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Historical trends in the risk of spring frost damages to fruit trees in Eastern Canada



Budong Qian¹, Denise Neilsen¹,
Gaétan Bourgeois¹, Xuebin Zhang²

¹ Agriculture and Agri-Food Canada

² Environment Canada

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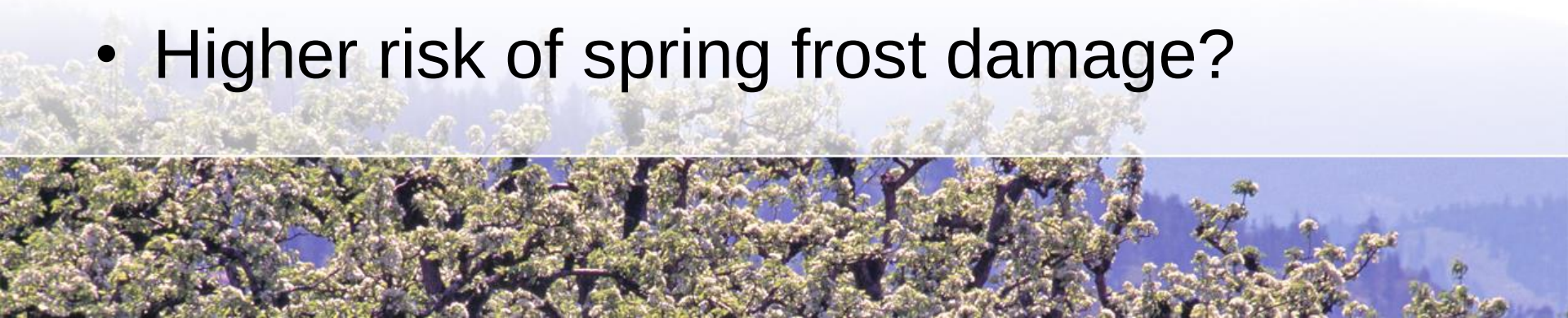
Outline

- Introduction
- Data and Methods
- Results
- Conclusions

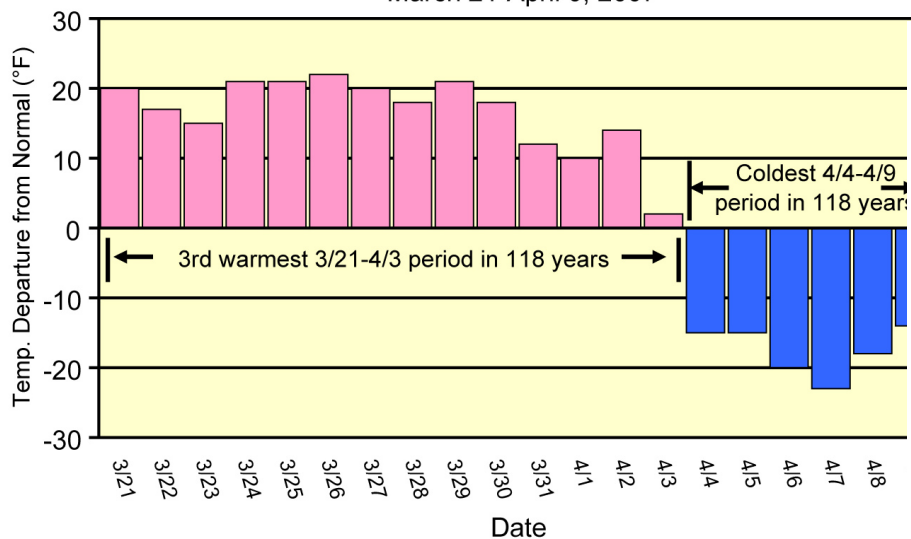


Introduction - Overview

- Global warming
- Earlier start of growing season
- Experiences in recent years (e.g., 2007, 2012)
- Increasing climatic variability?
- More climate extremes?
- Higher risk of spring frost damage?



Columbia, Missouri Daily Temperature Departure from Normal March 21-April 9, 2007



POSTED TORONTO

As weather warms, Ontario's apple blossoms fade



PETER KUTTENBROUWER, NATIONAL POST STAFF | May 8, 2012 6:37 PM ET | Last Updated: May 9, 2012 11:46 AM ET
More from National Post Staff

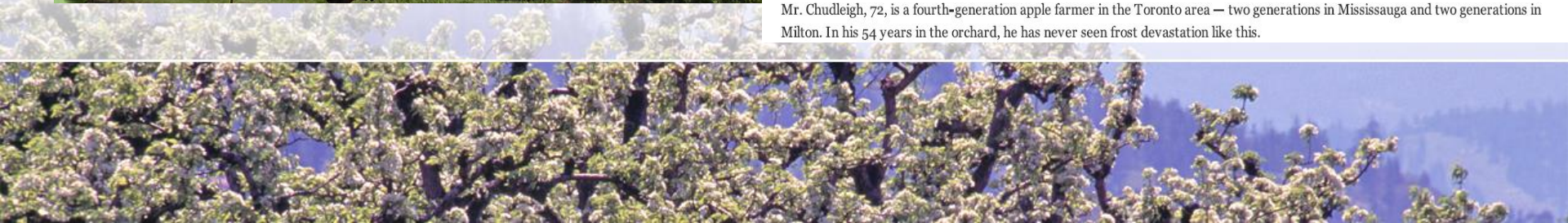


MILTON, ONTARIO, MAY 8, 2012 - Tom Chudleigh of Chudleigh's Apple Farm, poses for a portrait in the apple orchard in Milton, Ontario, Tuesday, May 8, 2012. Warmer weather in March, followed by April frost, has severely threatened this year's apple crop in southern Ontario. Tyler Anderson/National Post

When Tom Chudleigh awoke at 5:45 a.m. on April 28 at his orchard in Milton, about 65 kilometres west of Toronto, and saw his thermometer stuck at -5 degrees C, he knew he had a problem:

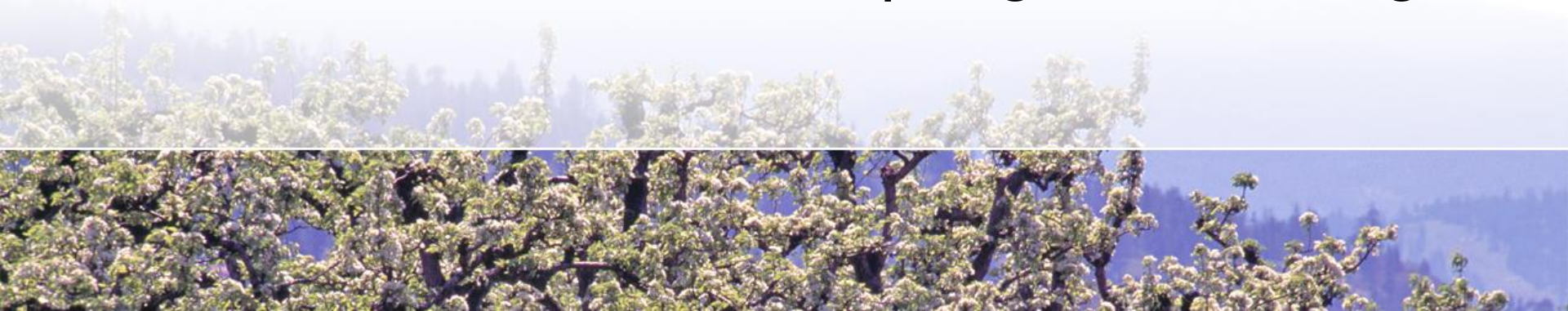
"The blossoms had three nights in a row of temperatures that they should not have been able to take."

Mr. Chudleigh, 72, is a fourth-generation apple farmer in the Toronto area — two generations in Mississauga and two generations in Milton. In his 54 years in the orchard, he has never seen frost devastation like this.



Introduction - Concerns

- Historical trends of spring frost damages
- Lack of long-term phenology data
- Rarity of major frost damage events
- Climate projections
- Future redistribution
- Evaluate future risk of spring frost damage



Data and Methods

- Daily maximum and minimum temperatures
- Homogenized data from 1890s to 2012
- Station data with missing
- Better coverage in Ontario than in Quebec



Data and Methods (*cont.*)

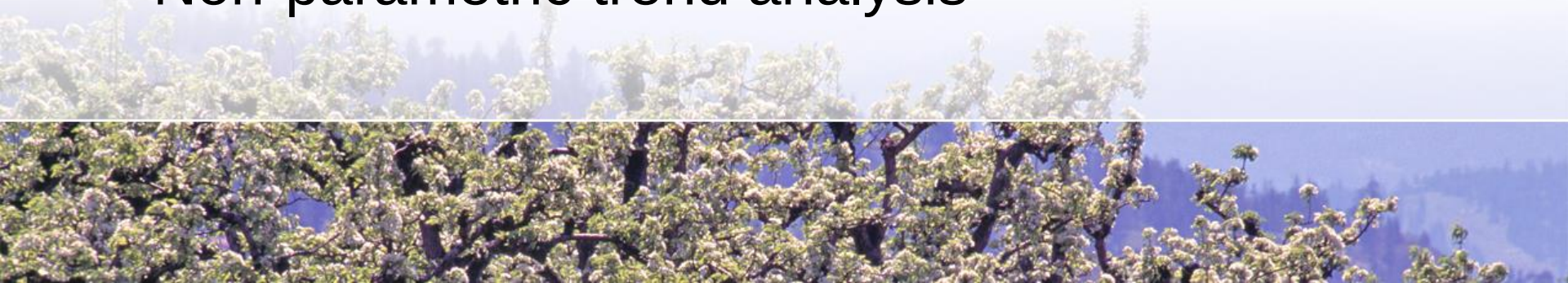
- Modeling spring phenology of apple trees*
- Temperature effectiveness curves for chilling
- Temperature effectiveness curves for forcing
- Curves based on lab experiments and validated with field experimental data
- Using the WAVE model to estimate hourly temperatures

*Neilsen, D., et al., **2014**. Development of chilling and forcing relationships for modeling spring phenology of apple and sweet cherry (to be published)

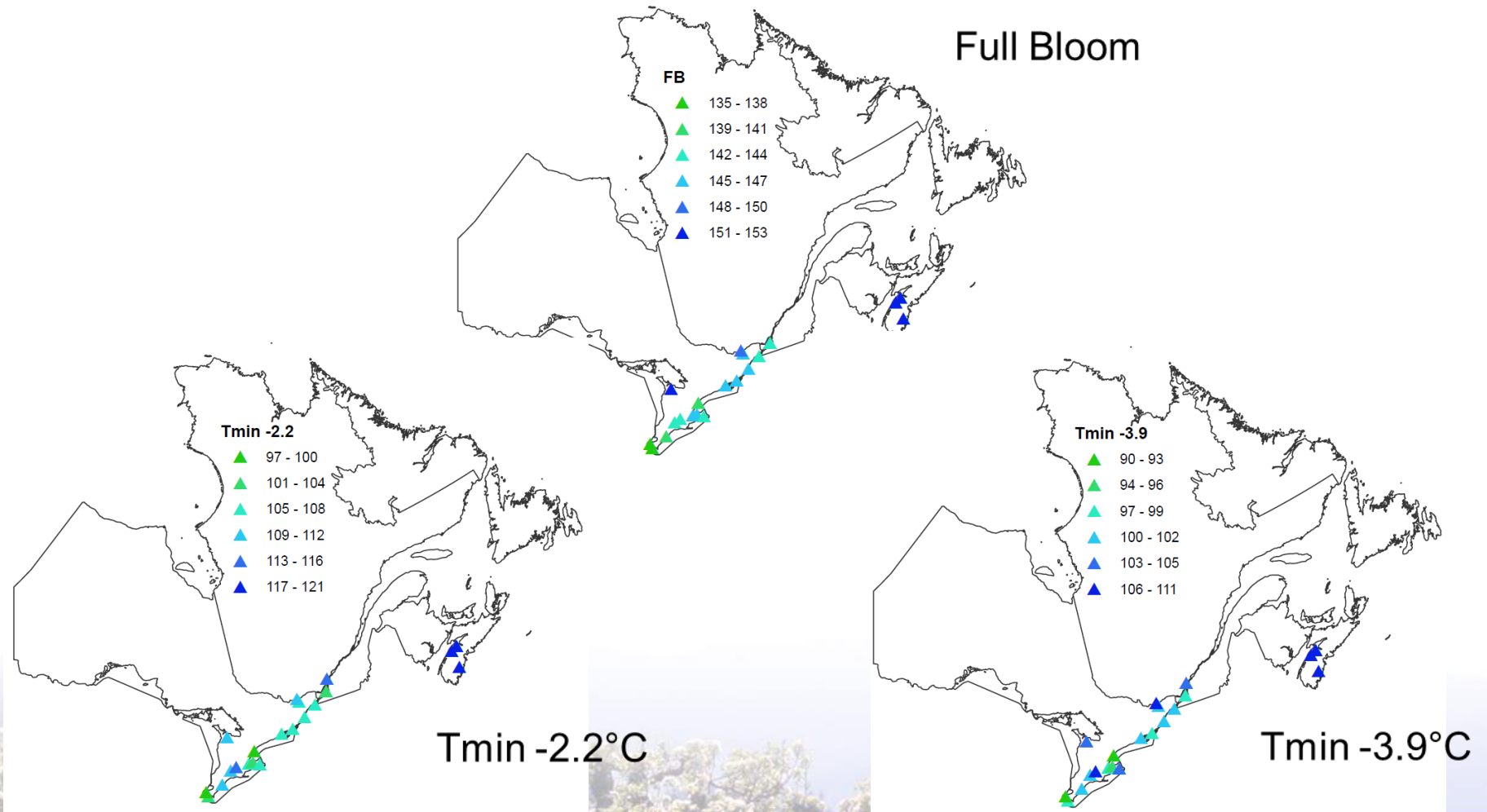


Data and Methods (*cont.*)

- Long time series of modeled dates of spring phenological stages
- Bud break (green tip), $\frac{1}{2}$ inch green, tight cluster, first pink, full pink, first bloom and full bloom
- Critical low temperature for 10% and 90% kill of buds at different stages
- Non-parametric trend analysis



Results (1971-2000 normal)



Results (*Trends 1902-2012*)



Full Bloom



Tmin -2.2°C

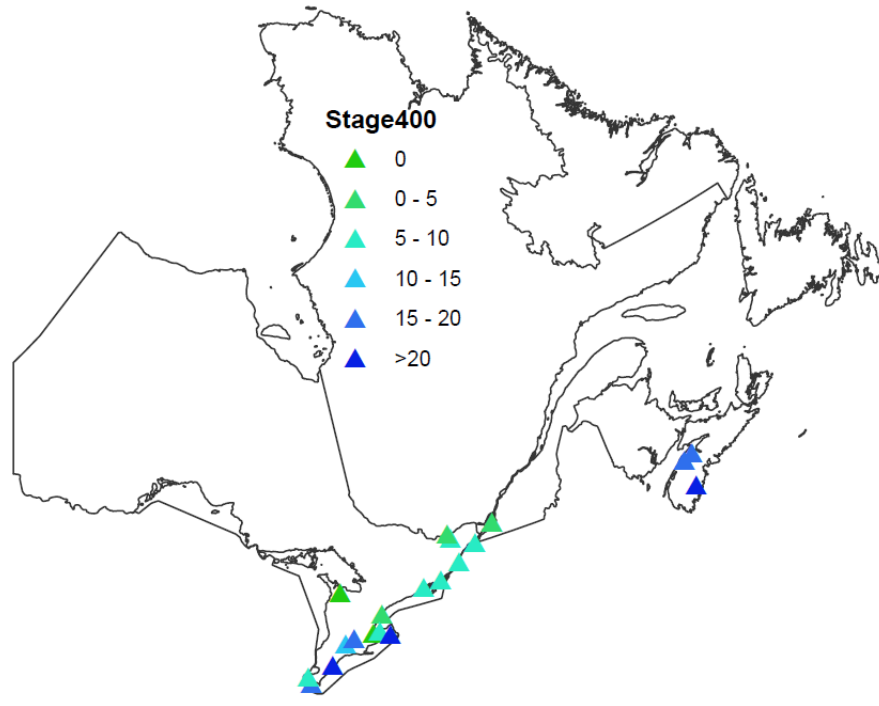


Tmin -3.9°C

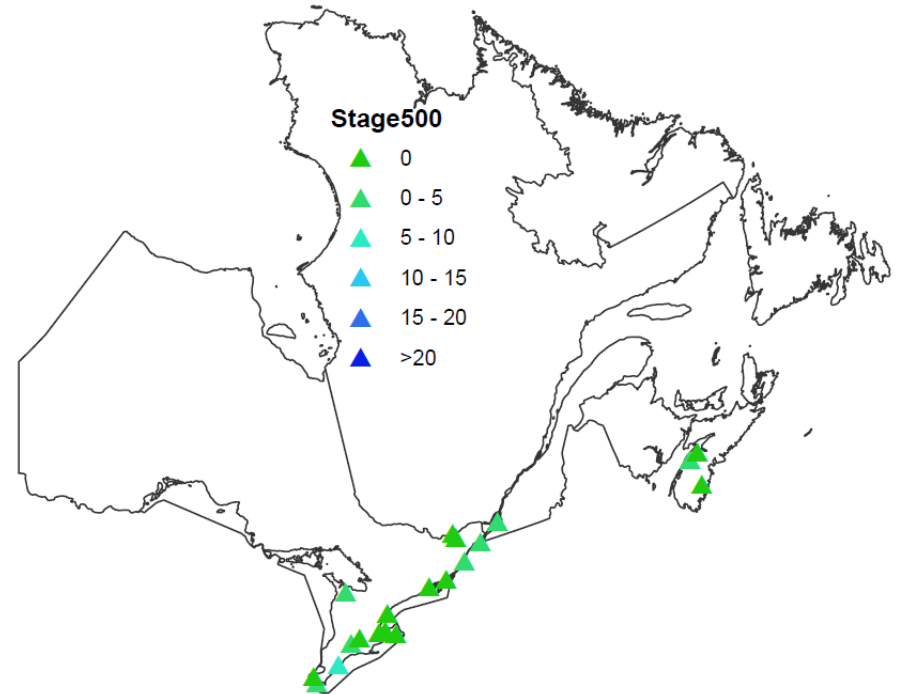


Results (*Risk 1971-2000*)

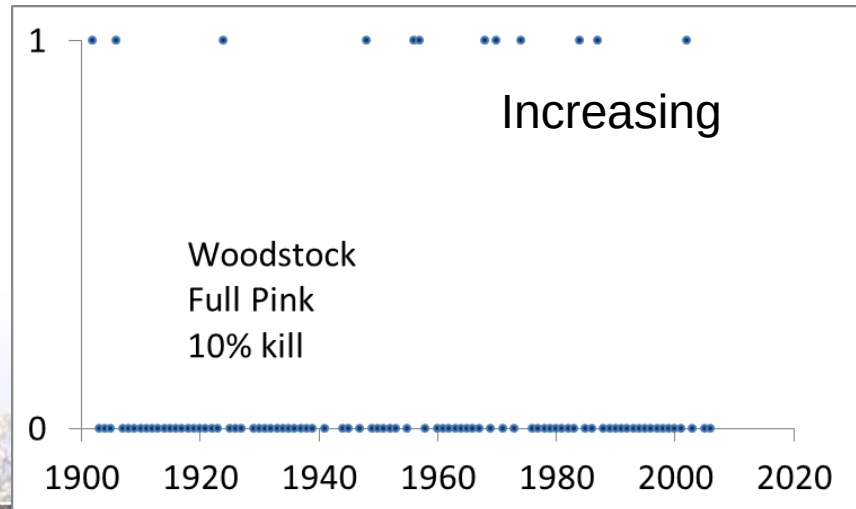
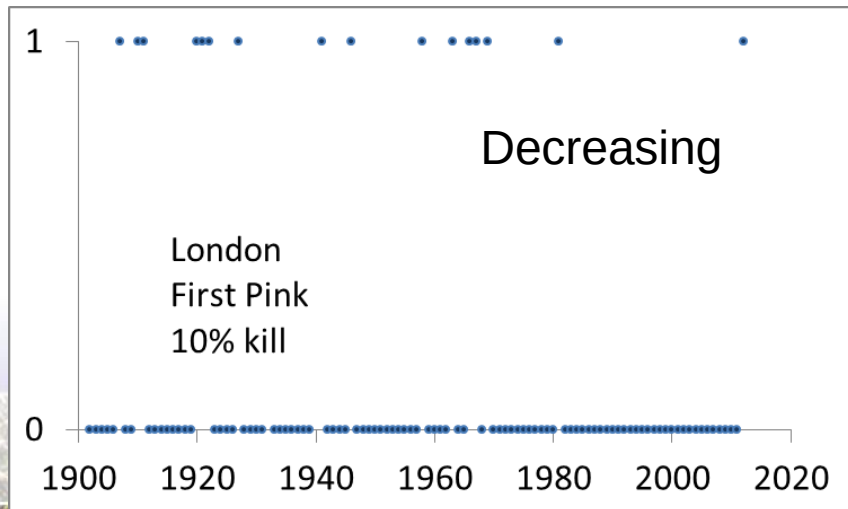
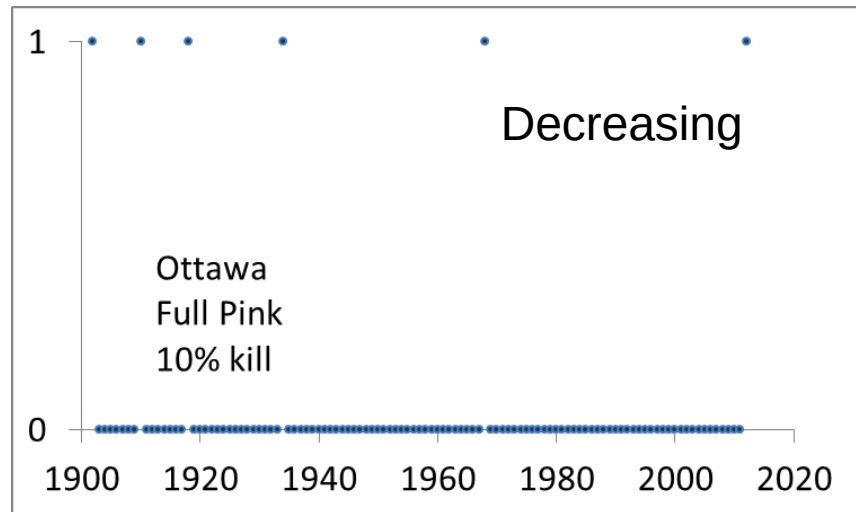
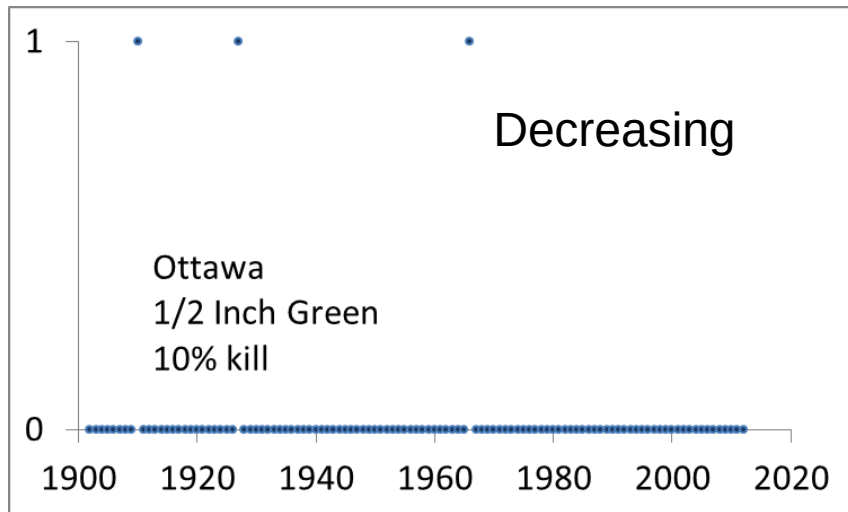
10% kill at Tight Cluster



90% kill at First Pink

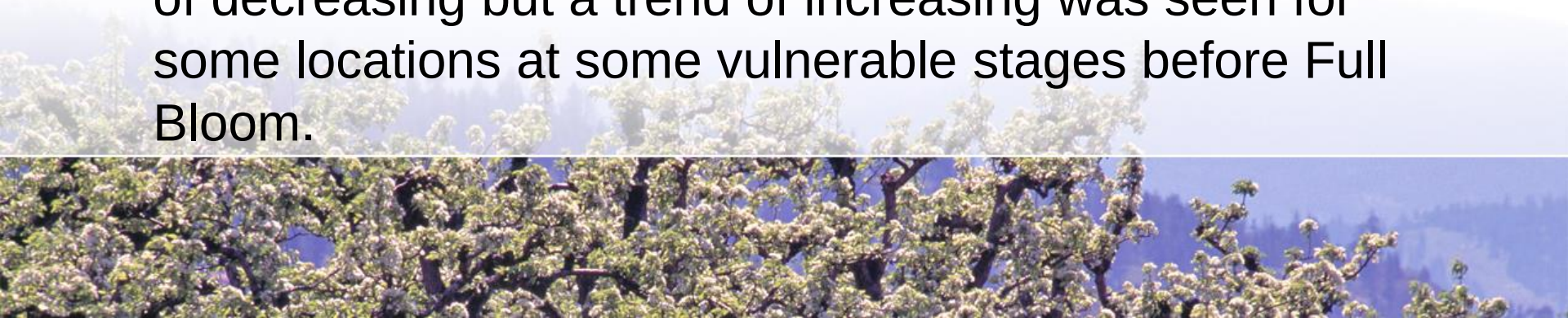


Results (*Risk Trend*)



Conclusions

- Spring phenology of apple trees has advanced by 8 – 10 days in the last 110 years in Eastern Canada.
- Last spring occurrences of critical low temperatures causing frost damages were also observed earlier by more than 10 days.
- Risk of 90% kill was very low and it was difficult to assess its trend.
- Risk of 10% kill was low to moderate with mostly a trend of decreasing but a trend of increasing was seen for some locations at some vulnerable stages before Full Bloom.





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Thank you!

For more information, please contact:
Budong.Qian@agr.gc.ca

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