

Analysis of Saint John's Maple Syrup Records: 1942–2009

Maple syrup makers at Saint John's have maintained production records since their inaugural season. Not only do these records provide a glimpse of the syruping history at Saint John's, they help us predict when to tap trees, how many taps to install, and so on. In addition, the records also provide a benchmark by which to compare the production yields of the current season.

In 1942, as a response to sugar shortages created by the war, Br. Wendelin Leutmer and his helpers tapped 150 sugar maple (*Acer saccharum*) trees, collected 1440 gallons of maple sap, and boiled it down to make 45 gallons of syrup. This successful experiment initiated a monastic ritual that has continued until the present (for details, see Saupe, 2006a & 2006b).

Just like Br. Wendelin did the first season, each subsequent time that the monks made syrup they maintained two sets of data. On a piece of scrap lumber they recorded the date, time, and number of gallons of syrup that was jugged. A second piece of wood listed the date and number of loads of sap that were hauled into the sugarhouse from the field. Each time a load of sap was emptied into the holding tank, a tick mark was made on the board. Since the sap was transported from the field to the sugarhouse in a 175-gallon tank mounted on a wagon pulled by a tractor, each tick mark is equivalent to 175 gallons of sap. Both "datasheets" were then nailed to the sugarhouse wall.

Sadly, the early sugaring records were lost when the original sugarhouse burned down under suspicious circumstances in 1970. The sugarhouse was rebuilt in its current location on the east side of the radio tower field in the fall of 1971. Following tradition, the monks continued to record sap and syrup production data on wood scraps. Fortunately, those records still exist (Fig. 1). Worried that our existing records might suffer the same fate as those in the original sugarhouse, in 2003 Erika Nunnink (CSB '04) and I initiated a project to preserve and summarize these data. We entered the data from the boards into an Excel spreadsheet and also searched through old journals, newspapers, and other publications to try and reconstruct some of the pre-1972 data. Data entry has been an ongoing effort. The raw data are available online (Saupe, 2010a, 2010b) and are summarized in Table 1.

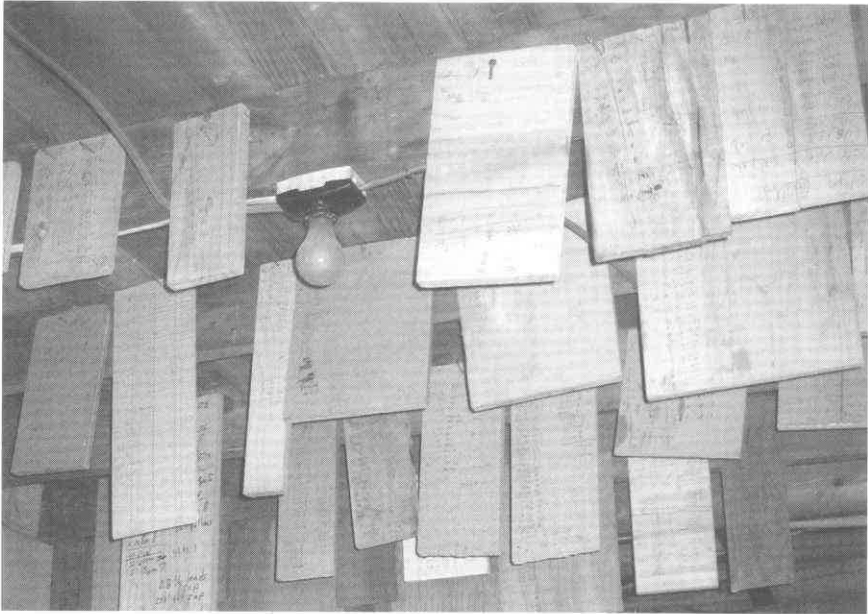


Figure 1. Scrap lumber recording syrup and sap data are nailed to joists in the ceiling of the Saint John's sugar house.

The purpose of this study was to analyze the Saint John's maple sap/syrup data. In the remainder of this article I will answer a series of commonly asked questions about the Saint John's maple syrup operation based on the data in Table 1.

Table 1. Summary of Saint John's Maple Syrup Statistics: 1942–2009. Ranges are shown in parentheses. Data prior to 1972 are incomplete because they were destroyed when the original sugar house burned down.

General	First season to make syrup	1942
	Number of years since St. John's began making syrup	67
	Number of seasons during which St. John's has made syrup	34
	Average time (in years) between successive syrup-making seasons	2.0 (1–4)
Tapping Data	Average date trees are tapped	10 March (26 Feb–19 Mar)
	Average date taps are removed	15 April (9–26 Apr)
	Average number of taps (<i>for all seasons</i>)	1375
	Average number of taps (<i>prior to 2002</i>)	1619
	Average number of taps (<i>since 2002</i>)	824
	Fewest number of taps (& year installed)	150 (1942)
	Maximum number of taps (& year installed)	3700 (1974)

Table 1 (continued from previous page)

Sap Collection Data	Average first date of sap collecting	19 March
	Earliest date on which sap was first collected (& the year)	26 February (1999)
	Latest date on which sap was first collected (& the year)	3 April (1974)
	Average last date of sap collecting	11 April
	Earliest date on which sap was last collected (& the year)	30 March (2000)
	Latest date on which sap was collected (& the year)	22 April (1982 & 1996)
	Average number of days during the season on which sap was collected	12.4 (7–19)
	Average number of sap collecting trips during the season	57.2 (15.8–121)
	Average number of days between first and last sap collection (= length of sap production season)	23.3 (14–42)
Sap Volume Data	Most sap, in gallons, collected during a season (& the year)	21,179 (1985)
	Average sap, in gallons, collected during a season	9834
	Average gallons of sap collected on a collecting day	800.6 (308–1282)
	Most sap, in gallons, collected on a single day (& the year)	2800 (1972)
	Average gallons of sap collected per tap	7.4 (3.8–12.1)
	Average gallons of sap collected per tap per collecting day	0.6 (0.3–1.1)
Syrup Production Data	Average gallons of syrup produced during a season (<i>data for all seasons</i>)	245
	Average gallons of syrup produced during a season (<i>since 2002</i>)	141.4 (45–268)
	Maximum gallons of syrup produced in a season	560 (1985)
	Minimum gallons of syrup produced in a season (& the year)	45 (1942, 2005)
	Average quarts of syrup per tap	0.76 (0.32–1.2)
Sugar Concentration Data	Average sap/syrup ratio	39.8 (31.3–61.6)
	Average seasonal sugar content of sap, in percent	2.2%
	Lowest seasonal sugar content of sap, in percent (& the year)	1.4% (2005)
	Highest seasonal sugar content of sap, in percent (& the year)	2.7% (1990)

When do sugar maple trees produce sap at Saint John's?

Maple sap flows when the daytime and nighttime temperatures fluctuate above and below freezing, respectively. In central Minnesota, mid-March to mid-April typically provide the best weather conditions to stimulate sap flow. Peak sap flow occurs in late March/early April (Fig. 2).

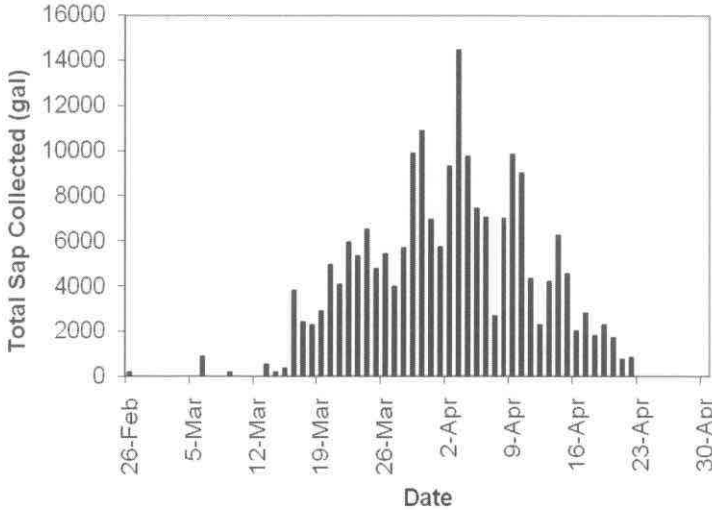


Figure 2. Sap production by day for the Saint John's maple syrup operation.

On average, March 19 is the first date on which there is enough sap to collect (Table 1). The earliest date there was enough sap to collect is February 26 while the latest is April 3. On average, the last day on which sap has been collected is April 11. The earliest date for our last sap collection was March 30 and the latest was April 22. Although these data provide a decent estimate of when sap flows in Central Minnesota, it is certainly possible that there may have been sap flow before and/or after the dates reported here. These dates are not only affected by the weather conditions but by the syrup leader's desire to get a jump on the season or close up shop early. For example, in 2007 our neighbors reported a significant sap run before we installed our taps.

When does Saint John's tap trees?

The ultimate goal of the syrup-makers at Saint John's is to tap trees only a day or so before the sap begins to flow. If trees are tapped too late, a sizable sap run may be missed, but on the other hand, tapping too soon increases the risk that the tap hole will dry out and become plugged by microbial growth. Since sap flow typically begins

on March 19, Saint John's usually taps trees on a weekend in the beginning of March while avoiding Spring Break, Easter, or other holidays so that students can participate in the process. Although the records are incomplete, our average tapping day is March 10 (Table 1). The earliest tapping date is February 26 while the latest was March 19.

When does Saint John's remove taps?

The average tap removal date at Saint John's is Tax Day, April 15 (Table 1). The earliest that we've pulled the taps is April 9 and the latest April 26. The main reason to remove taps is that the weather becomes too warm for syruping. Warm temperatures signal the end of syruping for three reasons: (1) the physiological mechanism responsible for sap flow requires that the nighttime temperatures drop below freezing; (2) the sap spoils before it can be processed into syrup. During any syrup season, mold and bacteria grow in the buckets and spiles used to collect the sap. Early in the season this is not a problem because cold minimizes microbial growth. However, as the season progresses and it gets progressively warmer, the contaminants multiply so quickly that any sap waiting to be collected will spoil or sour. An even bigger problem occurs when the partially cooked syrup waiting in the evaporator for the next firing sours. Spoiled sap smells awful, like spoiled milk, and must obviously be discarded; (3) as the maples prepare to leaf out, the trees load additional nutrients into the sap, called bud sap, which give the syrup an off-flavor.

Although warm weather is the primary reason to end the syrup season, on a few occasions we pulled taps even though the trees were running and there was an abundance of unspoiled sap to collect. At that point in the season, we had already made plenty of syrup but we were simply running out of enthusiasm and energy for the continued work.

How many taps does Saint John's install?

Historically speaking, Saint John's puts out nearly 1,400 taps (Table 1). The smallest number of taps was the first year (1942) when only 150 trees were tapped and the largest numbers of taps was 3,700 in 1974. Beginning with the 2002 season when the Arboretum joined the Abbey as co-leaders of the operation, there was a change in tapping philosophy. Syruping shifted to annual production with fewer taps (average = 824). Prior to that, the monks tapped less often but with more taps (average = 1619) enabling them to produce enough syrup to last multiple years (Saupe, 2006a).

How long is the sap collecting season at Saint John's?

The average time between the first and last sap collections is 23.3 days (Table 1). Our longest maple season on record was 42 days (1999) while the shortest sap flow season was 14 days (1988). A graph (Fig. 3) plotting the last day of sap collection versus the first day of sap collection shows a correlation ($r = 0.59$) between the beginning and end of the sap-collecting season. If the trees begin running early they quit producing sap early. Similarly, in years that the trees don't begin producing sap until late, they run longer into the season. This means that we can predict that in any given year our season will be over in a little more than three weeks after the first sap is collected. The explanation for this trend is based largely on whether we have a late or early spring. One might also argue that the Saint John's syrupmakers "run out of gas" after about three weeks of work.

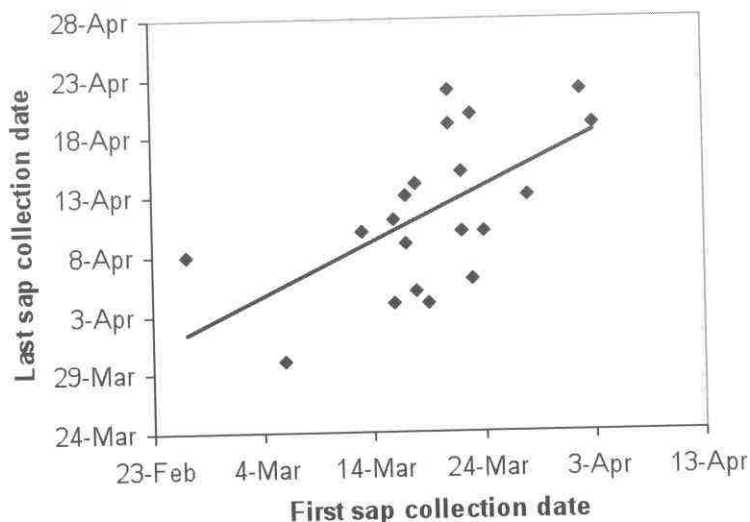


Figure 3. Relationship between the first and last sap collection dates, 1972–2009, in the Saint John's sugar bush.

How often does Saint John's collect sap?

Arguably, the most labor-intensive aspect of making maple syrup is collecting the sap from the buckets and bags hanging on the trees and then bringing it back to the sugarhouse. In a typical year, sap is collected about a dozen times (12.4; Table 1). The fewest times we've collected sap during a season is seven (in 2002) while the greatest number of sap collections occurred in 1999 when syrup makers collected sap on 19 occasions. Since we've already noted that the average sap season is 23.3 days long and

that we collect sap 12.4 times during a season, mathematically it suggests that we collect sap approximately every other day ($23.3 / 12.4 = 1.9$ days/collection). This figure is a little misleading because it suggests that sap flow is regular and predictable, which it isn't. Since sap flow is weather-dependent, there may be several days between periods of sap flow. For example, in 2007 there was a period of 10 days without any sap (Fig. 4). Perhaps the best way to describe sap flow is "feast or famine."

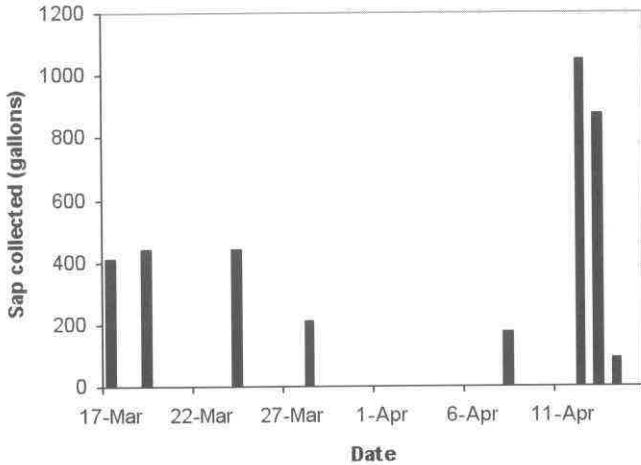


Figure 4. Sap volumes collected during the 2007 maple syrup season at Saint John's.

How much sap does Saint John's collect during a season?

The amount of sap we collect during a season varies considerably (Fig. 5). It is a function of the number of taps installed and the weather. Historically speaking, Saint John's collects nearly 10,000 gallons of sap every season (Table 1). The most sap ever collected during a season was about twice that amount (21,179 gal. in 1985). The smallest amount of sap collected was during the first season (1,440 gal. in 1942). As you might guess, it takes a lot of work to haul 10,000 gallons of sap from the woods to the sugarhouse. Since the tank used to haul the sap to the sugarhouse for most of Saint John's history held 175 gallons, it means that during an average year it takes about 57 trips back and forth from the sugar bush to the sugarhouse. During the record year for sap production in 1985 syrupmakers made 121 trips!

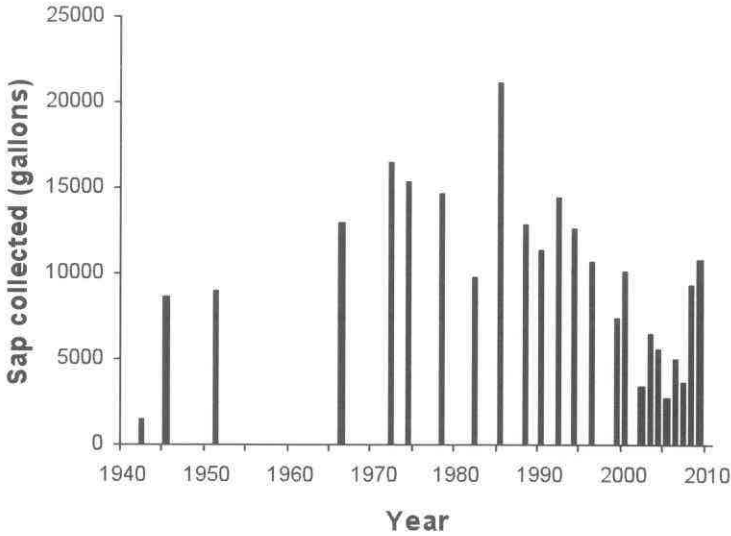


Figure 5. Sap production by year for the Saint John's maple syrup operation.

How much syrup does Saint John's produce in a season?

The average amount of syrup that is bottled annually at Saint John's is 245 gallons, though since 2002 when the Arboretum became involved, the syrup production has been considerably less (141.4 gallons) because we've tapped fewer trees (Table 1). The most syrup ever bottled was 560 gallons (1985) and the least amount of syrup was in the inaugural year (1942) and again in 2005 when only 45 gallons were jugged. The yield in the latter year was so poor because few trees had been tapped (600) and because we nearly destroyed the front pan in the evaporator. Someone accidentally dropped a napkin into the evaporator during a festival and we didn't notice that it blocked the flow of fresh sap into the front pan. As the sap continued to cook, the sap level in the pan dropped to a point where pan got so hot it began to burn. Fortunately, we realized what was occurring before too much damage had been done. Nevertheless, we needed to remove the pan, repair the holes and clean it thoroughly, all of which meant a significant loss in syrup.

The statistics cited above represent the amount of syrup actually bottled into gallon jugs. What these numbers don't reflect is the amount of syrup that was consumed or used before jugging. For example, in 2009 there were two maple festivals, attended by about 1,350 people, most of whom had a maple syrup sundae. In addition, each of the roughly 1,000 student visitors, from pre-school to college, received a syrup sample. Factoring in the syrup eaten by the syrupmakers, we estimate the actual amount of

syrup we've produced in recent years is 10 or more gallons larger than the figures shown in Table 1.

How much sap does it take to make one gallon of syrup?

The syrup maker's rule of thumb is that it takes approximately 40 gallons of sap to make a single gallon of syrup. The sap/syrup ratio is a good measure of the success of the maple season; the lower the ratio, the less sap required to make a gallon of syrup. Over time, at Saint John's our sap /syrup ratio has been 39.8 gallons of sap per gallon of syrup (Table 1). The best it's ever been is 31.3 gallons sap/syrup in 1990 while the worst ratio was 61.6 when we burned the pans in 2005. One important variable that affects the sap/syrup ratio is the concentration of sugar in the sap.

What is the sugar concentration in the sap at Saint John's?

Another rule of thumb is that the concentration of sugar in maple sap is 2%, though individual trees can vary considerably. Not surprisingly, the average sugar concentration in sap at Saint John's is 2.2% (Table 1). The highest average seasonal sugar concentration was 2.7% and the lowest 1.4%. Though this may seem like a minor difference, a quick calculation should convince you that small changes in sap sugar concentrations can markedly affect the syrup yield and amount of cooking necessary to produce the syrup. For example, consider an average sap flow season in which we collect 10,000 gallons of sap. If the average sugar concentration of the sap is 2.2%, using the "Rule of 86" we can calculate that it would make about 256 gallons of syrup. Without worrying about the derivation of the equation, according to the Rule of 86 the sap/syrup ratio = $86 / \% \text{ sugar}$. Thus, in our example the sap/syrup ratio is 39.1 ($= 86 / 2.2$), which means that we expect one gallon of syrup for every 39.1 gallons of sap. Since we have a total of 10,000 gallons of sap, it should yield 256 gallons of syrup ($= 10,000 / 39.1$). However, if the sap had an average concentration of 2.7%, then the same amount of sap would make 314 gallons of syrup — an additional 58 gallons! And even better, since our evaporator boils off about 200 gallons of sap per hour fueled by roughly one cord of wood per 22 gallons of syrup (Saupe, 2010c), we've essentially saved ourselves about 11 hours of cooking time ($= [58 \text{ gal syrup} \times 39.1 \text{ gal sap per gal syrup}] / 200$) and 2.5 cords of wood ($= 58 \text{ gal syrup} / 22 \text{ gals syrup per cord}$).

How much sap and syrup does a single tap produce?

The amount of sap produced by a single tap, or spile, varies from 3.8 to 12.1 gallons (Table 1). The average sap yield per tap at Saint John's is 7.4 gallons. From the perspective of syrup production, each tap at Saint John's yields an average of three-quarters (0.76) of a quart of syrup.

In conclusion, regardless of the actual statistics, the only meaningful and important measure of success for the syrupmakers at Saint John's is how many people with whom we have been able to share this Benedictine experience. We encourage you to join us next year and become part of our statistics.

Steve Saupe is Professor of Biology.

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