Special Letter to Forest Watch Teachers and Students

February 2013

Dear Forest Watch Students and Teachers,

Congratulations! You have helped us make a discovery.

In the past two years, everyone in northern New England has noticed that white pines are shedding their older needles. Wind rows of needles piled up along sidewalks, roadways, and under pines. Hundreds of citizens called their Extension Service offices with questions:

- Why are the white pines shedding so many of their needles?
- Is this normal or unusual?

Thanks to your diligent and careful observations over the past 20 years, Forest Watch can answer the second question. Yes, this is really unusual. White pines usually retain their needles for two or three full years. Those needles usually are healthy green needles that contribute significantly to the photosynthetic process by the whole pine tree. White pines can grow half a meter a year in height and add 1 or 2 centimeters in new wood because first, second and third-year needles all make sugar throughout the year.

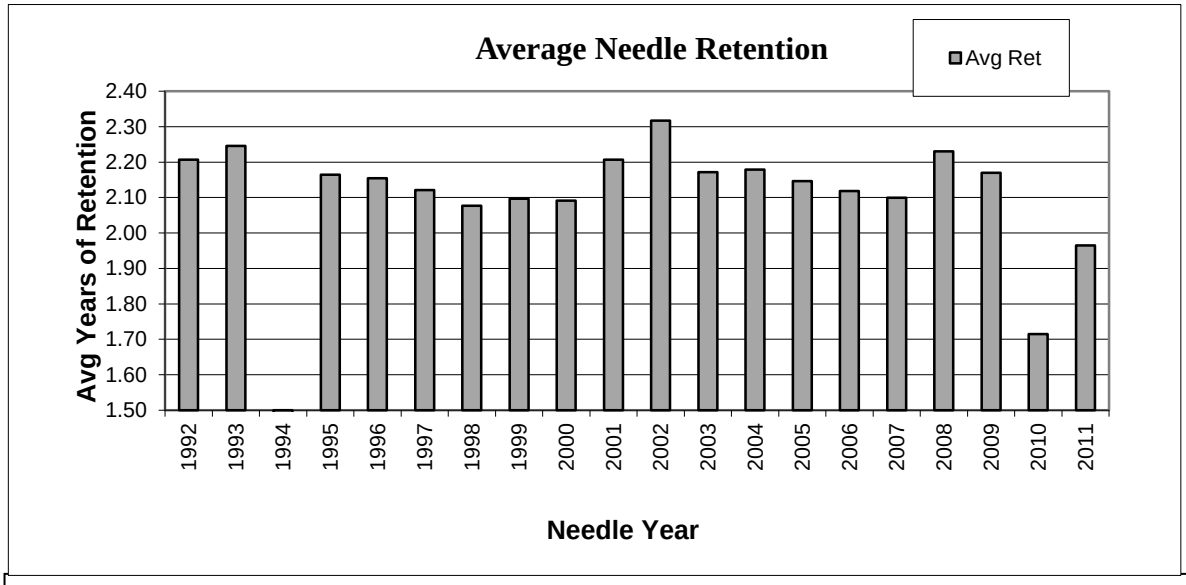

Figure 1: Average needle retention of trees in 2011 was 1.905, meaning that most schools saw some second-year needles along with current-year needles.

Your research finds that needle retention changed dramatically in 2010 (Figure 1 above). As can be seen from the Figure, that year was the first and only time older needles were not retained! Needle retention is a bit better this year (2011 collections) but still far below the average of all Forest Watch school measurements since 1992.

The Forest Watch measurement of needle retention is one of the most basic and perhaps the simplest measurement students and teachers make. When we started Forest Watch, we wanted to include a measurement that every student of any age could make and make well. Are there any second-year needles on the twig? Yes or No? Are there any third-year needles on the twig? Yes or No? Whether a twig had 10 or 100 needles on a third-year segment, that tree was rated as a 3. As Figure 1 shows, the ratings of 1, 2, and 3, with even an occasional 4, gave us a 20-year average that was well over 2.0.

In 2010, needle retention fell to 1.7. Many needles fell off the trees in June 2010 just as the new 2010 needles were expanding. It was the 2008 and 2009 needles that were cast. This year, you report that needle retention has improved somewhat but, at 1.94, it is still below 2.0. In northern portions of the region, schools are finding needle retention only at 1.0. All 2009 and 2010 needles were cast in the 2011-2012 school year.

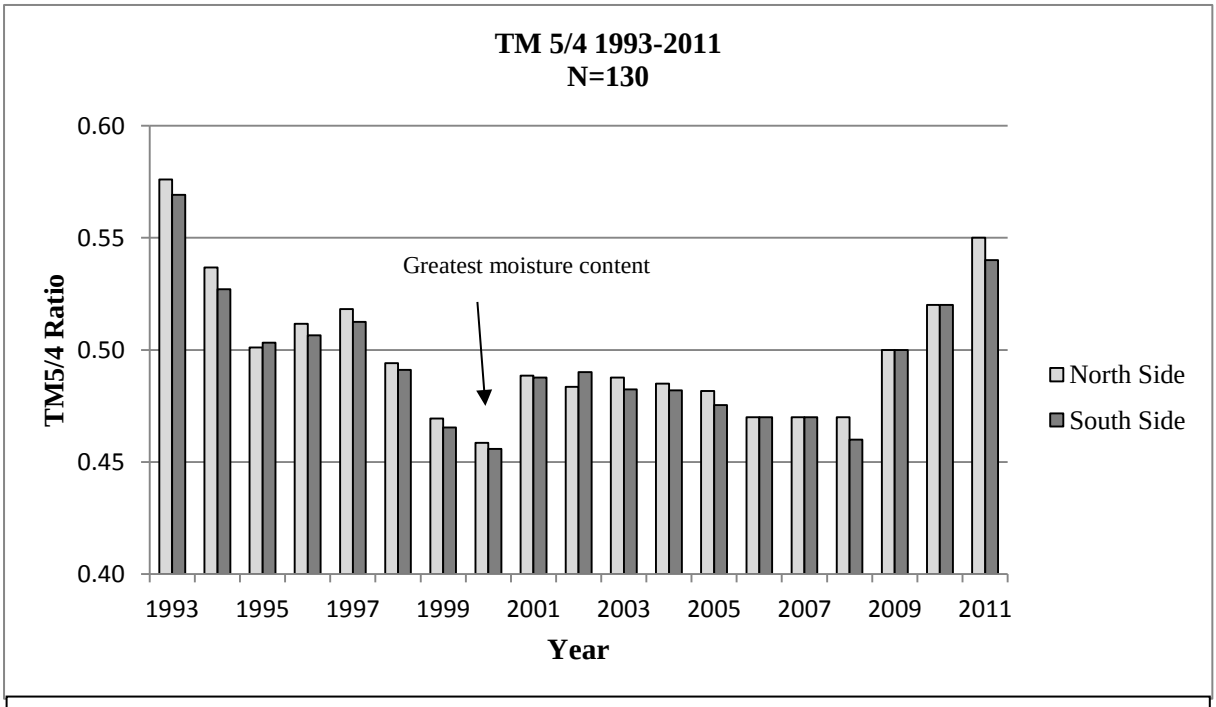

Figure 2: Water stress is apparent in the 2011 average TM5/4 ratio. At 0.55, the index is higher than at any time since 1993.

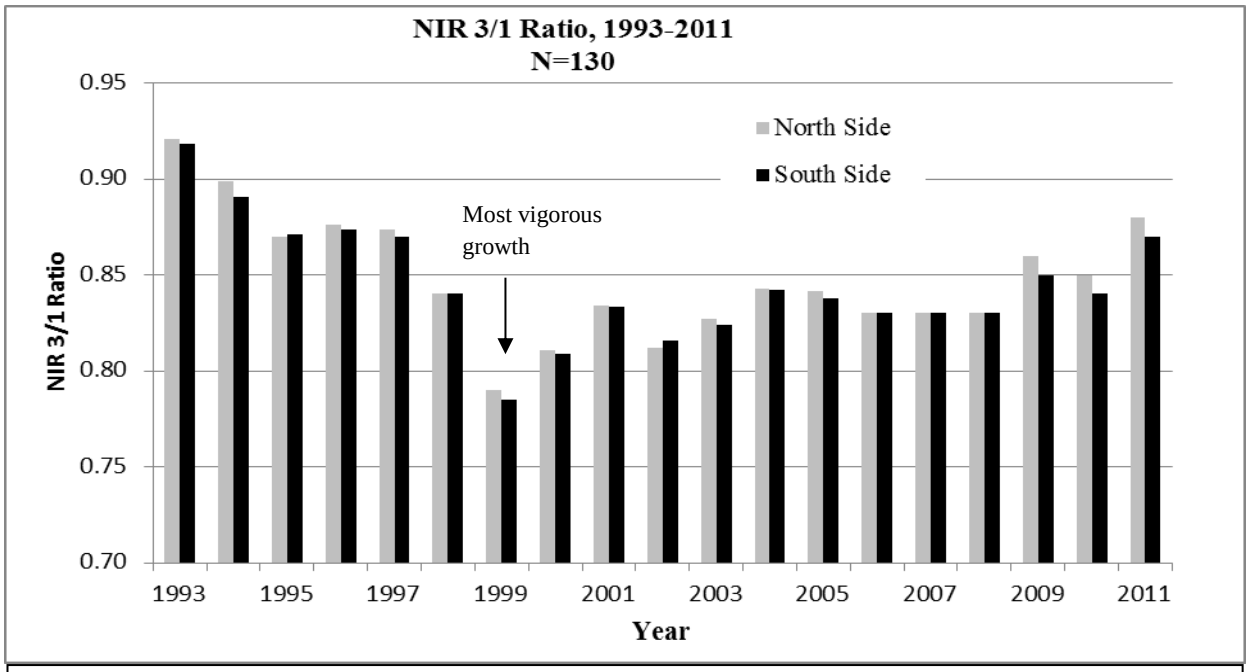

Figure 3: NIR 3/1 ratios are an indicator of cell maturity or senescence. 2011 1st year needles show unusually high NIR3/1 ratios.

Our measurement turns out to be immensely important. Yes, the needle cast that is occurring is not at all usual. That brings us back to the first question: Why did this happen in 2010 and to a lesser extent in 2011?

Forest Watch research provides some intriguing clues about why the needles are being cast. This year, for the first time since 1993, spectral measures of new first-year needles show signs of moisture stress when the 5/4 TM band ratios of these new needles are compared with previous years. Remember, in white pine, 5/4 ratio values above 0.50 are an indication of low water content of the needles.

In another test (Figure 3), 2009-2011 needles show signs of premature aging, Figure 3 indicates that in the early years of Forest Watch (1993-1997) similar pre-mature aging was indicated by the NIR 3/1 ratio measurement. Six years after Forest Watch started, in 1998, this ratio value dropped below 0.85 for the first time and remained below that value until 2009. Using the NIR 3/1 ratio, the lower the value (such as in 1999) means more active and vigorous growth, while a ratio value above 0.90 means slower, less vigorous growth, approaching senescence.

When we collect pine needles either in the Fall or the Spring, the current-year needles studied are in a condition typical of the end of their first growing season. We might surmise that high ozone levels in the early 1990s caused premature aging. Then in the late 1990s, as the Clean Air Act took effect, ozone levels fell and needles maintained vigorous growth longer.

Why would NIR3/1 ratios be rising now? Thanks to Forest Watch careful sampling of pine foliage, we can see a change over time in the pines' health. Something very serious is stressing them. Not since the early to mid-1990s, when ozone levels were extremely high, have we seen these kinds of measurements of stress.

Your reports, samples and measurements indicate that some new stressor is present in our environment. That stressor appeared in spring 2010 and continues to be present. It is stressing new needles that opened in 2010, in 2011 and now in 2012.

Various theories point to possible causes. We observed an air pollution event in May 2010 which defoliated sugar maples. We believe that peroxyacetyl nitrate (PAN), a powerful oxidant produced by wild fire smoke from Canada in combination with unusually high temperatures, might have heavily damaged those leaves. PAN might also have stressed the pines. And other pollutants from a growing number of wild fires might be stressing the pines.

Another theory is that unusually wet weather in 2009 released a population explosion of fungi which are clearly now feasting on the pine needles. In 2010 and 2011, the US Forest Service reported a new occurrence of pine needle cast fungi on the older needles. We are now working with the Forest Service to try to understand what is causing the dramatic increase in reported cases of needle cast fungus. Such fungi normally only attack needles that have been weakened by some other factor. And the fungi usually only damage a small percentage of the needles, not the large percentages we are seeing.

Recently, we find strange orange blisters on needles you submitted in the fall of 2012. We also are beginning to see a loss of chlorophyll in first year needles that expanded in the Spring of 2012. Forest Watch teachers, students and other citizen scientists who observe and report these unusual changes in white pine health are making an important contribution to science.

You can learn more about our recent findings in this year's Data Book.

Forest Watch and our long term study of the pines, our careful protocols for measuring and sampling, will help us test these theories and find the answers. Our research is now more important than ever. Now is a wonderful time to be doing Forest Watch together!

Congratulations! You are participating in a true scientific study. And your findings are revealing important answers to big questions.

Let's keep working together,
Proudly,

Dr. Barrett Rock, Founder and Director Martha Carlson, Coordinator