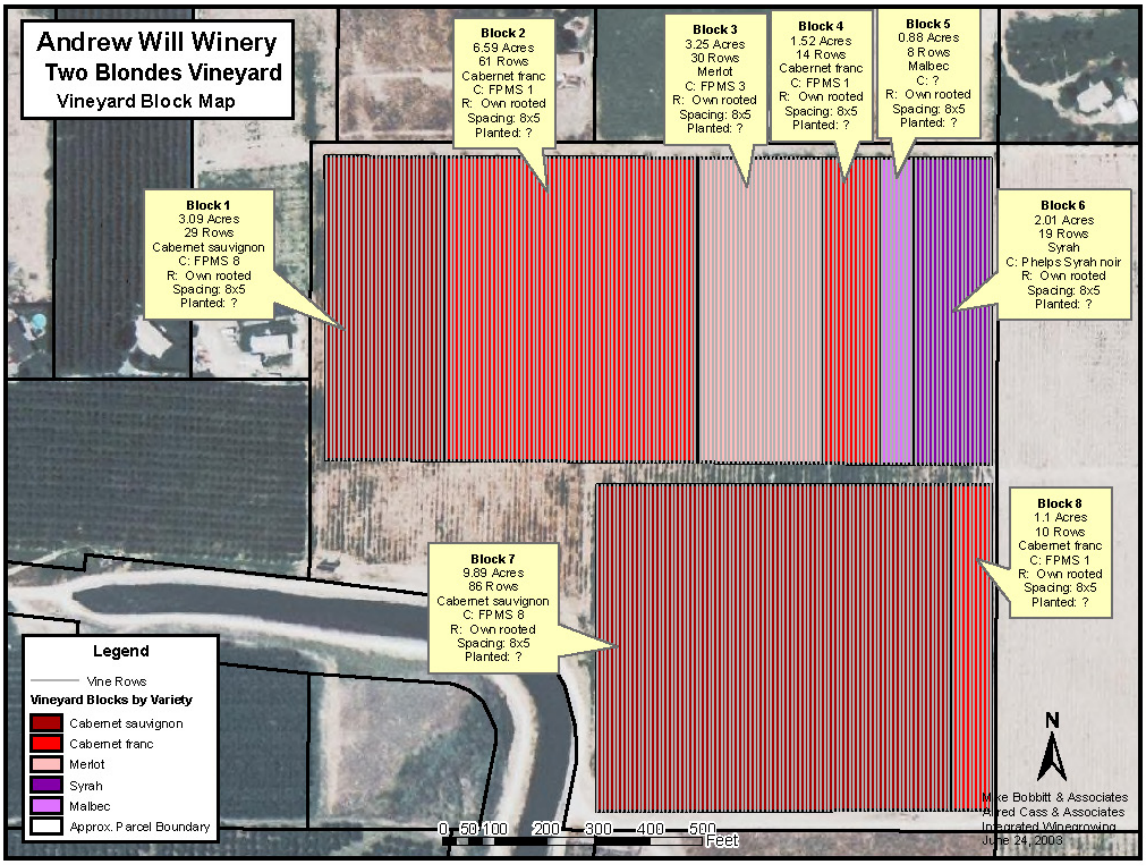
2007 Weather Summary for Two Blondes Vineyard



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Version 2

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Introduction

This is a weather summary for Two Blondes Vineyard based on measurements made during the 2007 growing season, with comparisons made to the 2005 and 2006 seasons. This report is not a true climate survey and does not purport to represent climatic characteristics of the vineyard sites. A climate report requires many years of data while this weather summary uses only the weather data that is available from the automated temperature data loggers that have been installed in the vineyards. As more years of data are collected, a better and better picture of the temperature climate of this location will be ascertained.

There are two Hobo weather stations at Two Blondes Vineyard, one located at a higher elevation and the other at a lower elevation. Comparisons between the two locations will be made, when differences are apparent. The top station was used as the reference when comparing 2007 to 2005 and 2006.

Long-term averages from Oakville, CA are included for reference. Oakville was chosen as a representative climate for Bordeaux varieties in California. Oakville's climate is on the cool end of fine Cabernet Sauvignon production and on the warm end of fine Merlot production. Comparison comments to Oakville are presented in italics.

I. Temperature and Heat Summation

Two Blondes had 3235 degree days in 2007 compared to 3253 in 2006 and only 3182 degree days in 2005 (**Figure 1**). July was the warmest month in 2007, as it was in 2006. Like the previous two years, the months of April and October were quite cool, indicative of the short, intense growing season at this location (and in the region). The upper station had about 280 more degree days than the lower station (**Figure 2**). This was a larger difference than was measured in previous years by about 80 degree days. There was an unusual anomaly to the diurnal temperature curves (to be discussed later) that probably contributed to the higher differential in this heat summations. The temperature anomaly was probably due to sensor placement and not due to a change in the temperature cycling at this location.

Degree days were higher at the top station for each month, though the differences were largest from July through September (as in prior years). The differences between the two locations were primarily due to lower nighttime temperatures at the lower location, though daytime temperatures were also a bit cooler at the bottom location (to be discussed).

There is a distinct difference in heat summations between Two Blondes Vineyard and Oakville. While the heat summations at Two Blondes is about 300 degree days F warmer than Oakville (top station), the season is shorter and more intense at Two Blondes. July and August are much warmer at Two Blondes compared to Oakville, but the heat fades quickly into the fall, where the month of October is much cooler than in Oakville. This indicates the importance of early fruit maturation at Two Blondes vineyard, as ripening will slow immensely during the month of October. While the bottom station had very similar heat summations as the Oakville average, the difference in the seasonal pattern is striking.

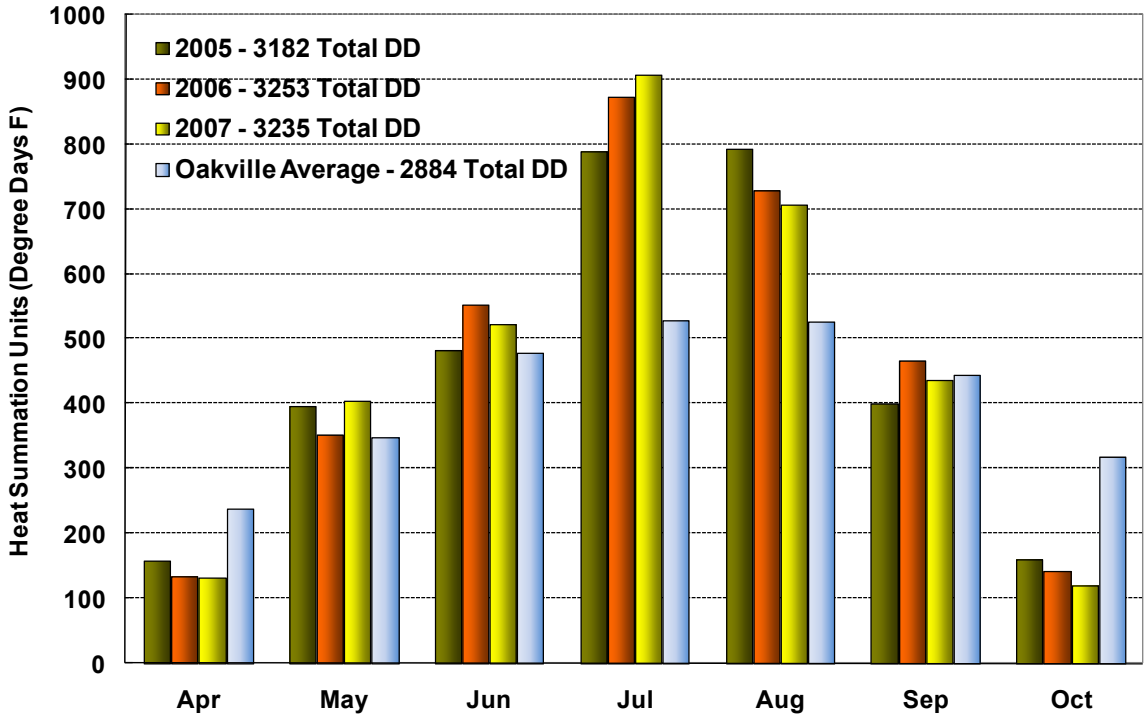

Figure 1: Monthly heat summations for the top station at Two Blondes Vineyard for the 2005-2007 growing seasons, along with a long-term average for Oakville, CA. 50°F was used as the baseline temperature.

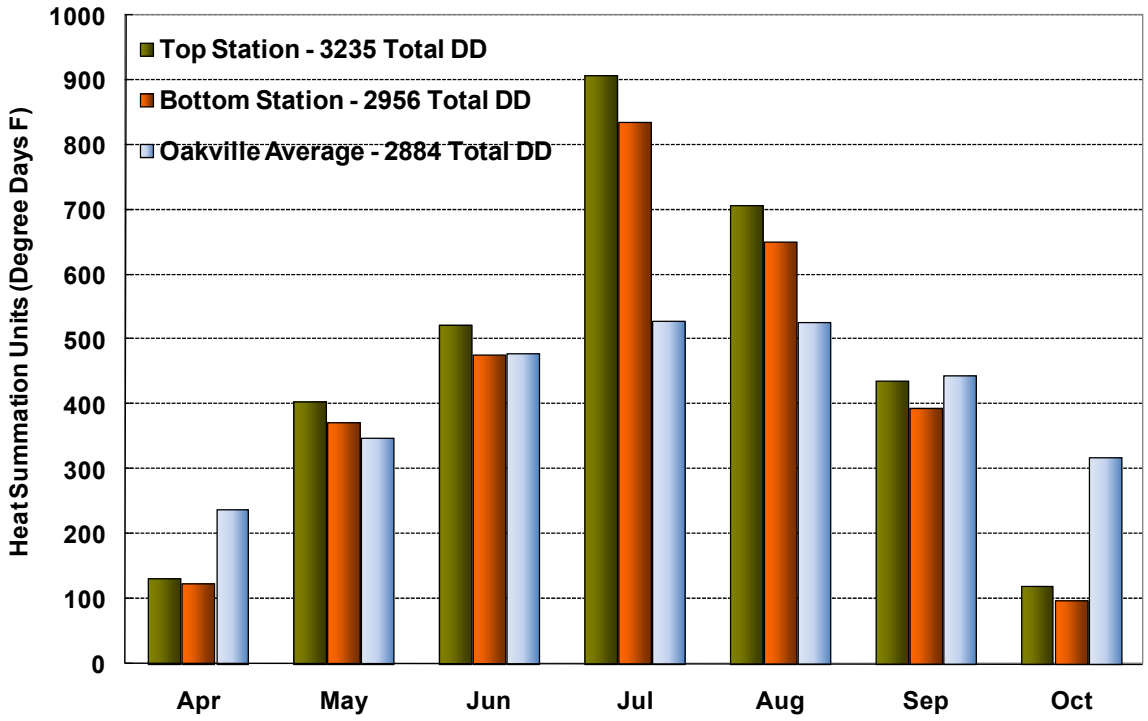

Figure 2: 2007 monthly heat summations for two locations at Two Blondes Vineyard, along with a long-term average for Oakville, CA. 50°F was used as the baseline temperature.

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Average daily maximum temperatures were generally lower in 2007 than in 2006, though July had similar temperature maxima (**Figure 3**). The month of August was considerably less hot in 2007 relative to either of the previous two years. September had similar maxima to 2005, but lower maxima than 2006. Patterns of high temperatures at this location indicate a brief hot season (July and part of August), with most of the year experiencing very mild temperatures during the daytime.

The top station produced higher maximum temperatures than the lower station (**Figure 4**), but this was confined primarily to the period between May and July.

Generally, the heat extremes are not very high at this locations, though the month of July seems to have pushed into quite warm temperature territory.

Daily high temperatures are higher at Two Blondes than at Oakville during July and August. However, Oakville temperatures are higher during September and much higher during October. In 2007, however, August high temperatures were quite similar between the two locations, though July temperatures were much warmer at Two Blondes.

Temperature minima were similar between 2006 and 2007 (**Figure 5**), though they were much warmer in March than the other years and cooler in October. The cold October temperature minima would have made "flavor ripening" difficult in the later varieties. It is likely that fruit maturation proceeded very slowly during the month of October, if indeed fruit remained on the vines. Any problems with fruit development would be exacerbated at locations represented by the bottom temperature station. The bottom station had consistently colder temperatures than the top station (**Figure 6**), with temperature differences between 2 and 3°F. Colder nighttime temperatures are to be expected at lower elevations within a given location, due to settling of the colder air during the stable night conditions.

The night temperatures are quite cold during early spring and during Fall. Night temperatures during mid-summer are quite mild, and even a bit warm. The warm nights during a portion of the season will aid in fruit development, since fruit metabolism is generally independent of photosynthesis, and is highly temperature dependent. However, if fruit has not matured by the month of September, further ripening will be impeded by both cool daytime and cold nighttime temperatures.

Minimum temperatures are remarkably similar between Two Blondes and Oakville during much of the season, though Two Blondes has much warmer night temperatures during July and August. September minimum temperatures are similar, though October temperatures tend to be warmer at Oakville.

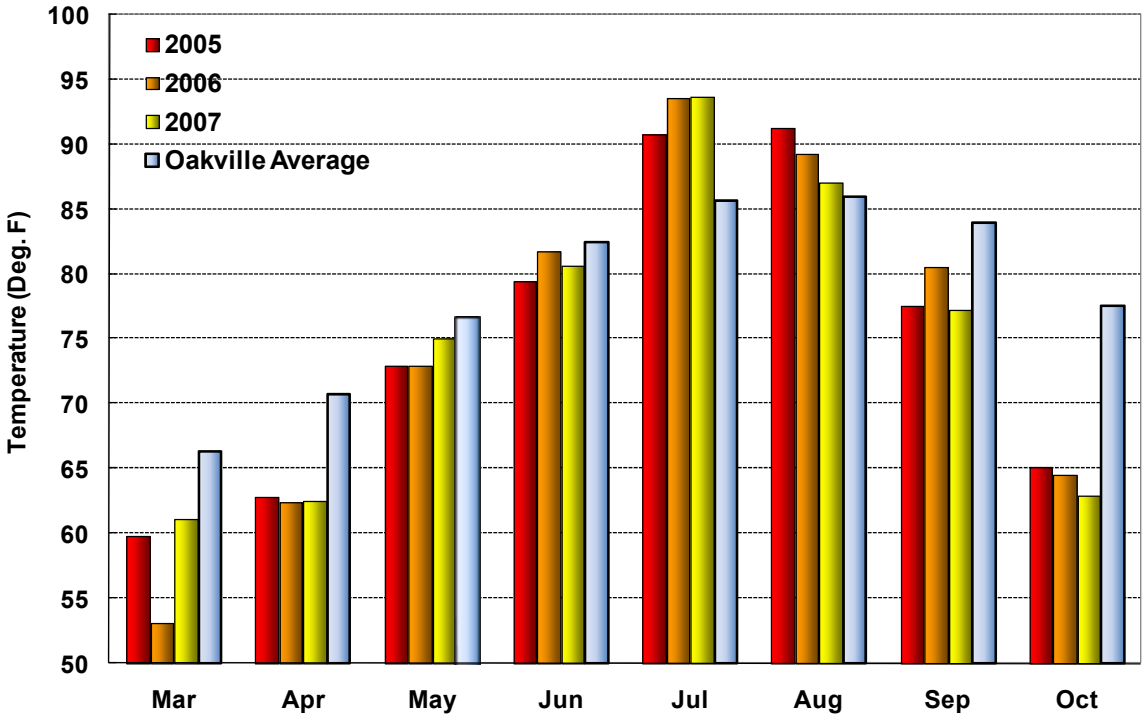

Figure 3: Monthly averages of daily maximum temperature for the top station at Two Blondes Vineyard, along with a long-term average for Oakville, CA for the 2005-2007 growing seasons.

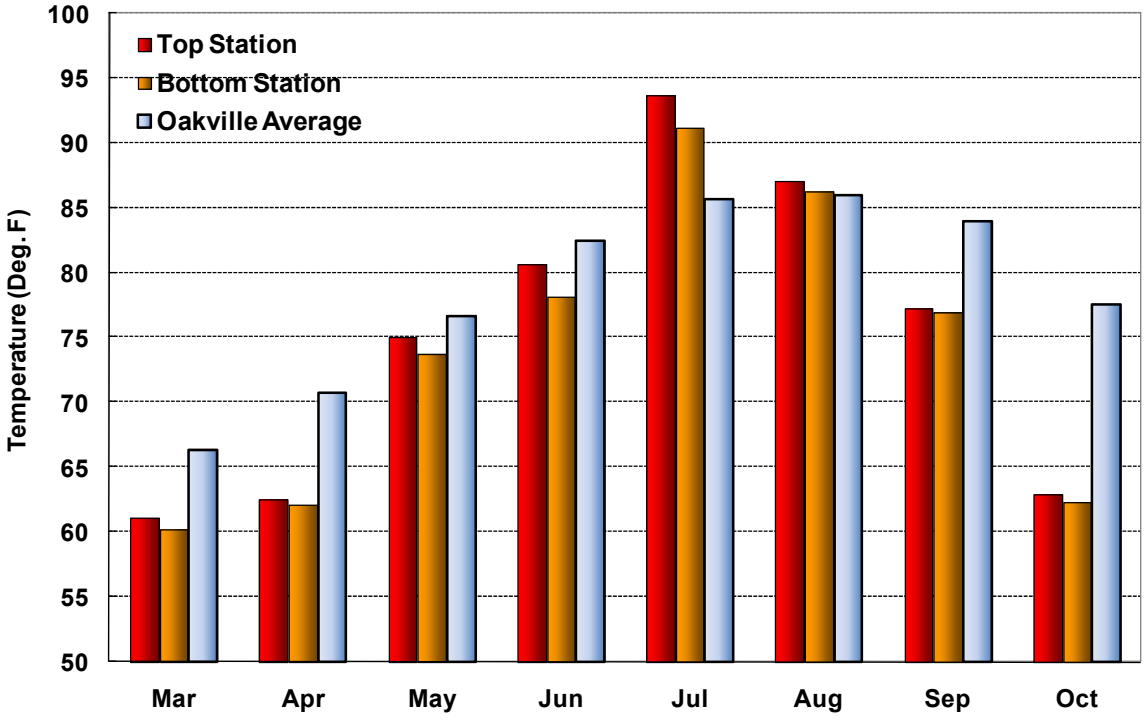

Figure 4: 2007 monthly averages of daily maximum temperatures for two locations at Two Blondes Vineyard, along with a long-term average for Oakville, CA.

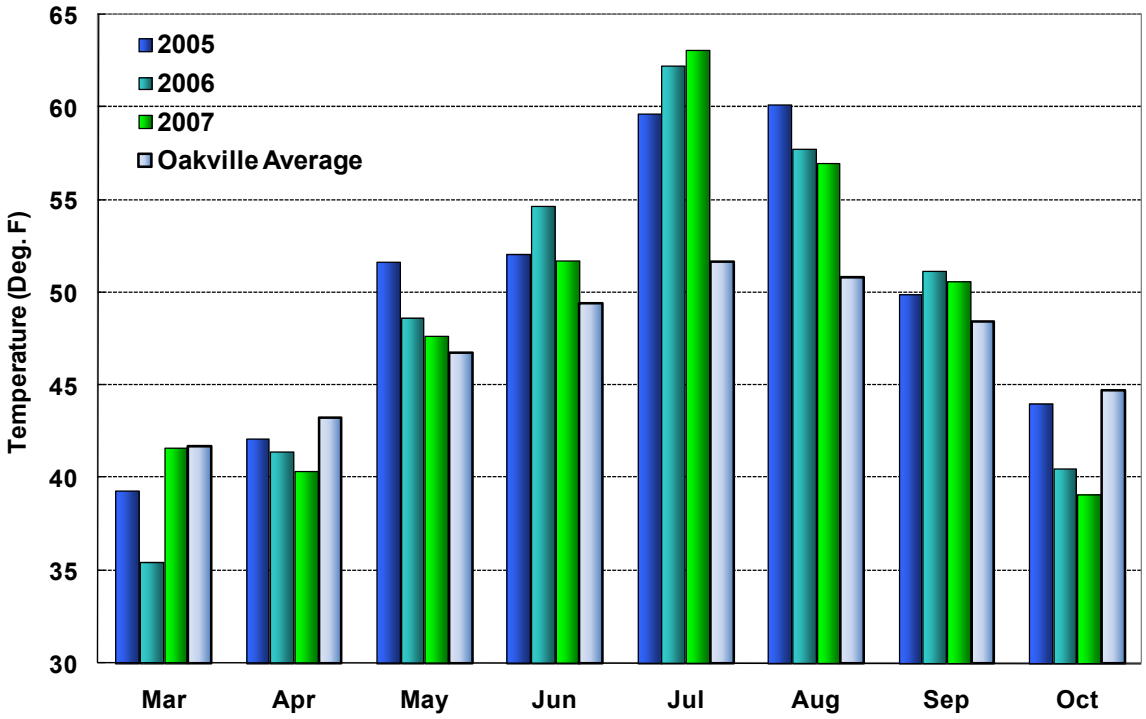

Figure 5: Monthly averages of daily minimum temperature for the top station at Two Blondes Vineyard, along with a long-term average for Oakville, CA for the 2005-2007 growing seasons.

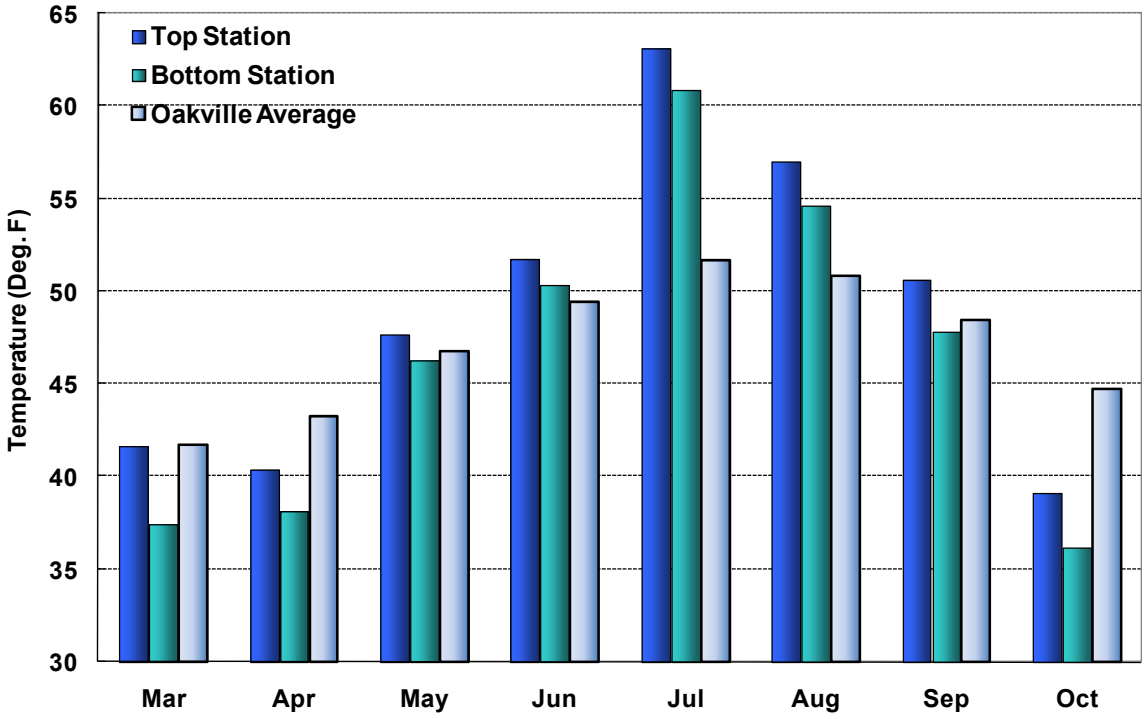

Figure 6: 2007 monthly averages of daily minimum temperatures for two locations at Two Blondes Vineyard, along with a long-term average for Oakville, CA.

II. Ripening Period Analysis

A general period of ripening was chosen for analysis, which comprises mid-August through mid-October. This period was chosen as a standard to capture the ripening periods of multiple regions and grape varieties. The average daily minimum, maximum and mean during the ripening period are shown in **Figure 7** for 2005 through 2007. Clearly, temperature minima, maxima and averages were very similar among the three years, although the maximum temperatures were about 3 degrees warmer in 2006 (relative to 2007) during the ripening period, and about 1 degree warmer in 2005. Daily minimum temperatures during this time period did not differ substantially, on average, among the three growing seasons. As was found with all months of the year, temperatures at the top station had higher temperature minima during the ripening period (**Figure 8**). Temperature maxima did not differ among the two sites in 2007.

One aspect of the quality of a vintage is the variability of temperatures from day-to-day. Temperature variability generally is detrimental to wine quality, especially if variability includes high heat spikes. Dips in night temperature from time-to-time can also retard flavor ripening, causing flavor maturity to occur at higher brix levels or sometimes not occurring to the winemaker's satisfaction at all (especially problematic with short season regions, such as this one). The standard deviations in the daily temperature minima, maxima and averages during ripening are shown in **Figure 9**. There were not great differences among the last three seasons, though 2007 was more similar to 2005 with regard to variation in temperature maxima. On the other hand, variation in temperature minima in 2007 was more similar to 2005.

The average diurnal temperatures during the ripening period are a very illustrative way of looking at the temperature characteristics during this critical period. Comparing diurnal temperatures in 2005-2007 (**Figure 10**), the night temperatures were nearly identical to one another in 2005 and 2006. Nighttime temperatures were about 1 degree colder in 2007 compared to the prior years, which would have had the effect of delaying flavor maturity. On the other hand, the daytime temperatures were warmest in 2006, and coolest in 2007, with about a 3 °F temperature difference at mid-day.

The temperature curve of the top station exhibited an unusual "bump" in temperature during the morning, though the temperature pattern became more typical at around noon. This unusual pattern appears to be an anomaly, as it was not present in the bottom station (**Figure 11**). It is likely that the sensor position was picking up some reflected or advected heat from a nearby building or other terrestrial feature. If that was not the case, then there may have been a problem with the sensor's radiation shield. Since heat summations, described earlier, were computed on a fine time scale, the anomalous pattern would have incorrectly increased the computed heat summations.

Comparing the diurnal temperature curves between the top and bottom locations (**Figure 11**), it is clear to see that the top station experienced warmer temperatures during the nighttime. Unlike previous seasons, daytime temperatures were very similar between the two sites in 2007. The temperatures during the nighttime are critical for fruit maturation. Temperatures need to stay above 50°F for berry metabolism to continue. Generally speaking, warmer night temperatures will allow fruit to reach "flavor maturity" at lower sugar content. The upper location better epitomizes the warmer night characteristic.

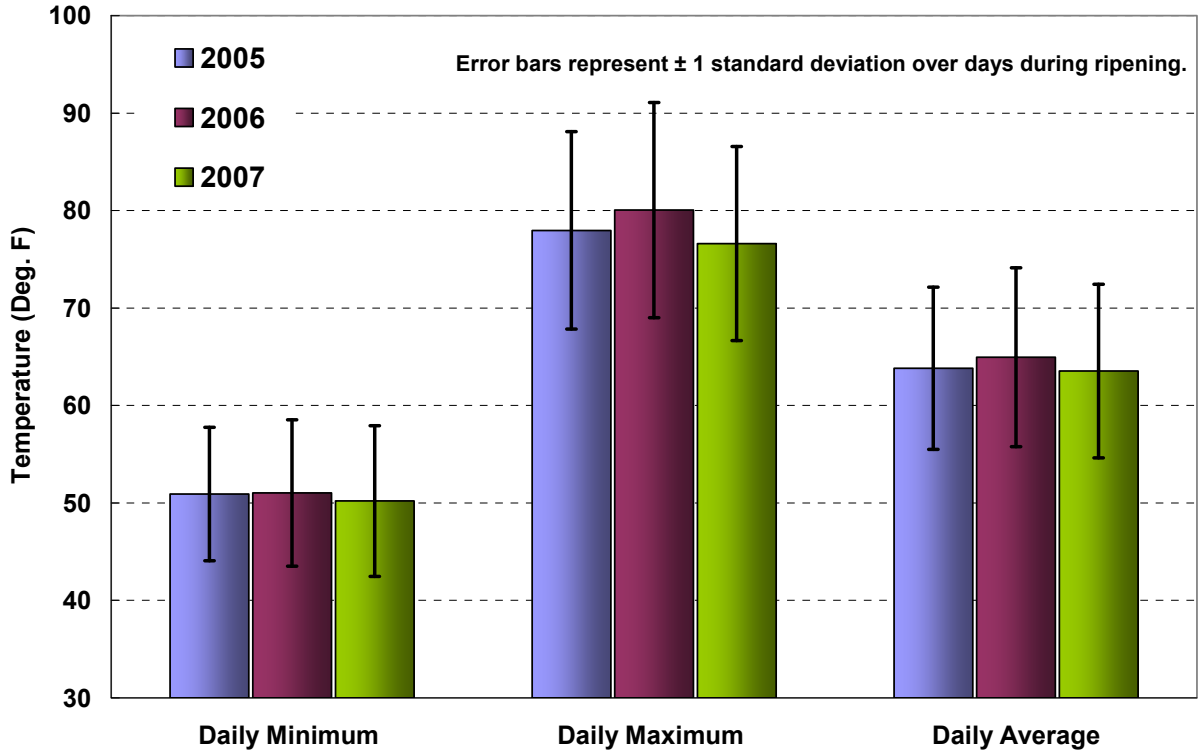

Figure 7: Average daily minimum, maximum and average temperature during the 2005-2007 ripening periods (August 15th through October 15th).

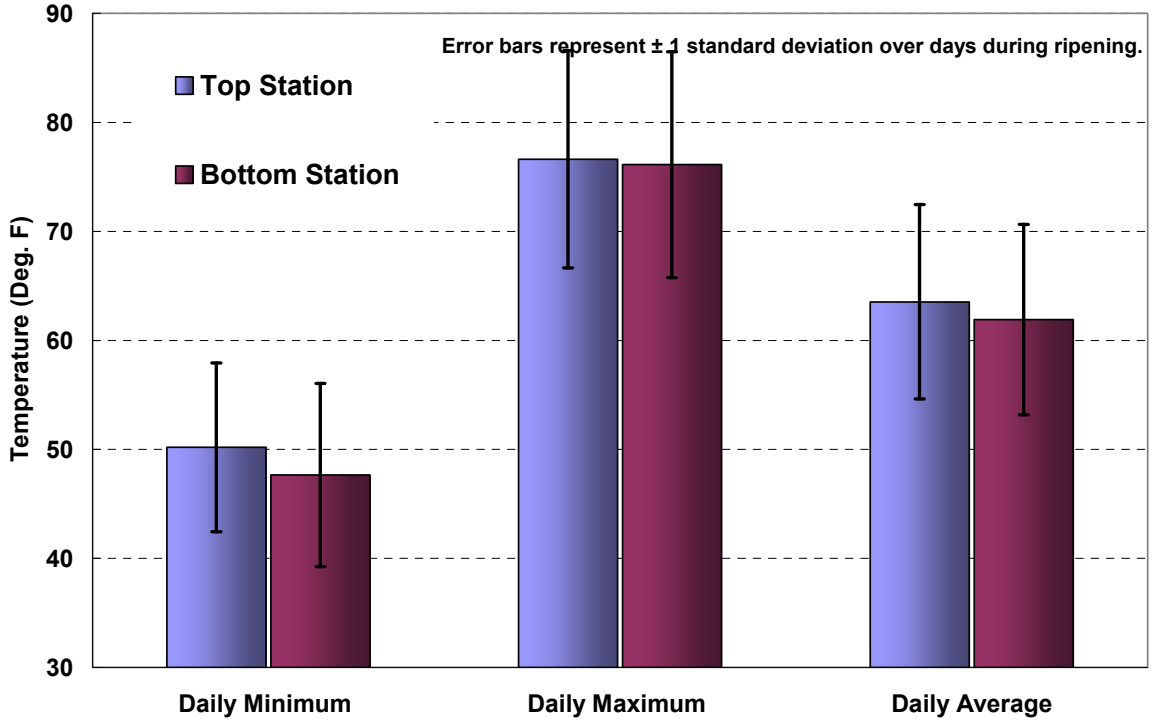

Figure 8: Average daily minimum, maximum and average temperature during the 2007 ripening period for two stations at Two Blondes Vineyard.

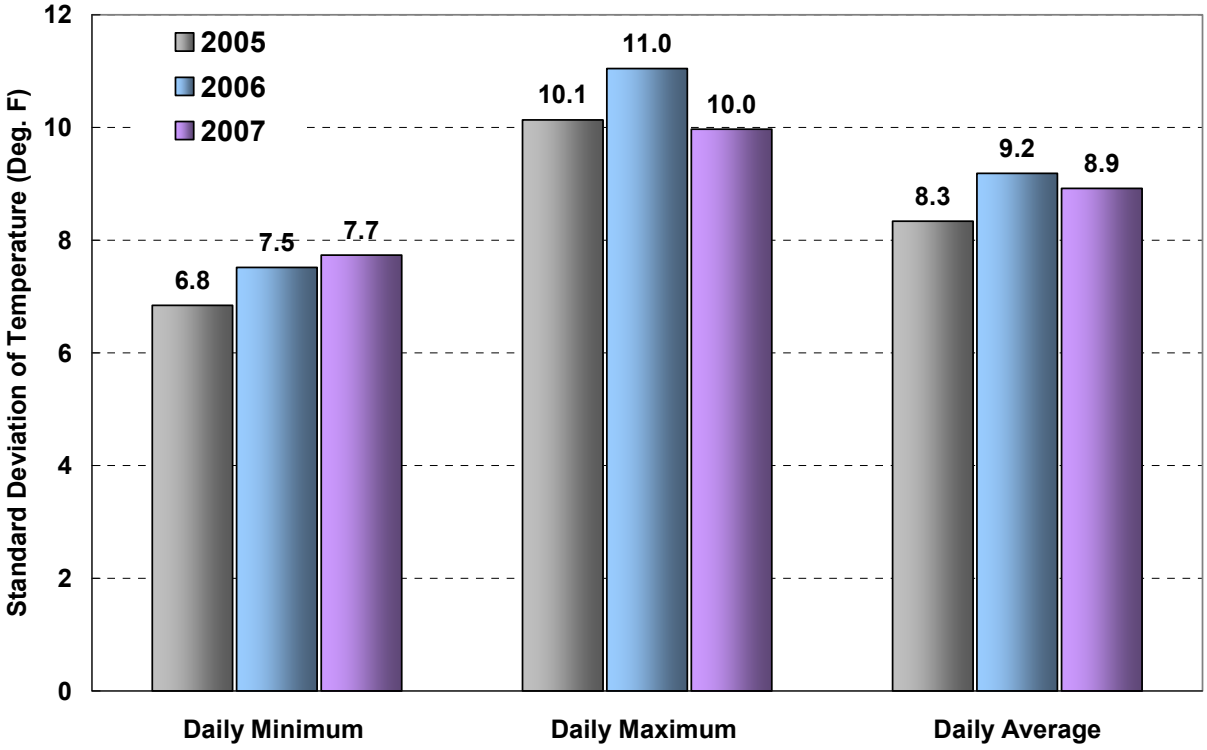

Figure 9: Standard deviations of daily minimum, maximum and average temperature during the 2005-2007 ripening periods for the top station at Two Blondes Vineyard.

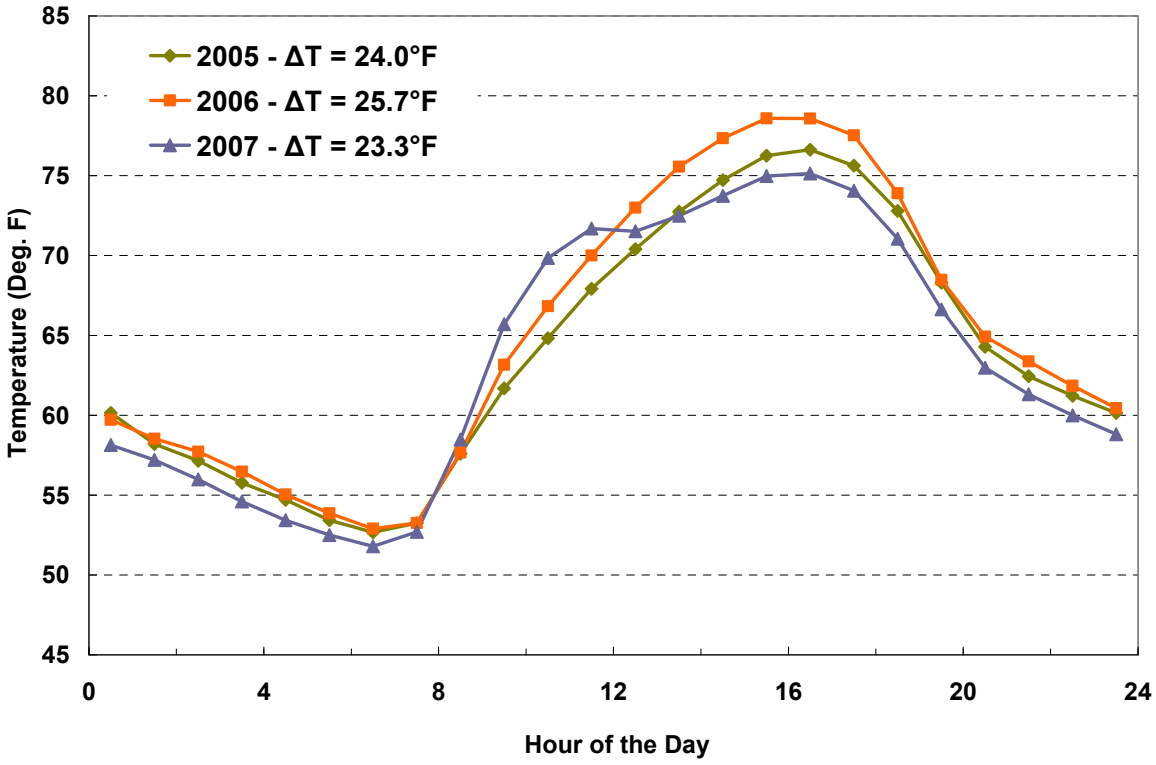

Figure 10: Average diurnal temperature cycle for two locations during the 2005-2007 ripening periods (mid-August through mid-October) for Two Blondes Vineyard.

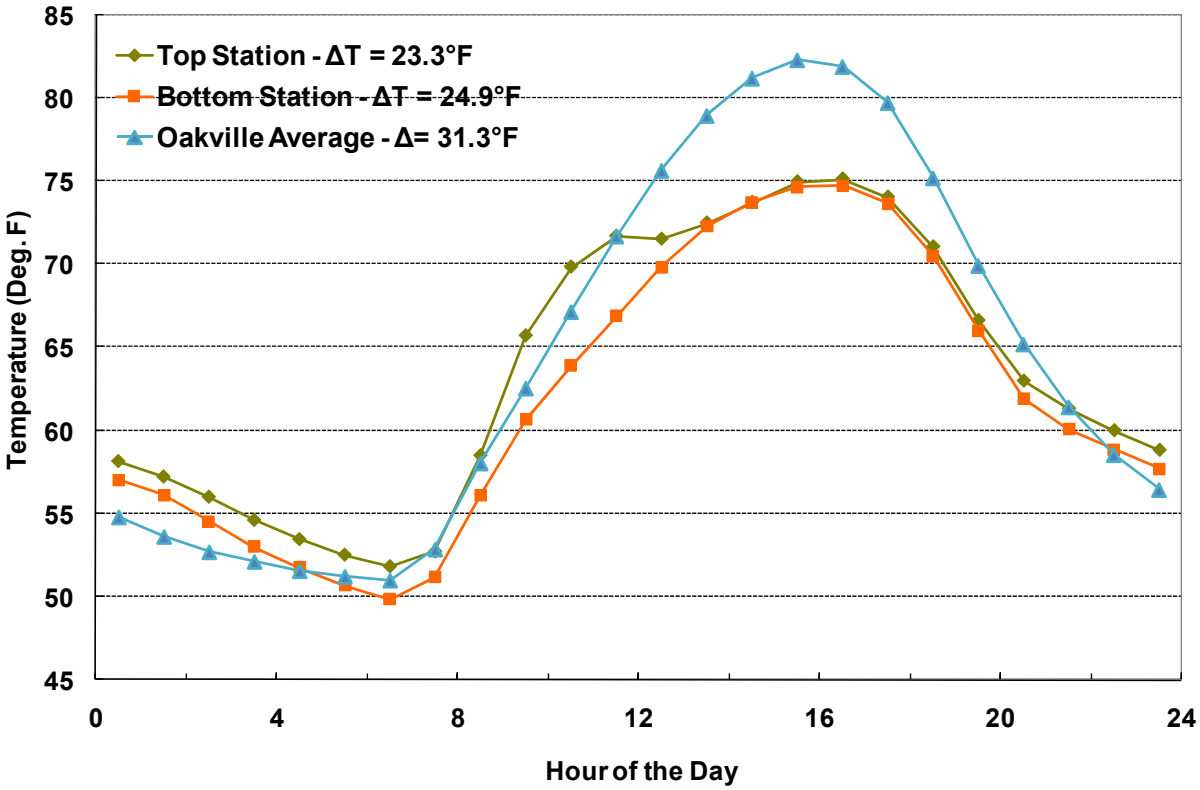

Figure 11: Average diurnal temperature cycle for two locations at Two Blondes Vineyard, along with a long-term average for Oakville, CA during the 2007 ripening period (mid-August through mid-October).

The primary difference between the average diurnal temperature pattern during ripening between Two Blondes and Oakville, CA is that the Oakville temperatures are warmer during the day (during the ripening period, at least). This pattern is not typical for the entire season, as Oakville high temperatures are not as high as Two Blondes during July and August. Night temperatures at Oakville tend to drop more quickly in the evening, but remain mostly level during the nighttime. Two Blondes temperature remains warmer in the early afternoon and declines steadily until dawn, arriving at a similar temperature minima as Oakville.

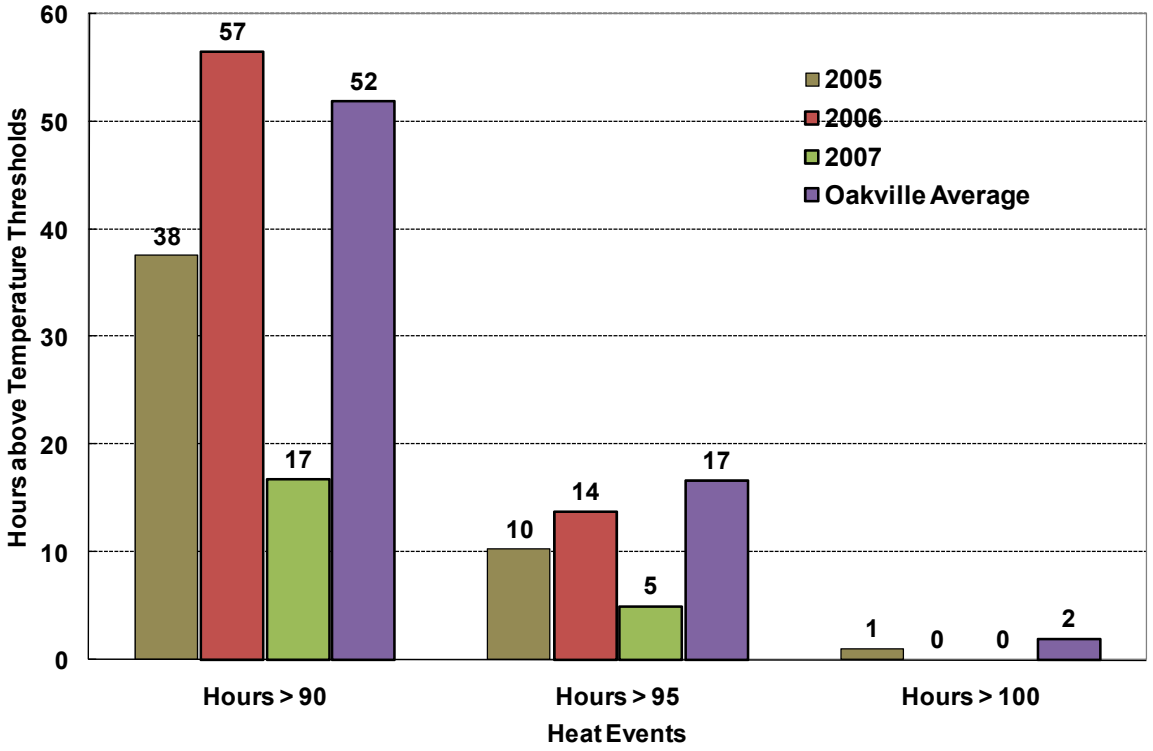

Figure 12: Hours above given critical temperatures during the ripening stage in 2005-2007 for Two Blondes Vineyard along with long term averages for Oakville, CA.

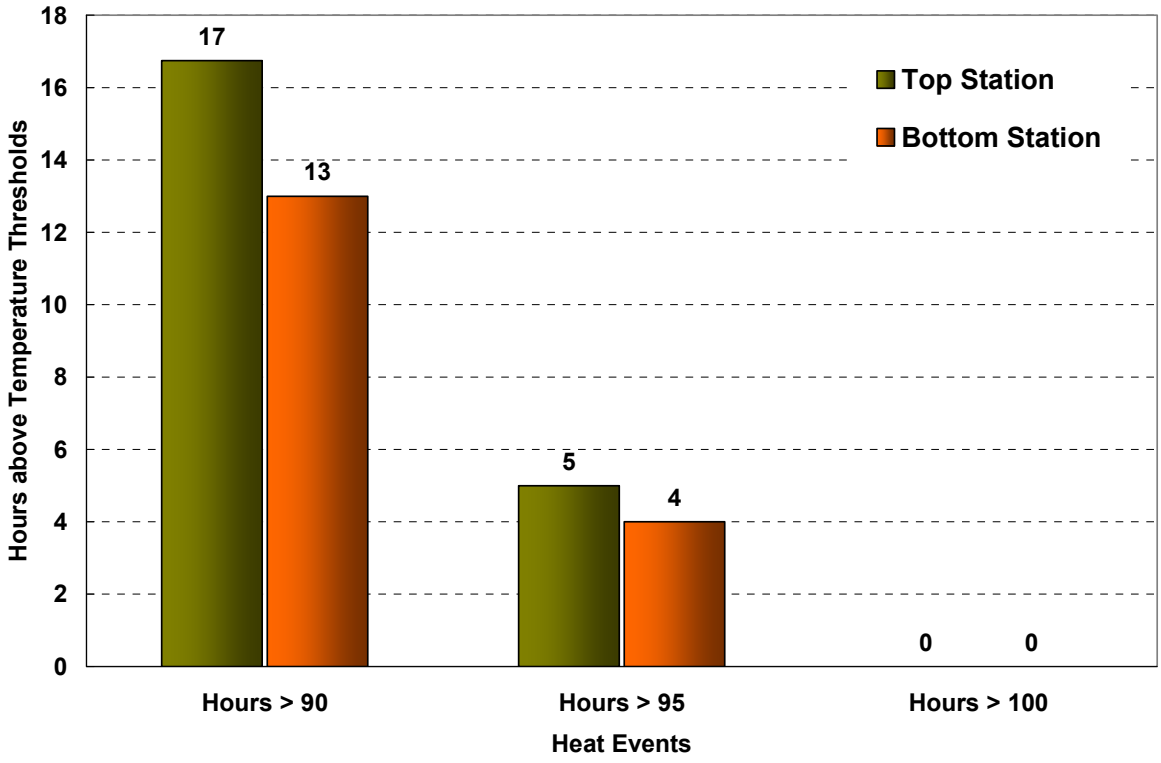

Figure 13: Hours above given critical temperatures during the ripening stage in 2007 for two locations at Two Blondes Vineyard.

Finally, it is instructive to evaluate the time during which the temperatures exceeded given threshold levels during the ripening period (**Figs. 12 and 13**). While foliage and fruit temperatures are of primary importance (not ambient temperatures), we can estimate that foliage temperature roughly tracks air temperature ± a few degrees, depending on stomatal opening or closure. Fruit temperature, on the other hand, is difficult to broadly determine. However, fruit in persistent shade will equilibrate to ambient temperature, while fruit exposed to sunlight will reach at least 15°F above ambient temperature. 90°F represents a temperature where photosynthesis in the leaves diminishes. There were fewer hours above 90°F in 2007 than in 2005 or 2006. The bottom station experienced even fewer hours above that threshold than did the top station.

At 95°F, leaf photosynthesis is essentially zero while 100°F is the temperature at which heat shock proteins are produced by the plant (a protection against heat stress). In the fruit, secondary metabolism (responsible for anthocyanin, tannin and flavor precursor formation and degradation) is highly sensitive to temperature, although the optima and maxima have not been elucidated by researchers yet. However, it is clear that, at hot temperatures (especially those of exposed fruit), anthocyanins are degraded resulting in lower extractable wine color. Fruit aromatic compounds are similarly degraded. It is generally felt that air temperatures in excess of 100°F will degrade wine quality, while temperatures between 95 and 100°F will be less detrimental to quality.

At Two Blondes Vineyard, 2007 exhibited only four hours above 95°F and no hours above 100°F. From the last three seasons' data sets, it does not appear as though this location receives high heat during the ripening period, which bodes well for wine quality. The scarcity of high temperature events indicates that high heat stress conditions are not a common occurrence at this vineyard during ripening, which is a strong positive characteristic. That will allow the fruit to attain high quality with a rapid degradation of undesirable vegetative character during the ripening process.

However, temperatures can be quite high during the months of July and early August. While fruit is less susceptible to damage before veraison, it may be damaged when temperatures rise above 105°, or even slightly lower. Hence some fruit protection should be provided by leaves on the west side of the canopy.

High temperature events during ripening are quite similar to those of Oakville, or even less common. The scarcity of high temperatures during ripening is a characteristic of high-quality growing regions.

III. Frost Risk Analysis

The bottom station is most likely to be affected by frost, due to its consistently lower minimum temperatures than the top station **(Figure 15)**. Using the bottom station as a reference from which to compare year-to-year, there were many fewer hours of potential frost temperatures in March relative to the previous year (**Figure 14**). However, April featured more hours of frost temperatures, which was more hazardous than in 2006 because the vines would have been active. It appears consistent that the spring frost season ends with the month of April. On the other hand, the fall frost season begins with the month of October, for which 2007 was similar to 2006.

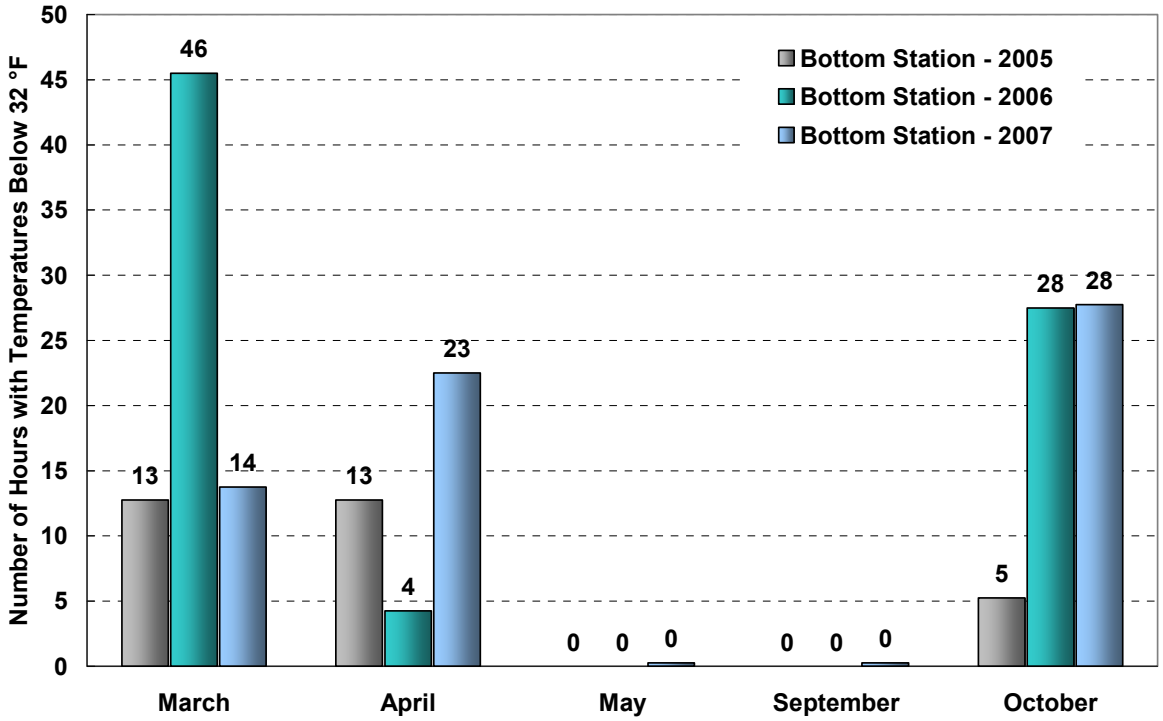

Figure 14: Total number of hours per month below 32°F for the bottom location at Two Blondes Vineyard for 2005-2007 (frost-prone months only).

More detailed looks at the daily minimum temperatures and how they may impact frost are shown in Figures **16 and 17**. Frost potential appears to diminish quickly after mid-April, though some frosts seem possible into the latter part of the month. Some severe frosts appear to have occurred in 2005 and 2007, with temperatures reaching to 25°F or below. Those frosts will be difficult to protect using only wind machines – sprinklers will be necessary for those events.

From the last 3 years of data, fall frost does not appear to be a significant hazard. Frosts seem to occur mostly at the very end of October. Because the temperatures cool so quickly in the fall, fruit will probably not continue to mature that late into the month anyway.

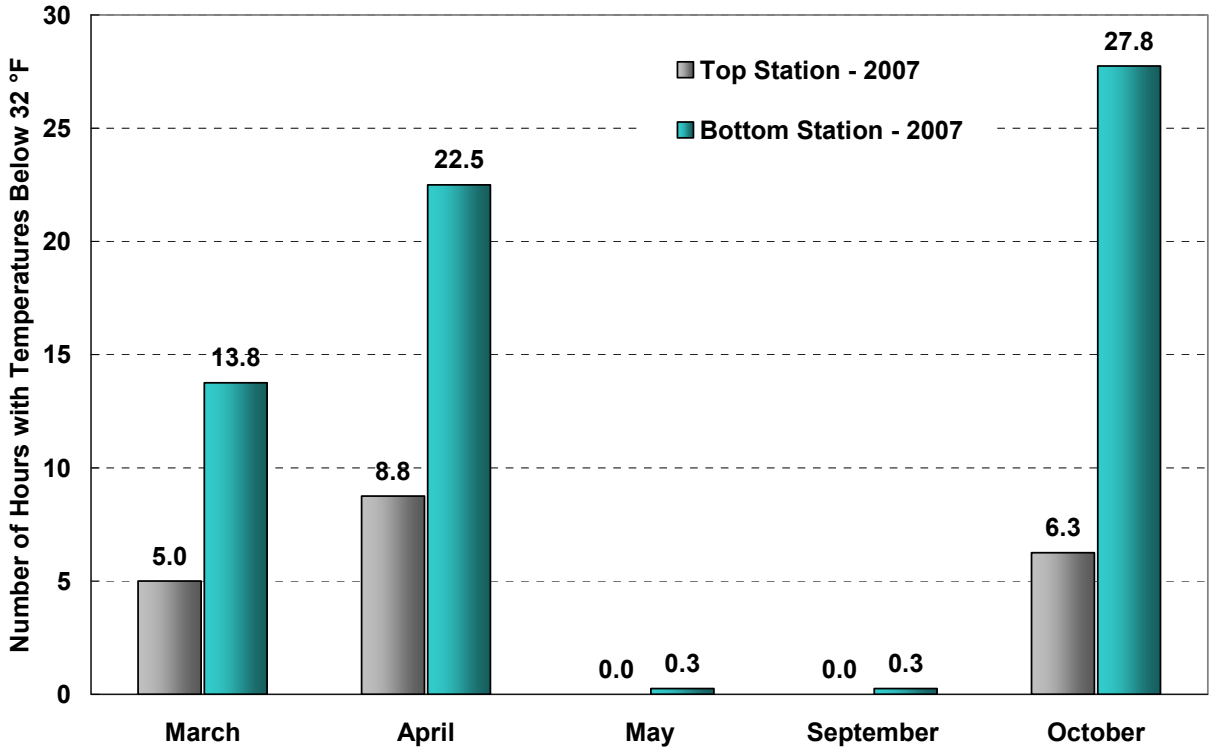

Figure 15: Total number of hours per month below 32°F during the frost-prone periods for two locations at Two Blondes Vineyard in 2007.

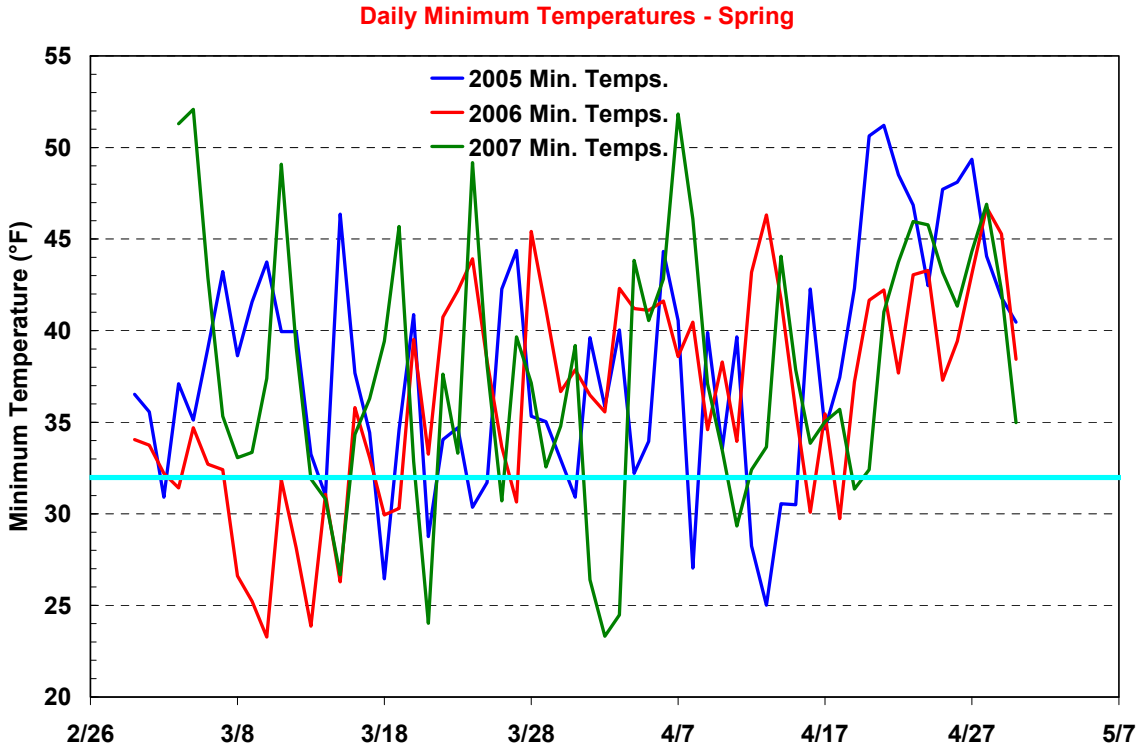

Figure 16: Daily minimum temperatures during the spring frost periods of 2005-2007 for the bottom station at Two Blondes Vineyard.

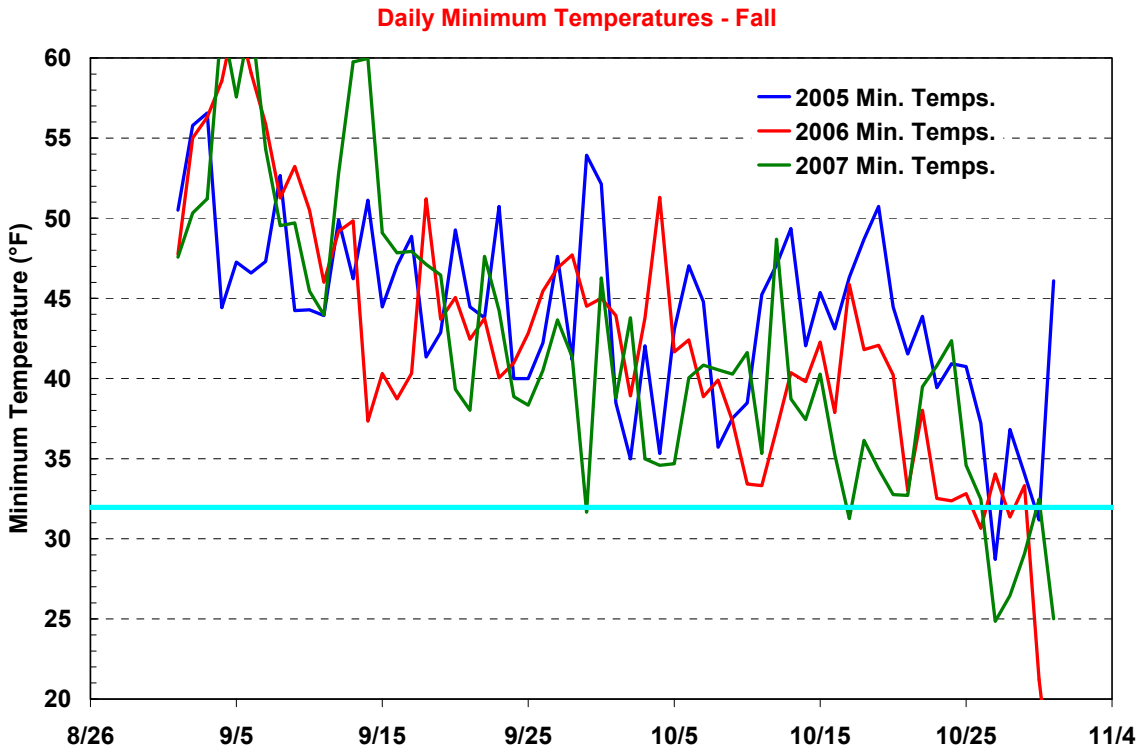

Figure 17: Daily minimum temperatures during the fall frost periods of 2005-2007 for the bottom station at Two Blondes Vineyard.

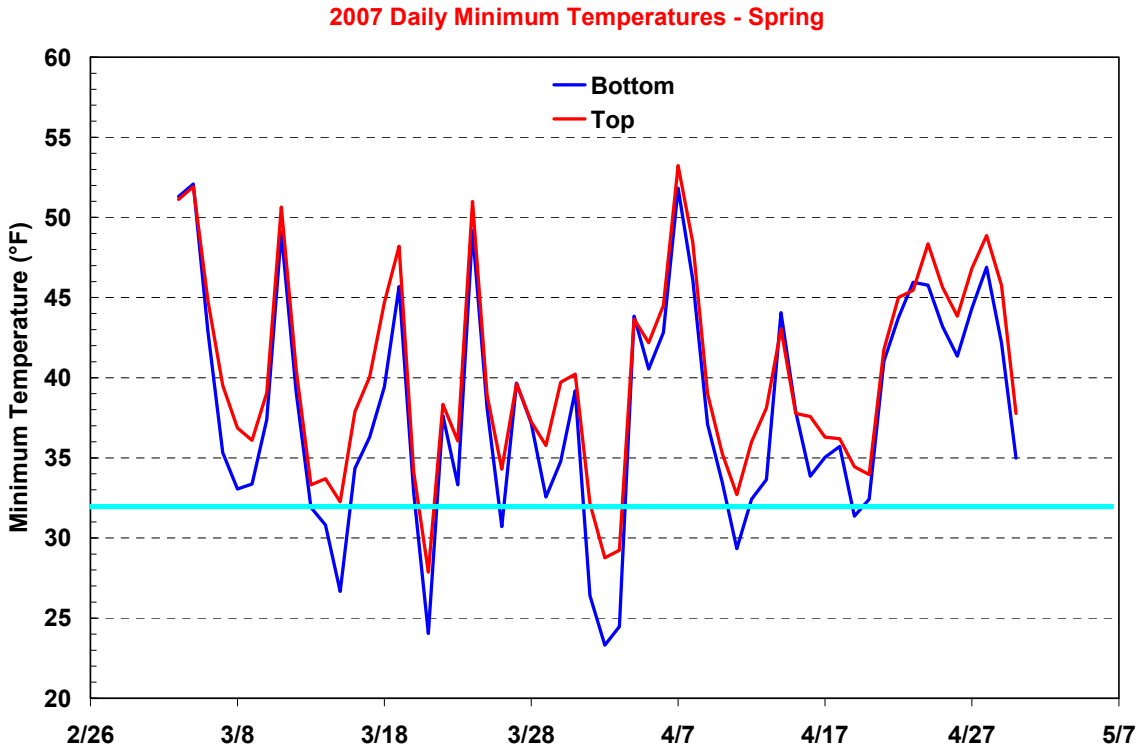

Figure 18: Daily minimum temperatures during the spring frost period of 2007 for the two stations at Two Blondes Vineyard.

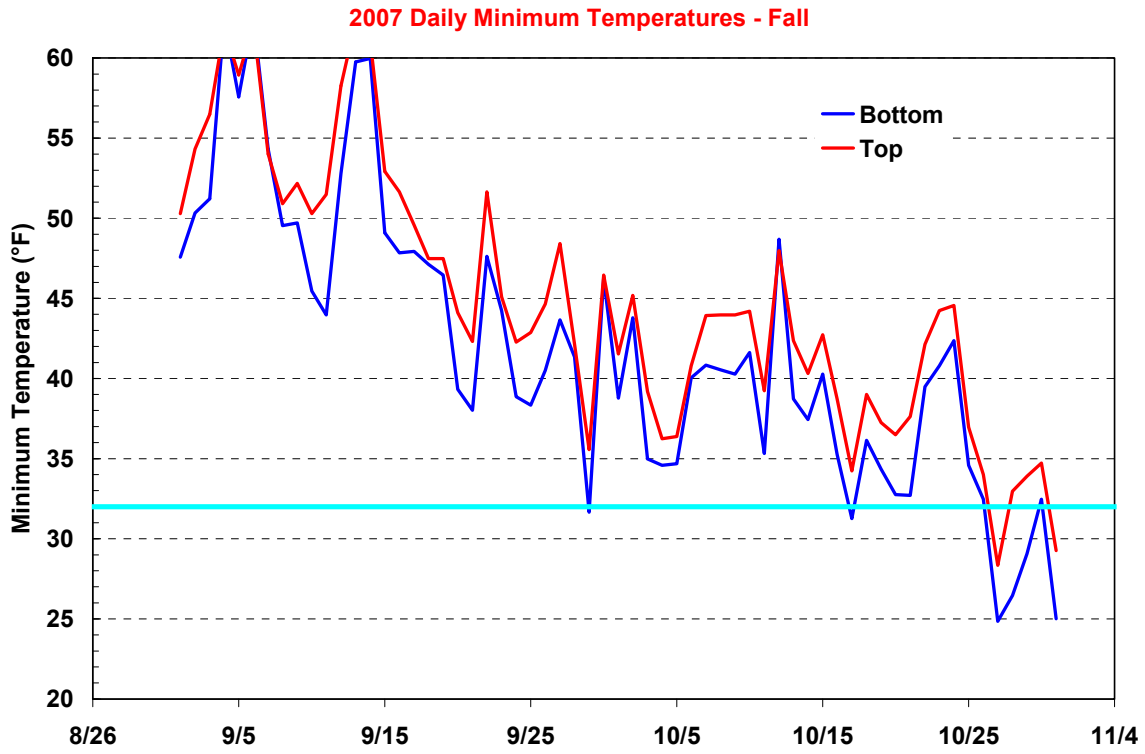

Figure 19: Daily minimum temperatures during the fall frost period of 2007 for the two stations at Two Blondes Vineyard.

For interest, plots of daily minimum temperatures for the two locations are plotted alongside one another for 2007 in **Figures 18 and 19**.

IV. Conclusions

This limited data set suggests that there are sufficient heat summation units available to ripen all Bordeaux varieties. The site receives about 3100-3200 degree days F, putting it in a cool Region II on the Winkler scale. The lower portions of the vineyard receive about 200+ fewer degree days than the upper portions, which may make ripening of the later-season varieties more difficult. The season length is short, but temperatures warm quickly in spring, allowing vine development to catch up with other growing regions, such as those at lower latitudes. However, temperatures also fall rapidly during the fall, so fruit must mature by early October, or it will have difficulty achieving flavor maturity. Cabernet Sauvignon is the most difficult variety to ripen here, so it should be treated with some exposure of the fruit to increase fruit temperature, so as to expedite the ripening process.

The lack of extreme temperatures during ripening is a benefit to this vineyard, as this will allow fruit to ripen without potential for sunburn or other degradation due to excessive heat. However, there may be high temperatures before fruit has reached veraison, since July temperatures tend to be warm to hot. Heat during July may also be damaging to the green berries, so some heat protection should be maintained, in the form of retained leaves on the afternoon sun side of the canopy. This is particularly important for the Merlot.

2007 Weather Summary for Two Blondes Vineyard

The mild temperatures during ripening are accompanied by mild, but not cold, temperatures at night (at least early in the ripening period). This will allow for some "night ripening" of fruit, which allows flavors and tannins (etc.) to develop without accompanying sugar accumulation, which occurs during daylight hours. The net result is that flavor maturity may be reached before sugar (and potential alcohol) levels become excessive.