Did Record Summer Heat Turn Fredonia into Napa?
The 2005 Lake Erie Season

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The 2005 growing season will go down in the record books as the warmest in at least 40 years. Growing degree accumulation measured from April 1 to October 31 (base 50°F) indicates a long term average of 2636 GDD at the Fredonia Vineyard Laboratory (table 1).

Fredonia Vineyard Laboratory		
	LT avg	2005
Bud break	5/6	5/10
Bloom	6/16	6/13
Veraison	8/24	8/21
GDD (4/1-10/31)	2636	3258

Table 1: Lake Erie Concord growing season attributes. Data collected at the Fredonia Vineyard Laboratory and posted on the Lake Erie Regional Grape Program web site.

In General Viticulture, Winkler categorized grape growing areas into five climatic regions based on growing season heat summation. Cool Geneva, NY with approximately 2400 heat units falls into region I and hot Fresno, CA with 4680 heat units falls into region V. The long term average of 2636 heat units in Fredonia categorizes it as a low-climatic region II. In 2005, Fredonia accumulated 3258 GDD, bumping it up to a mid-climatic region III and making it the warmest growing season in Fredonia since at least 1964. The next warmest season was 1991 with 3052 GDD. So what was the impact of the additional heat on the 2005 growing season?

Other than some cases of severe water stress (i.e. shallow soils with poor weed control), the majority of Lake Erie Concord vines and crops developed normally despite the record breaking heat. There is more to viticultural classification than total heat summation. For comparison, the U.C. Davis experiment station in Oakville, CA near Napa is also considered a climatic region III (figure 1) and Fredonia actually beat Oakville in heat summation in 2005. However, the GDD accumulation comparison between Fredonia and Oakville also shows how Oakville accumulates heat earlier and later in the season, extending its growing and fruit ripening seasons. This difference may have little impact on the ripening of Concord for the fresh juice market but it would make a large difference in the maturation of a long-season variety such as Cabernet Sauvignon.

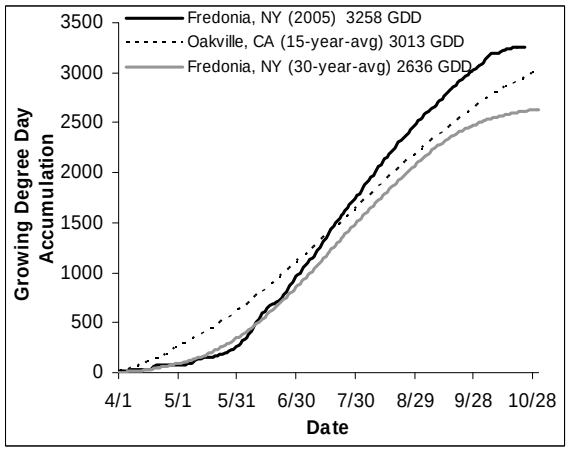

Figure 1: Growing degree day accumulation from April 1 to Oct. 31 in Fredonia, NY and Oakville, CA. NY data collected from the Lake Erie Grape program (http://lenewa.netsyc.net/public/IPM/Home.htm) and CA data collected from UC Davis (http://www.ipm.ucdavis.edu)

Fredonia heat accumulation in April and May lags behind regions like Oakville because of the influence of Lake Erie water temperature on air temperature. Early season air temperature and precipitation in 2005

were not far off from the long term average and these early season environmental conditions set the course for the remainder of the growing season for an individual variety. Last winter, Rich Erdle and Jay Hardenburg of National Grape Co-op inquired about the influence of Lake Erie water temperature on Concord bloom date in the region. After calculating Lake Erie heat accumulation over 10 years and comparing it to official Concord bloom date in Fredonia, it turns out there is a relatively strong relationship between Lake Erie heat accumulation and Concord bloom date. On May 1st in 2005, after calculating lake heat accumulation through April, we could predict Concord bloom date with about 60% confidence (which was good enough to be dead on in 2005).

In the variety Concord, veraison typically occurs 69 days after bloom (+/- 3 days), a trend which held true in 2005 despite the warm and dry summer conditions. From bloom to veraison in Fredonia, the minimum air temperature is rarely below 50°F and the maximum air temperature is rarely above 90°F. Without getting into a full discussion on the response of photosynthesis and photorespiration to temperature, let us just say vine systems are a "go" and temperature is typically not a limiting factor in vine development during this period. With benign environmental conditions in the summer, the time from Concord bloom to veraison is primarily influenced by variety (genetics) and yields a fairly consistent 69 days.

Therefore, in our unique situation of growing Concord in the Lake Erie grape belt, temperature buffered lake water influences spring air temperature which influences vine phenology and bloom date. Genetics then becomes the primary influence on the time it will take to get to veraison.

The rate of sugar accumulation in Concord fruit after veraison (the characteristic of fruit maturation the Concord juice industry is most interested in) is dependent on the functional leaf area to fruit ratio from veraison to harvest. This opens a complex discussion on the quantity and quality of sunlight hitting the vineyard, the quantity and quality of leaf area receiving sunlight, water and mineral nutrients influencing the rate of photosynthesis, as well as the overall crop size. However, by examining data from "standard" Concord vines with consistent spacing (9'row x 8'vine) vine size (2-3 pounds/vine), pruning level (120 nodes), training system (single wire cordon), and crop size (9-11 tons/acre), the effect of the 2005 growing season on fruit development can be measured and compared to other seasons.

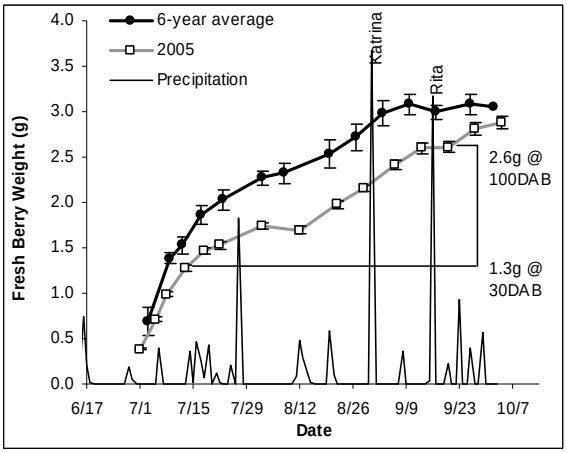

Figure 2: Average and 2005 Concord berry weight from 120 node vines at the Fredonia Vineyard Lab and 2005 growing season precipitation (in inches).

First, the warm and dry summer conditions led to lower than average berry weight (figure 2). Second, the low berry weight led to elevated juice soluble solids measurements at veraison (figure 3). On average, Concord juice soluble solids are approximately 7 °brix at veraison and in 2005 the refractometer read 9 °brix at

veraison. However, this simply appeared to be a concentration effect of packing a normal amount of sugar into a smaller than normal berry size. If juice soluble solids are adjusted based on average berry weight (i.e. what if we had normal size berries in 2005?) Concord juice soluble solids at veraison would again have been approximately 7 ^{o}brix (figure 3).

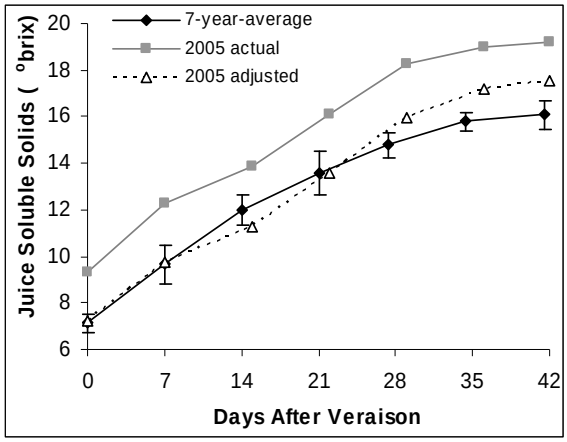

Figure 3. The rate of sugar accumulation in 120 node Concord vines at the Fredonia Vineyard Lab compared to the 7-year-average. Sugar concentration was inflated in 2005 because of the small berry weight. Adjusted data allows for the easy comparison to the average.

Well placed rain events courtesy of hurricanes Katrina and Rita during the post-veraison period helped to increase berry weight and maintain good vine water relations and leaf photosynthesis. Both the actual and adjusted juice soluble solids data show how the rate of Concord sugar accumulation was not much different than the 7-year-average, especially in the first few weeks after veraison. The exceptional ripening of the 2005 season occurred four to seven weeks after veraison when continued sunny and warm conditions increased both berry weight and juice soluble solids during a period when they normally plateau.

Therefore, despite record breaking heat accumulation in Fredonia which placed it in comparison with Napa, the 2005 season as a whole was not far from average. The strong influence of cool Lake Erie temperatures led to normal spring vine development with the 2005 bloom only 3 days ahead of average. The time from bloom to veraison was the average 69 days and the actual rate of juice soluble solids accumulation for several weeks after veraison was. . .well. . .average. Two characteristics which stand out are (1) below average precipitation leading to small berry weight and concentrated sugars and (2) the late season weather conditions extending the ripening season by a couple extra weeks.

What about 2006? Although weather during bud initiation was dry, most vineyards did not show signs of major water stress until later in the season. The post-veraison rain events coupled with the extended season added to overall wood maturity. Therefore, without having dissected any Concord buds, I would predict average to above average bud quality for 2006 Lake Erie Concord. Overall wood quantity (vine size) also looks good in vineyards which maintained good vine water relations throughout the summer because of deep soil, good weed control, and/or rootstock selection. Water stressed vineyards or blocks, on the other hand, have considerably lower vine weights and should carry lower crop sizes in 2006.