HOW DEEP DO YOU TAP? *Reprinted from Farming, the Journal of Northeast Agriculture. October, 2011*

In 1967, an article written by two scientists from the USDA Forest Service was published in the Maple Syrup Digest titled *Are you tapping deep enough*? The authors argue that sap yields are maximized by holes 3 ½ inches deep below the bark, that many sugarmakers underestimate bark thickness, and that "it is doubtful that tree vigor will be greatly affected by drilling an additional inch or so." Data on sap yields for the study (and other studies performed around this time) came from gravity (bucket) sap collection, with the assistance of a paraformaldehyde pill in each taphole. Times have changed—no one uses the pill, most sap collecting is done by vacuum, and for many sugarmakers there is much more awareness about the need to minimize tapping damage. With respect to the latter, improved tapping guidelines, which have caused many producers to reduce the number of holes per tree, also take depth into consideration in order to limit internal damage to the trunk. Any wound, including a taphole, results in a permanent blockage of some of the sap conducting vessels in the wood, roughly equivalent in size to the area of the dark stain column that forms above and below the hole. Following reasonable guidelines, these areas of blockage are quite minimal in the trunk of a tree that has been tapped for many years; however, deeper tapholes result in deeper blockages, and in smaller trees several deep holes could result in the loss of a significant amount of sap conducting wood. Research performed at the UVM Proctor Maple Research Center, showed that the total stained (blocked) area of the wood was proportional to hole depth (as well as hole diameter), so that a 2 ½ inch deep hole had roughly 2/3 more stained area than a 1 ½ inch deep hole; but also that in smaller trees a deep taphole sometimes melded with a nonfunctional areas in the center of the tree to create a larger area of sapwood blockage.

When tapping trees year after year, many sugarmakers simply look for a convenient spot in the trunk that has no indication of a previous nearby taphole, and drill there. With tubing, 30 inch droplines allow the spout to be placed over a broad range of the trunk, and the chances of hitting the nonfunctional wood from an old taphole, now completely healed over and invisible on the bark, are very small. It is certainly possible to put a new taphole over an old wound, and this is much more likely to happen with a bucket collection system, as these holes tend to be at about the same height each year. Given the normal rate at which mature maple trunks expand, as discussed in a previous column, it might take 18 or more years for a taphole and its stained wood to be covered by 1 ½ inches of new wood, and twice that for a 3 inch deep hole. Thus, a deeper hole is more likely to hit an old wound. A sugarmaker who unwisely taps the same aspect (often south) each year is also much more likely to hit an old taphole wound.

While wounding can't be ignored, the reason a sugarmaker might favor a deeper taphole is to improve sap yield. It is important to understand how sap flows to the taphole (and subsequently out the spout). Although it may seem logical that cutting more of the small sap transport tubes (vessels) in the wood with a deeper hole (and larger diameter hole) would yield more sap, research has shown that sap moves to the taphole from more than just those vessels that are cut by the drill. This movement of sap is the result of the design of the transport vessels, which are very short and have many horizontal as well as vertical connections to other vessels, and because of large pressure differentials between the inside and outside of the tree. The greatest pressure differentials occur at the start of a sap run when the inside of the tree is far above atmospheric pressure, and when the spout is connected to a vacuum system, and the tubing is far below atmospheric pressure. Under these conditions, sap can move in all directions toward a small hole in the trunk. A good example of this comes from an experiment at the Proctor Center. Tapholes in a number

of trees were drilled to a depth of either 1 ½ inches (including the bark thickness) or ¾ inches. The trees were no bigger than 12 inches dbh and had thin bark. A standard 5/16 inch spout was placed in each hole and the depth to which the spout tip penetrated was measured—it was about ½ inch. Thus the ¾ inch hole was mostly filled with the spout tip. The average sap yields, using high vacuum, were 33 gallons per hole for the deeper holes (a very good yield) and 22 gallons per hole from the shallower holes, where there was only a very small space beyond the spout tip into which the sap could flow.

There is little information currently available that compares tapping depth with sap yields, especially in modern vacuum systems. In an older experiment from the Proctor Center using buckets, 2 ½ inch deep holes yielded only slightly more sap than 1 ½ deep holes, using either 7/16 or 5/16 spouts. As described in my July column, Vermont producers in a 2011 survey reported their tapping depth and the majority—both vacuum and gravity sap collectors—claimed to limit depth to less than 2 inches, including the bark. I don't know if this was measured, or just estimated, but the practice of slipping a piece of 5/16 inch tubing over the drill bit to act as a depth stop has made hole depth very consistent for its practitioners. Only 35% producers in my survey collecting sap via gravity (buckets or tubing) and 17% using vacuum reported drilling even as deep as 2 inches from the outside of the tree. Since sugar maple bark thickness varies from about 3/8 to 3/4 inches in thickness, according to another USDA Forest Service publication, this means that few producers adhere to the recommendations in the first edition (1996) of the North American Maple Syrup Producers Manual that tapholes should be 3 inches deep below the bark. Whether collecting sap by vacuum or gravity, there was no discernable trend relating sap yield to taphole depth—deeper holes did not yield more sap among these 200+ producers. It should be cautioned that there are many other factors, including average tree diameter and age, weather conditions, vacuum level, spout age, tubing arrangement etc that could also affect sap yield, and therefore this was in no way a controlled experiment that could precisely relate taphole depth to sap yield. This subject seems ripe for a research study; however there is no question that shallower tapholes help keep the process of sugaring sustainable by reducing the impact of annual wounding.