



UNIVERSITY  
of NEW HAMPSHIRE



# What Did A 7-Year Study of Maples Find?

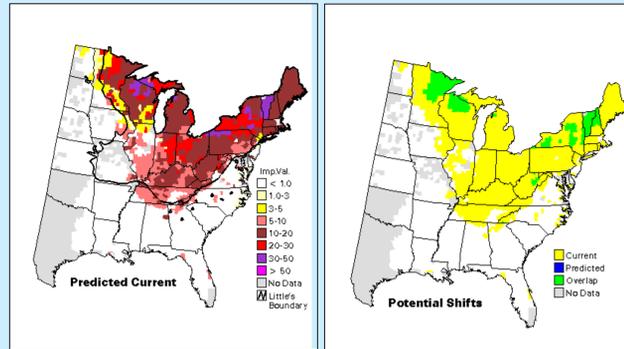
## Martha Carlson



Sugar producers from left: Jackie Hunter Rollins, Bill Eva, Hank Peterson, the Hunter family, Brian Folsom, Hank Parker, Russ Lampron. Citizen scientists played a key role in this study.



### Alarms in the Sugar Bush



The U.S. Forest Service Climate Change Tree Atlas, building on 5 global climate change models (Iverson and Prasad 1999-ongoing), projects sugar maples will lose 88% to 100% of its range by 2100.

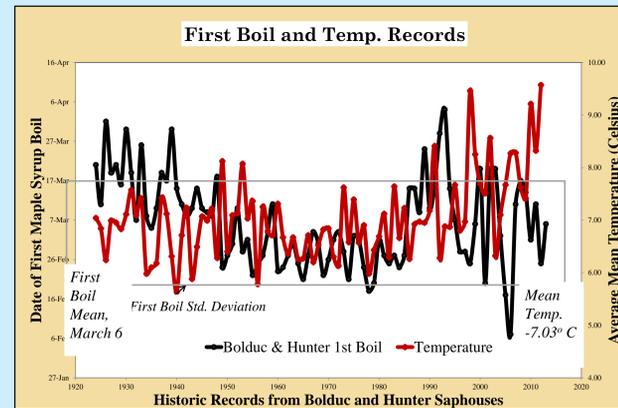


Figure 2. The start of the sugar season has become more erratic in recent years.

What caused dark maple syrup in 2009? Why is maple sap less sweet than it was 100 years ago? Why do some maple leaves turn brown and fall off in August? How did wild fires in Quebec cause the 2010 defoliation of maple trees in West Campton?

Since 2007, I have been monitoring sugar maples on my farm in Sandwich, NH, and on a dozen other farms in the State. I want to understand the alarms in my sugar bush. Maybe I can help my sugar maples.

### Major Findings

**Finding #1.** Some stress is normal.

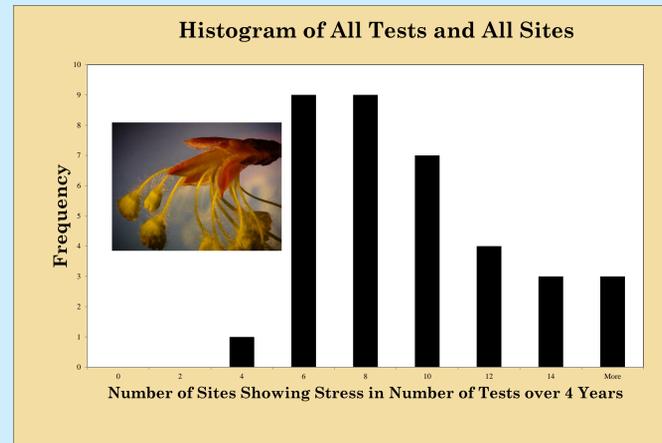


Figure 3. Tested 18 different ways, most trees showed some signs of stress at least 6 to 8 times. In 2011, the flowering year, almost all trees had smaller leaves, less chlorophyll, less water and more vanillin than average.

**Finding #2.** Damage and differences in damage can be identified and linked to probable causes—each year.



Figure 4. Record hot temperatures in 2012 correlate with water stress and early death of leaves in 2012. The leaves on stressed trees were dull in color, dry in texture and covered with fungi and insect damage.

### Next Step: MAPLE WATCH --

The sugar maple in the school yard is the perfect subject for studies of science, technology, engineering and math. Together, schools and sugar makers could conduct authentic long term research. If you would like to help with Maple Watch, please contact Martha Carlson at [martha.carlson@unh.edu](mailto:martha.carlson@unh.edu)



**Finding #3.** During the most stressful year, 2012, the growing season was reduced 8 to 20%.

Highly stressed trees had 40 to 50 fewer days to make sugar than healthy trees. Does a shorter growing season explain the drop in sap sugar content?

Less sugar means less sugar for growth of the tree, less lignin to stiffen wood, less sugar for winter storage, less sugar for protective phenolics.

Waxy cuticles are made of vanillin, a phenolic. Phenolics are made of sugar.

If a tree loses its leaves 40 days earlier than it should, what are the consequences? could the tree enter a spiral of stress and damage?

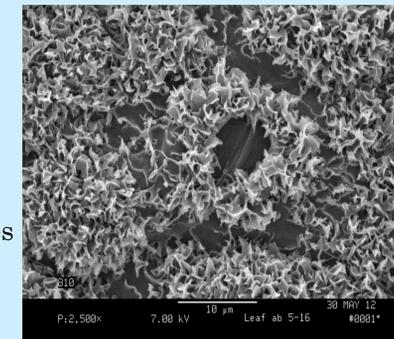


Figure 5. Infant leaves lack stomates or waxy cuticles. Those are formed in June. This scanning electron microscope shows a developing stomata and emerging leaves of wax.

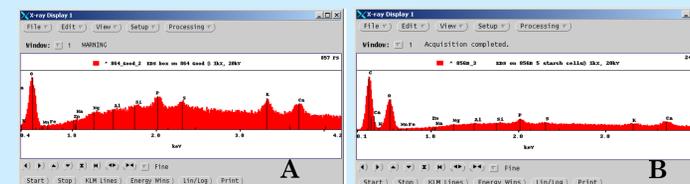


Figure 6. A slow long foliage season gives the maple tree time to dismantle valuable pigments and proteins in the leaf. When leaves drop off in August, as in B, the tree has no time to preserve and store these vital nutrients. Sample A has significantly more phosphorous (P), magnesium (Mg), sulfur (S), and calcium (Ca) than the stressed Sample B.

**Finding #4.** The sugar maple is “complacent”: Even under stress, it maintains essentials of health:

- Ample water content in leaves.
- Usual leaf size.
- High quality buds.



Dry or wilting leaves in June and July, small leaves or deformed leaves, and dead or deformed buds are a clear indication that a maple tree is in severe distress. Such a tree has probably sustained numerous stresses.

**Finding #5.** What makes the sap go up the tree? Sugar.

A long slow fall gives trees time to store sugar in every twig, packed densely around each bud. These sugars help protect the bud during the winter and create an osmotic differential between watery root sap and sweet twig sap. Water rushes up the tree to dilute the sugar—giving healthy trees strong runs of sap.



Figure 7. A twig from a healthy tree shows embryonic leaves within the bud. Stained blue with iodine, dense stores of starch will protect the bud and help create a strong sap run next spring.

### Acknowledgements

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