EXPANDING TREES: DIAMETER GROWTH IN SUGAR MAPLES *Reprinted from Farming, the Journal of Northeast Agriculture. September, 2011*

In Vermont, the first few months of the 2011 growing season have been characterized by above-normal rainfall; inconvenient for many farmers and homeowners, but resulting in excellent conditions for sugar maple growth. While growth in young trees means gaining height as well as girth, in a mature sugarbush most trees that are tapped have reached the canopy and their growth is characterized less by height extension and more by broadening of the crown and expansion of the trunk. Yearly growth rings add layers of wood that close tapholes and make possible continuous annual tapping of the same few feet of the trunk, which is critical for the sustainability of our industry. While technically the wood that heals a taphole is a wound response tissue called callus, it is correct to say that diameter growth is closely related to taphole closure.

Yearly growth rings in sugar maple are a permanent record of increasing diameter of each tree, and they can be sampled and measured by taking a core with an increment borer. Samples of ring widths tell us that not all trees grow at an equal rate even though they are outwardly similar, that growth can vary considerably from site to site, and that growth rate varies from year to year at any single site. Available soil moisture is one important source of the annual differences in ring widths. In the southwestern US, yearly rainfall is so variable that tree rings can be used to map the climate for hundreds of years before the present. In the northeastern US, rainfall is much less uneven; nevertheless, sugar maple ring width usually fluctuates in response to dry vs. wet growing seasons, especially in the critical months of early summer. Insect defoliation can result in dramatically narrowed rings; for example the 1988 pear thrips infestation, coupled with a hot dry summer, reduced photosynthesis in many Vermont sugar maples to the point where diameter growth in that year was miniscule. Other defoliators such as forest tent caterpillar also cause trees to use starch reserves for refoliation, and thus take away some of the materials otherwise used for wood growth.

Stand characteristics also influence growth rates. Tree density, or the amount of sunlight reaching the canopy of each sugar maple, is an important factor in determining which trees grow faster, yet researchers have noted that density is often not as important as other factors in a mature stand. Many sugarbushes are not that dissimilar in density and yet the trees have vastly different growth rates. Soil conditions, in particular the amount of soil calcium, seems to be a major influence on sugar maple growth rates, especially in a state like Vermont which has regions of both high and low calcium due to the state's complex geologic history. Based on samples I collected, some stands in enriched soils have an average growth rate that is 3 or 4 times that of other stands, despite similar tree density. Trees on high calcium soils may also be better able to withstand damage from acid rain. The sites with the slowest sugar maple growth are often not only on soils of low fertility, but also thin, or unusually wet or dry soils, and in these stands the maples are often accompanied by trees uncharacteristic of a rich maple stand, such as balsam fir. Trees at higher elevations may be growing slowly due to a combination of unfavorable soils and weather and a shorter growing season, all of which limit their ability to compete with other tree species.

Within a stand, diameter growth rate can be quite variable for no apparent reason. While influences such as logging wounds might slow the growth of individuals, I found that some trees were expanding at double or more the average rate of the stand. Superior genetics and microsite variation in soil conditions were likely explanations.

While growth rings are relatively easy to measure from an increment core, ring width is not the best measurement for comparing trees of different diameters. Basal area increment (BAI), which is used to calculate the amount of wood added to the tree girth at a certain height, is a superior measurement. BAI is determined by computing the cross sectional area of the tree and then subtracting the cross sectional area of the tree minus the width of the last ring. BAI should be relatively constant in healthy mature sugar maples, but because of their expanding diameter, the same amount of wood added each year results in progressively narrower rings. For example, a 1/8” wide ring added to a trunk 12” in diameter is almost exactly the same amount of wood as a 1/16” wide ring added to a 24” diameter trunk. Thus it is understandable that tapholes in vigorous trees 10-12” in diameter might close in a single season, compared to holes in a large tree that take longer.

What is “normal” ring width? I cored hundreds of sugar maples around the state during the 1990’s, in an effort to answer this and other questions. Many of these trees were tapped annually, although this was before the days when most trees were exposed to high vacuum sap collection. The majority of healthy mature trees had annual rings between 1/16” and 1/8” wide. Twenty five percent of the stands averaged rings wider than 1/8”, and almost all were on enriched soils, while 17% of the stands averaged rings less than 1/16” wide. There was no apparent difference between the growth rate of tapped and untapped trees, although my study was not designed to answer that question. A study currently underway at the UVM Proctor Maple Research Center, led by Dr. Abby van den Berg, is examining the growth of trees that have been tapped with high vacuum for a number of years, and results of this study should provide new information about sugar maple growth and sugaring that could influence our future tapping guideline recommendations.