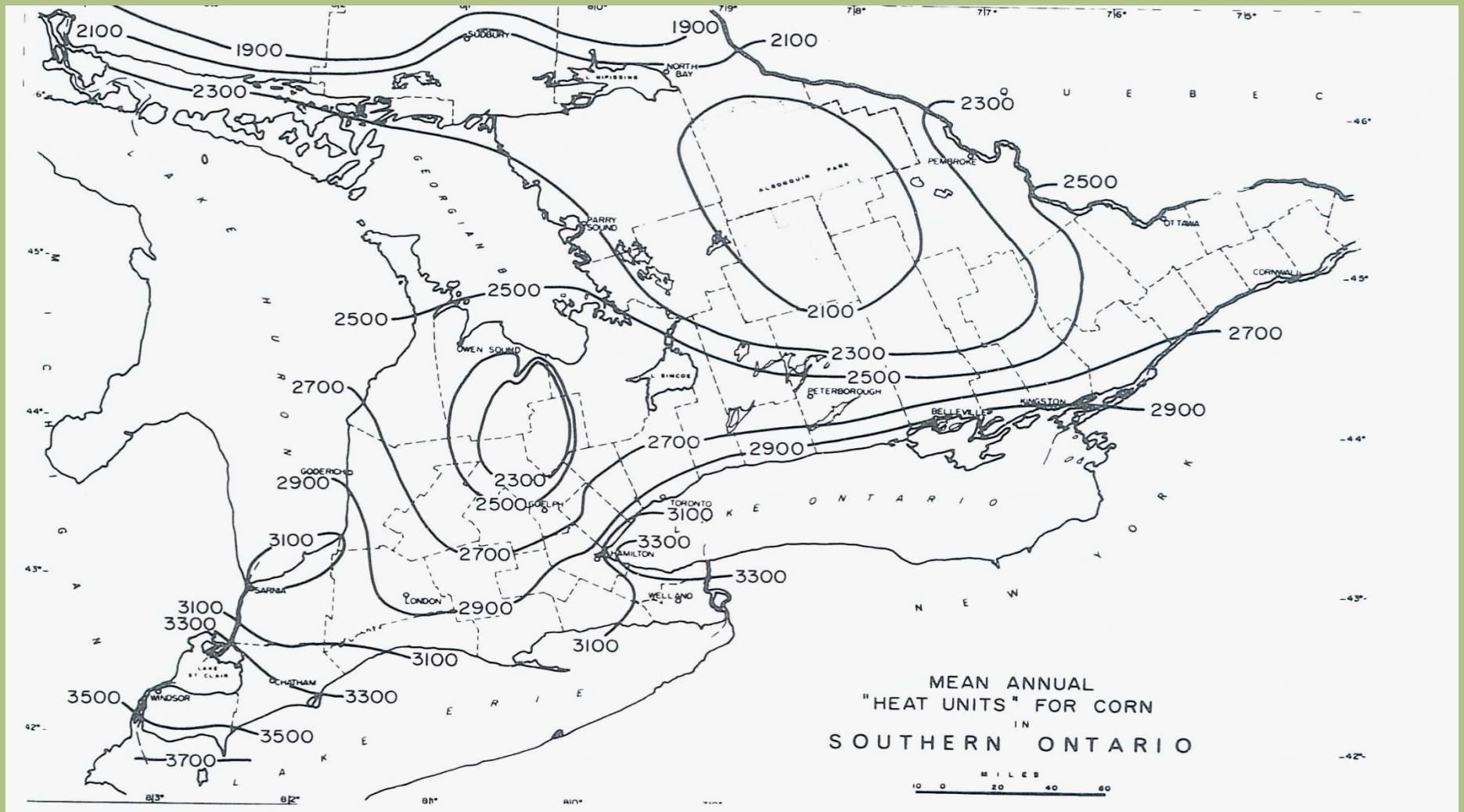


Fig. 4 Mean annual corn heat units (CHU) accumulated for the frost-free season in southern Ontario. (Based on a frost risk of 10% in the fall.)

Conditions to grow hazelnuts (cont.)

- Frost-free period 150 days,
- Average temperature for growing season 16.7°C,
- Corn heat units >2500,
- Tissue hardiness.

Lowest surviving temperatures of *Corylus* tissues without artificial hardening

Tissue	Temperature (°C)
Catkins	-15 to -35
Cortex (Bark)	-25 to -40
Xylem	-20 to -30
Vegetative buds	-20 to <-40
Female flowers	-15 to <-40

Source: Hummer et al., 1989.

Lowest surviving temperatures of *Corylus* tissues subjected to artificial hardening (potential)

Tissue	Temperature (°C)
Cortex (Bark)	-34 to -40
Xylem	-30 to -36
Vegetative buds	-26 to -40
Female flowers	-32 to -45

Source: Hummer et al., 1989

Ratings of winter tissue damage

- pith ≤ xylem ≤ cambium ≤ cortex (bark),
- female flowers,
  - very winter hardy (up to -45°C)
  - dormancy is not requirement for cold hardiness
  - damaged styles: replaced with functional tissue

Ratings of winter catkin damage

- scale 1 to 4:

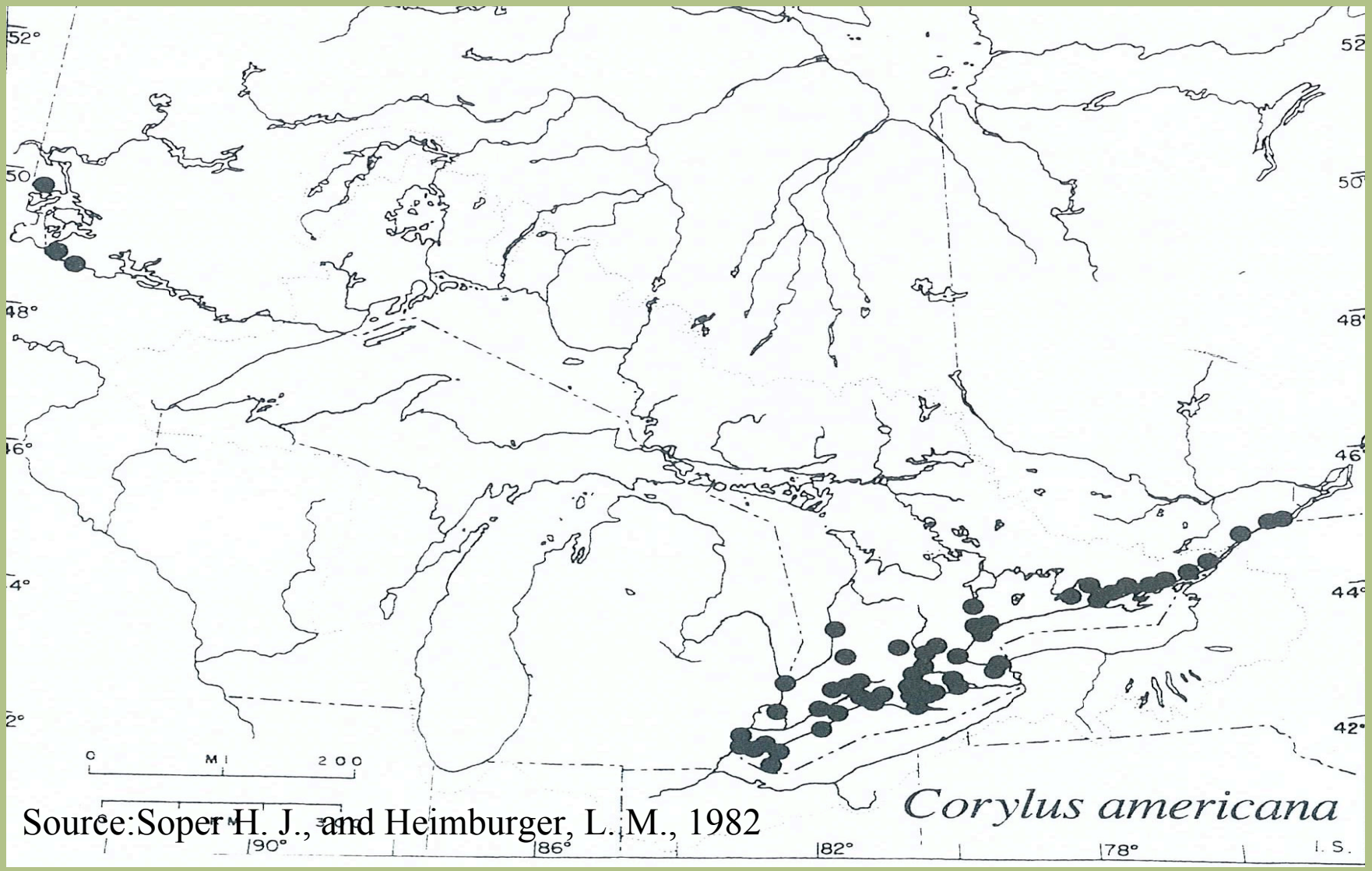
  1 low injury - shed pollen

  2 moderate injury - shed pollen

  3 & 4 severe catkin freezing – no pollen shed
- pollen very winter hardy (up to -40°C)

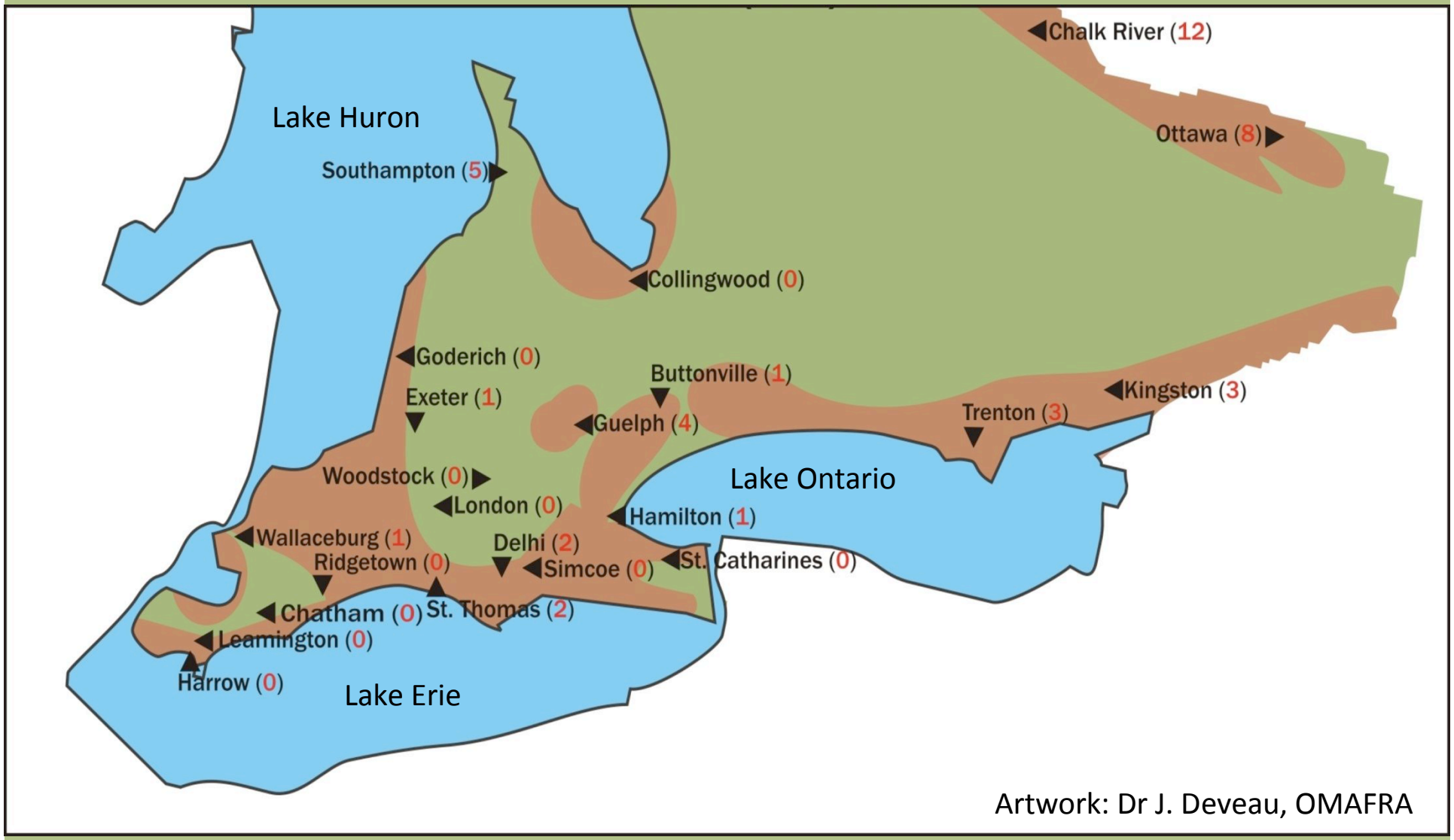

100 ml
PYREX®
USA
No. 1000
BUTLER (rep2)

Corylus americana geographic distribution in Ontario

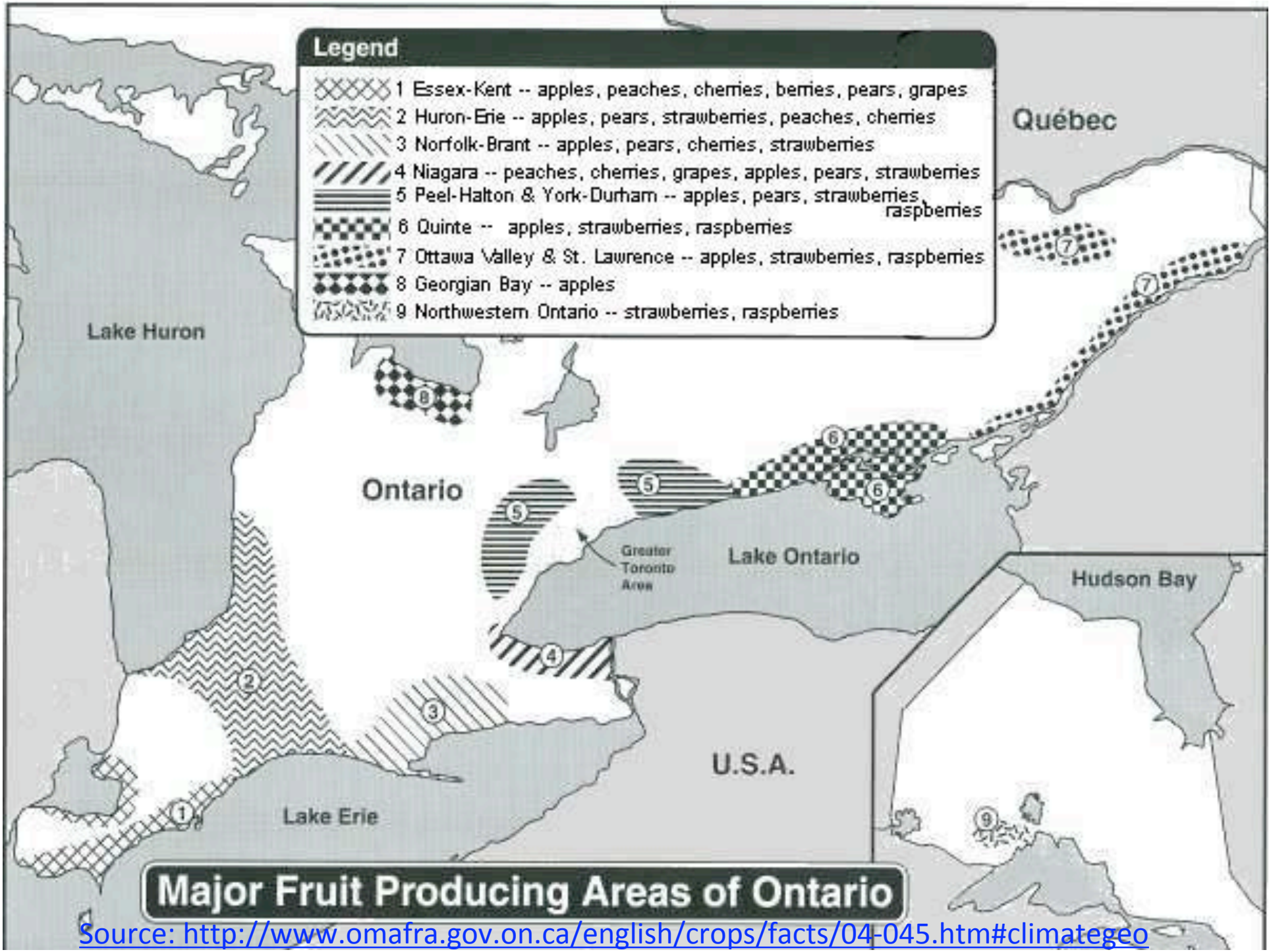


Source:Soper H. J., and Heimburger, L. M., 1982

South Ontario (1990-2010)

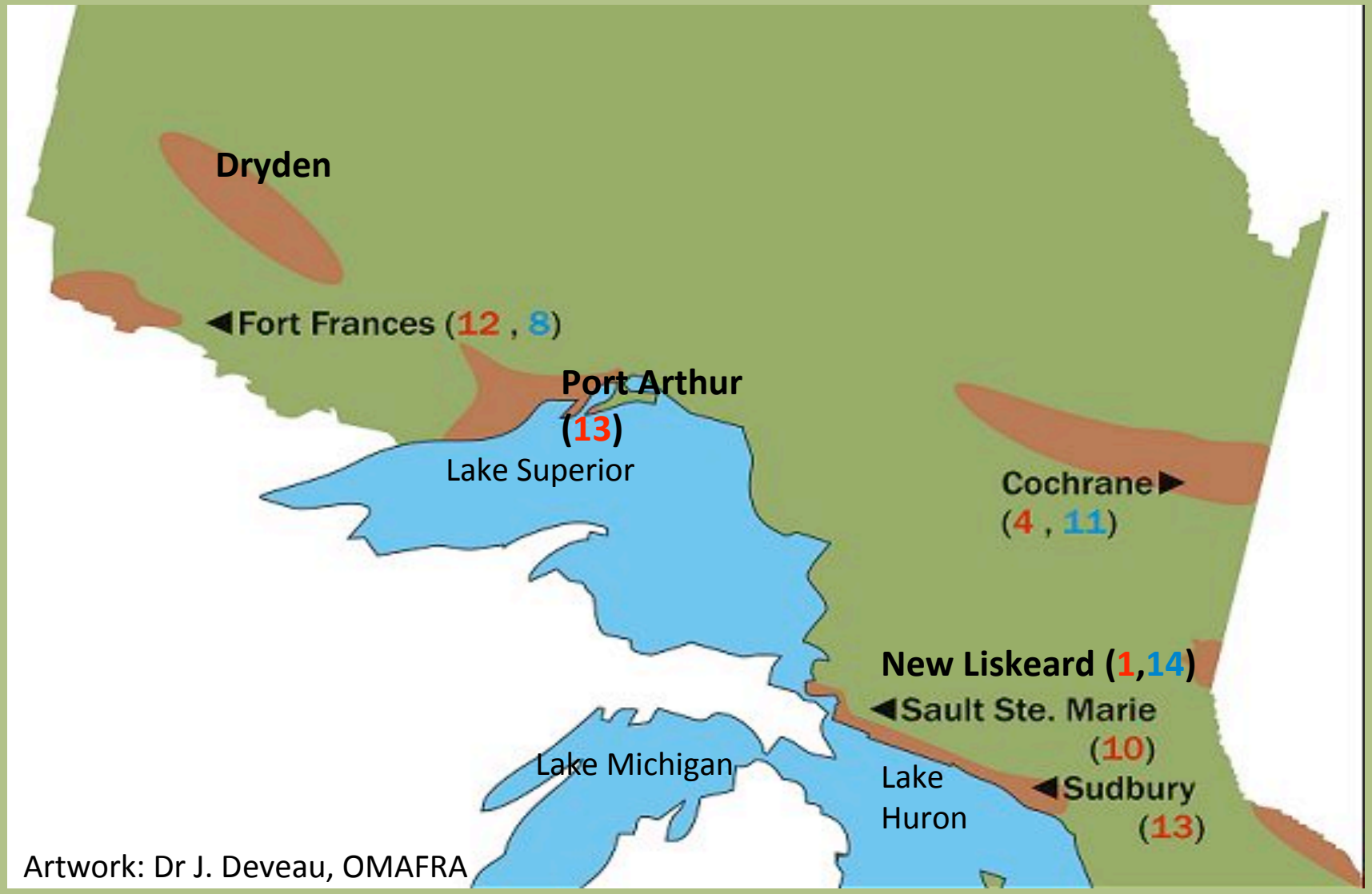


Artwork: Dr J. Deveau, OMAFRA



Source: http://www.omafra.gov.on.ca/english/crops/facts/04-045.htm#climategeo

North Ontario (1990- 2010)



Artwork: Dr J. Deveau, OMAFRA

Minimum temperature with frequencies 1990-2010

Location	Years 1990-2010	Minimum temp. (°C)	Frequency -30°C to -40°C
Goderich	20	-24.2	0
Simcoe	20	-26.7	0
London	20	-27.1	0
Ridgetown	20	-29.0	0
Woodstock	20	-29.0	0
Exeter	20	-30.0	1
Delhi	20	-30.4	2
Brantford	20	-30.0	3
Southampton	13	-35.0	5

Minimum temperature with frequencies 1990-2010 (cont.)

Location	Years 1990-2010	Minimum temp. (°C)	Frequency -30°C to -40°C
St. Catharines	20	-23.8	0
Collingwood	16	-28.1	0
Hamilton	20	-30.0	1
Kingston	20	-32.0	3
Ottawa	20	-33.1	8
Chalk River	15	-35.0	12
Trenton	20	-35.1	3
Buttonville	20	-35.2	1
Morrisburg	20	-38.5	9

Minimum temperature with frequencies 1990-2010 (cont.)

Location	Years 1990-2010	Minimum temp.	Frequency -30°C to -40°C	Frequency <-40°C
Port Arthur	20	-37.2	13	0
Sault Ste Marrie	16	-37.3	10	0
Sudbury	20	-38.0	13	0
Fort Frances	20	-45.0	12	8
New Liskeard	15	-45.0	1	14
Cochrane	15	-47.0	4	11

Summary

- Soil type,
  - moist loam to sandy loam soils with good aeration,
  - soil pH 6 to 7,
- Harvesting requirements,
  - wet soils hold machinery at harvest.

Summary (cont.)

- Temperature
  - less then 1 in 15 years with temperature -40°C and below,
  - no more then 1 in 15 years with temperature -30°C for selected variety.