

2005 Sample Weather Summary and Climate Evaluation for XYZ Ranch



January 10, 2006

Introduction

This is a weather and climate summary for XYZ Ranch based on measurements made during the 2005 growing season. While end-of-year weather summaries are usually for the purpose of documenting and describing the growing conditions that shaped the prior vintage, this report will be used to base vineyard development decisions. Therefore, this report will present data on climatic characteristics of the site and not just recent weather. A climate report requires many years of data while this weather summary uses only the weather data that is available from the automated weather stations that have been installed in the vineyards. Weather stations have been in operation at XYZ Ranch for only the 2005 season. To obtain climatic averages, the 2005 temperature data were scaled to the ABC weather station, located approximately 7.5 miles south-southwest from the XYZ property. While not as accurate as long-term measurements made on-site, this method provides history otherwise not obtainable. Temperature records from 1991 to 2005 were used for the evaluations.

These data represent an archive of historical information that will be built upon as time progresses. To fully exploit the weather data set, it is imperative that a viticultural and wine-quality data set be built simultaneously. The data set should include phenology, yield and yield components, fruit exposure assessments, wine quality assessments, wine review scores, etc. so that correlations can be made as the data set becomes larger.

There are four Hobo weather stations at XYZ Ranch, located roughly along a southwest-northeast transect across the property (Figure 1). Some of the 2005 data comparisons show only the two most distant stations for contrast: locations #1 and #2. Location #1 is on a plateau while Location #2 is in a low spot and at the foot of a north-facing slope. The Hobo weather stations are used to measure temperature only. An Adcon weather station was installed recently to measure other weather parameters, but there is not enough data to present in this report.

II. Temperature and Heat Summation

2005 was a very mild weather year, with the Ranch accumulating from ca. 2500 to 2630 degree days, depending on location (Fig. 2). The five locations accumulated almost identical heat during April through May. In fact, with the exception of location #2, the heat units per month were very similar among all locations on the ranch. Location 2 was slightly lower than the other locations during June through October.

Long-term heat summation data (Figure 3) shows that locations #1 and #4 have the most heat units, while locations #3 and #5 are only slightly (about 50 degree days) lower. With the exception of location #2, the heat summations fall into the 2800 to 2900 degree day range, though there is a tremendous year-to-year variability in the data. Standard deviation over years are about 250 degree days. The available heat is sufficient to ripen a number of different varieties, from Rhone to Bordeaux varieties. Cabernet Sauvignon should ripen well at the higher elevations, but cool years, such as 2005 will find the ripening to be difficult, resulting in some herbaceous character in the wines during those years. Other Bordeaux varieties will ripen without difficulty.

The lowest heat summation units are found at location #2, which has about 2740 degree days. The reason that this location has lower degree days than the others lies in the lower nighttime temperatures, which will be discussed below.

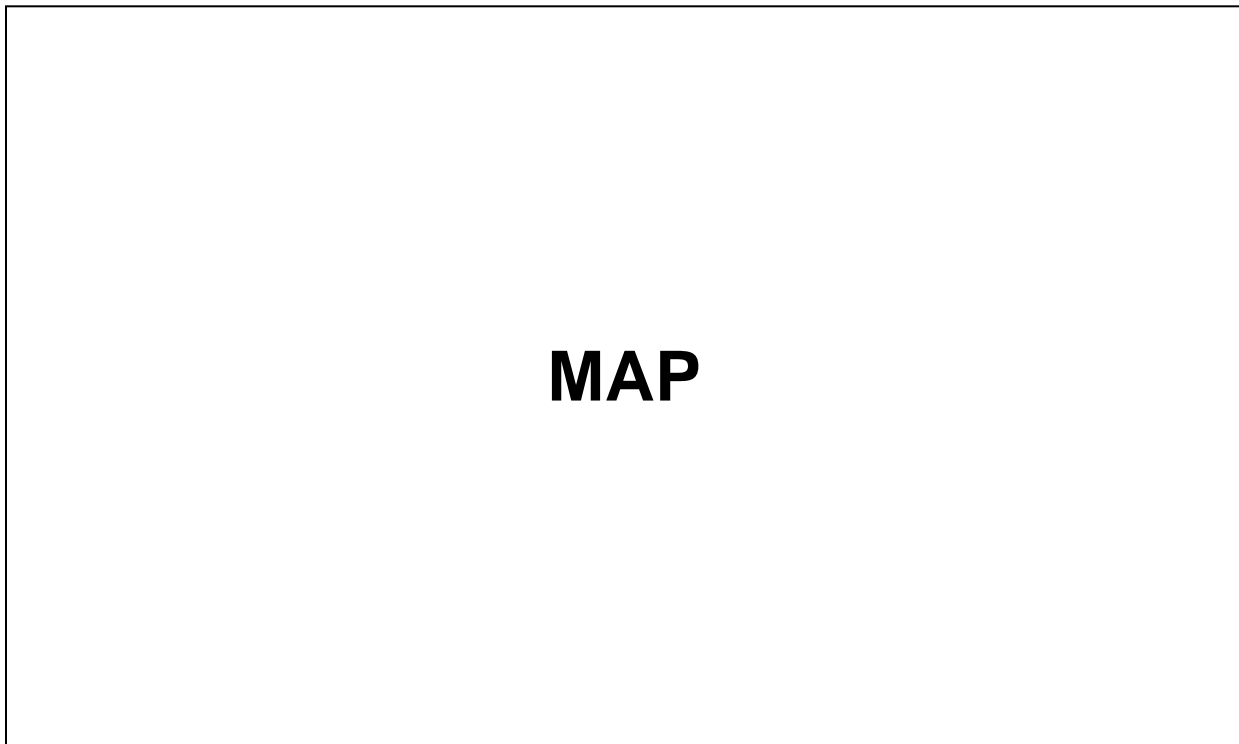


Figure 1: Map of Hobo Weather Stations at XYZ Ranch.

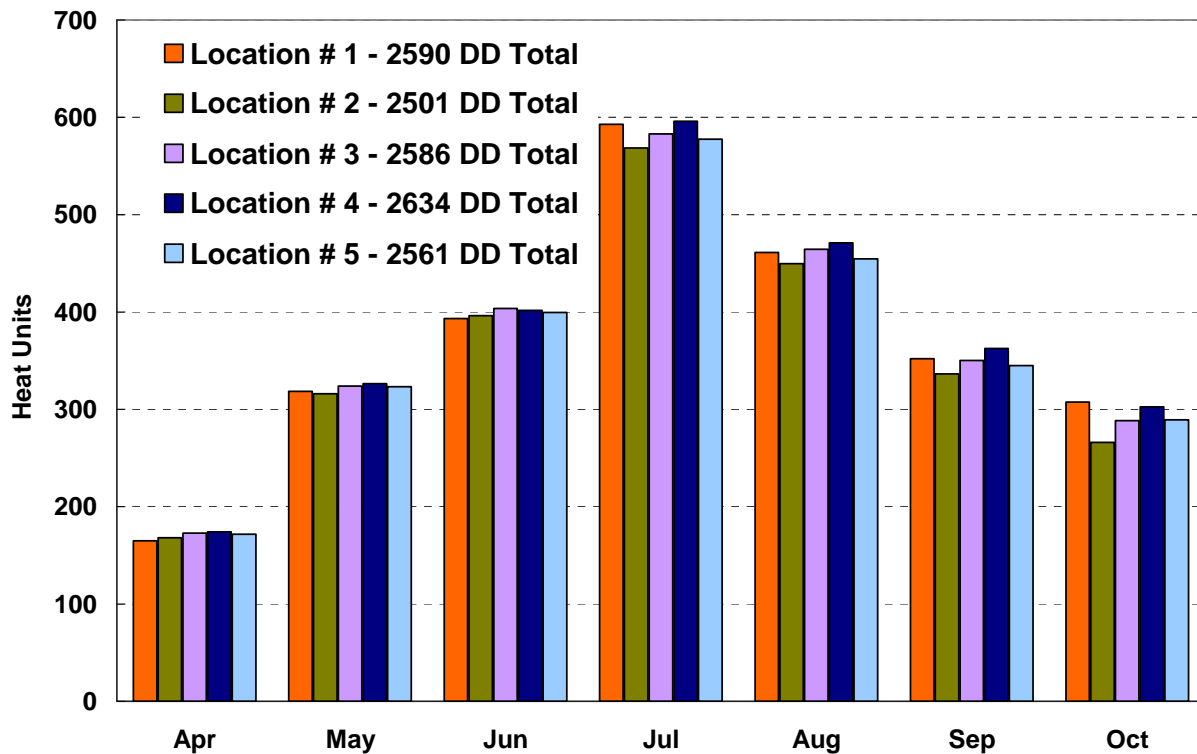


Figure 2: 2005 monthly heat summations for five locations. 50°F was used as the baseline temperature.

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Comparing monthly heat summations at locations #1 and #2 (Figure 4), location #2 has consistently lower heat units, with the exception of April when it is the same as location #1. Monthly heat units are from 10 to 30 degree days fewer at location #2 than at location #1.

Comparing daily maximum temperatures at the same two locations (Figure 5) for 2005, it is clear that any differences in heat summations are not related to daily high temperatures, as the daily maximum temperatures are virtually identical (within 2 degrees of one another). Clearly it is the nighttime temperatures that create differences in the heat summations for the XYZ property. Daily minimum temperatures at Location #2 are consistently lower than Location #1 by about 2 to 6 degrees. The differences between the plateau location (#1) and the bottom location (#2) is that cool air drains down the slopes at night, leaving warmer air at higher elevations and cooler air in the valleys. This is an important consideration for fruit ripening as well as for spring frost risk (discussed below). Daily average temperatures for the two contrasting locations (Figure 7) shows only small (1 to 3 degree) differences in the temperatures.

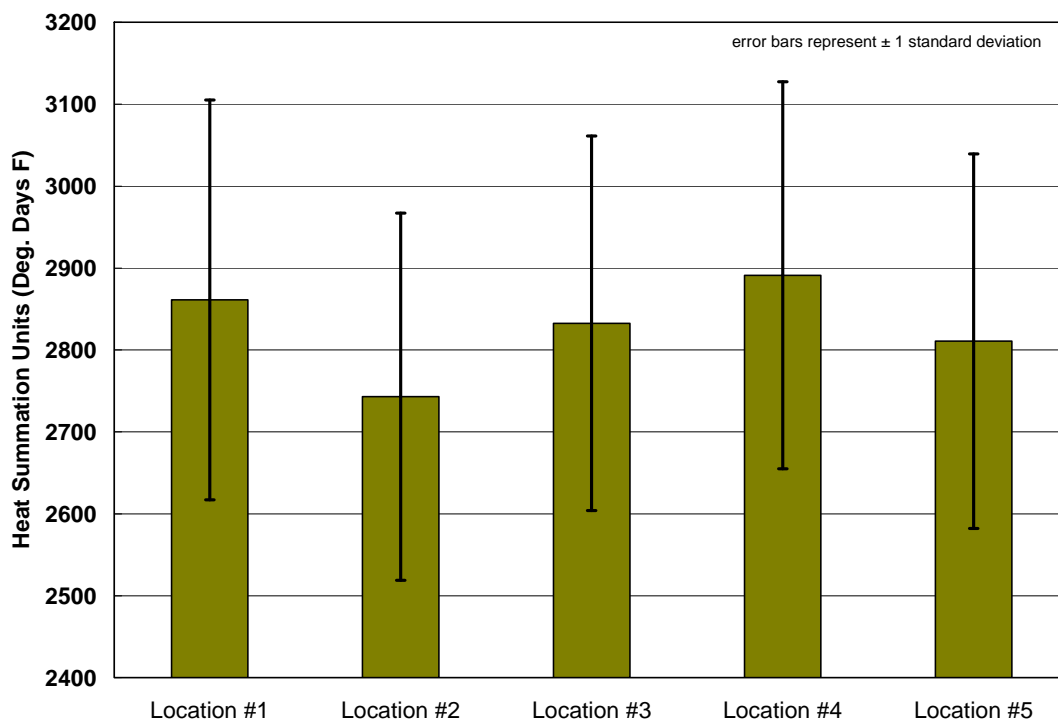


Figure 3: Estimated annual heat summations for the five locations. Data were modeled using the ABC weather station, by scaling the 2005 data sets. The data are means of years from 1991 through 2005.

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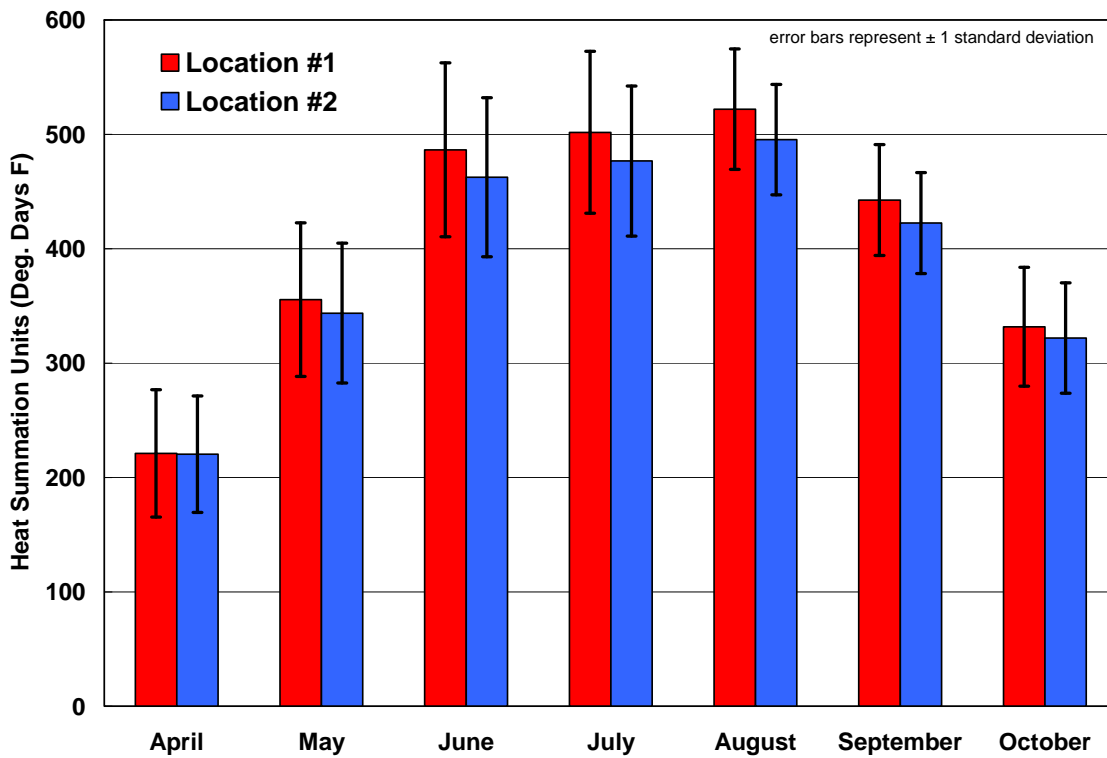
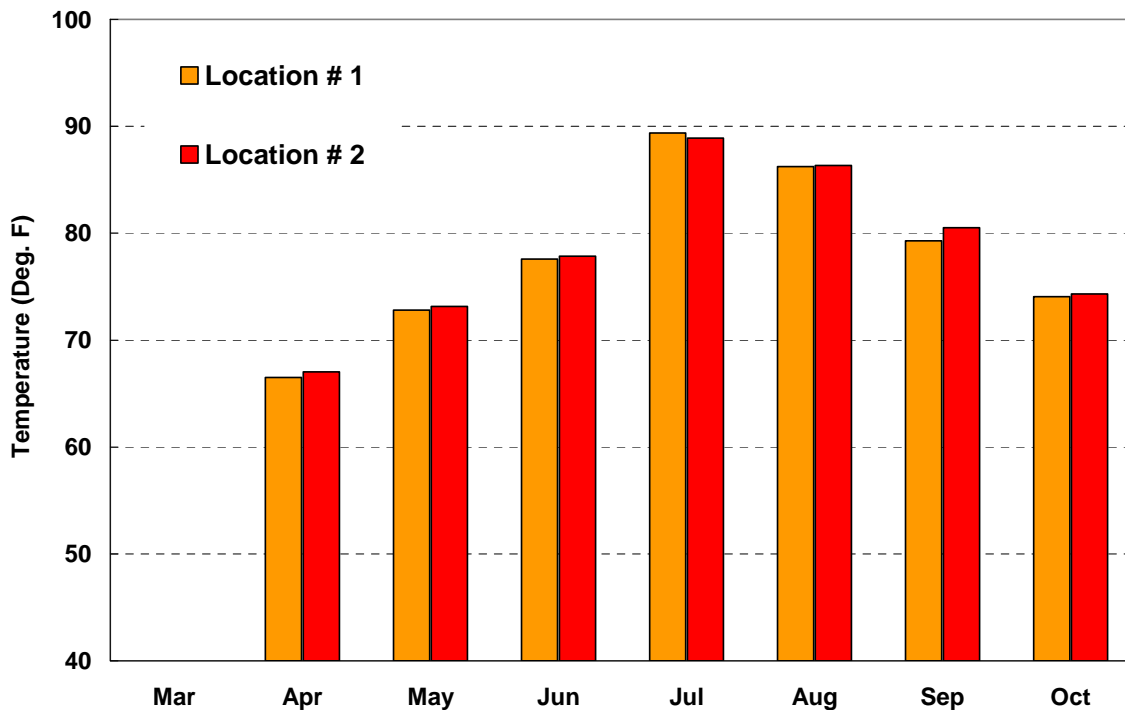


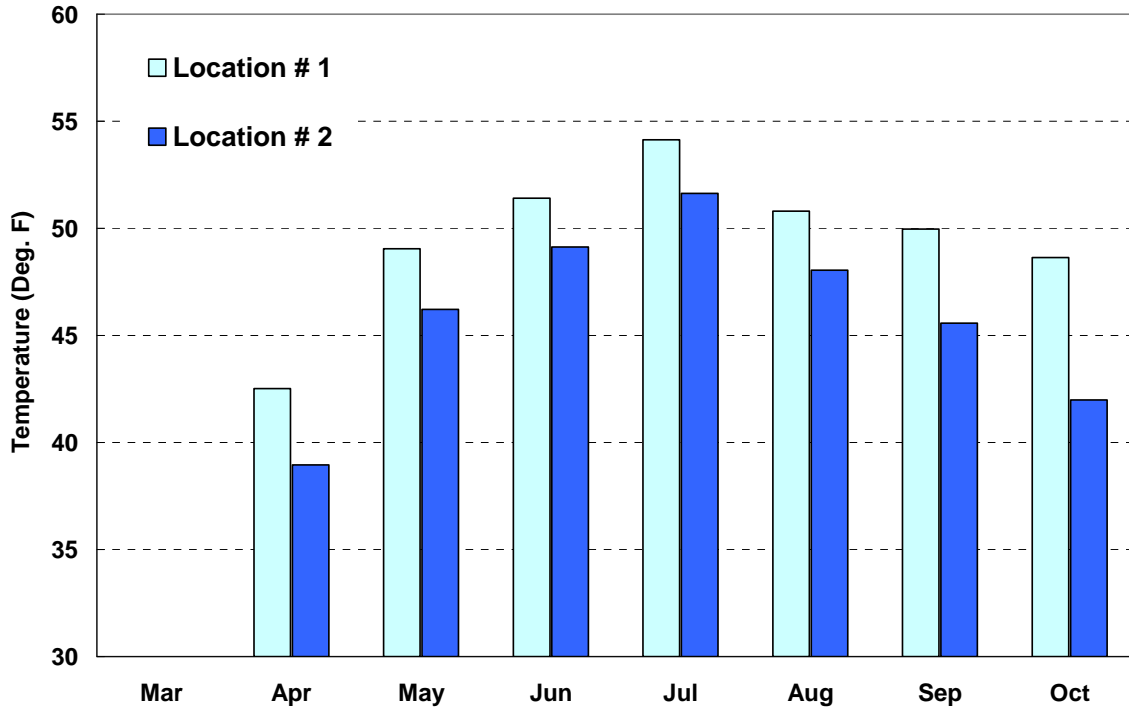
Figure 4: Estimated monthly heat summations for two contrasting locations. Data were modeled using the ABC weather station, by scaling the 2005 data sets. The data are means of years from 1991 through 2005.



hobos installed 3/30/05

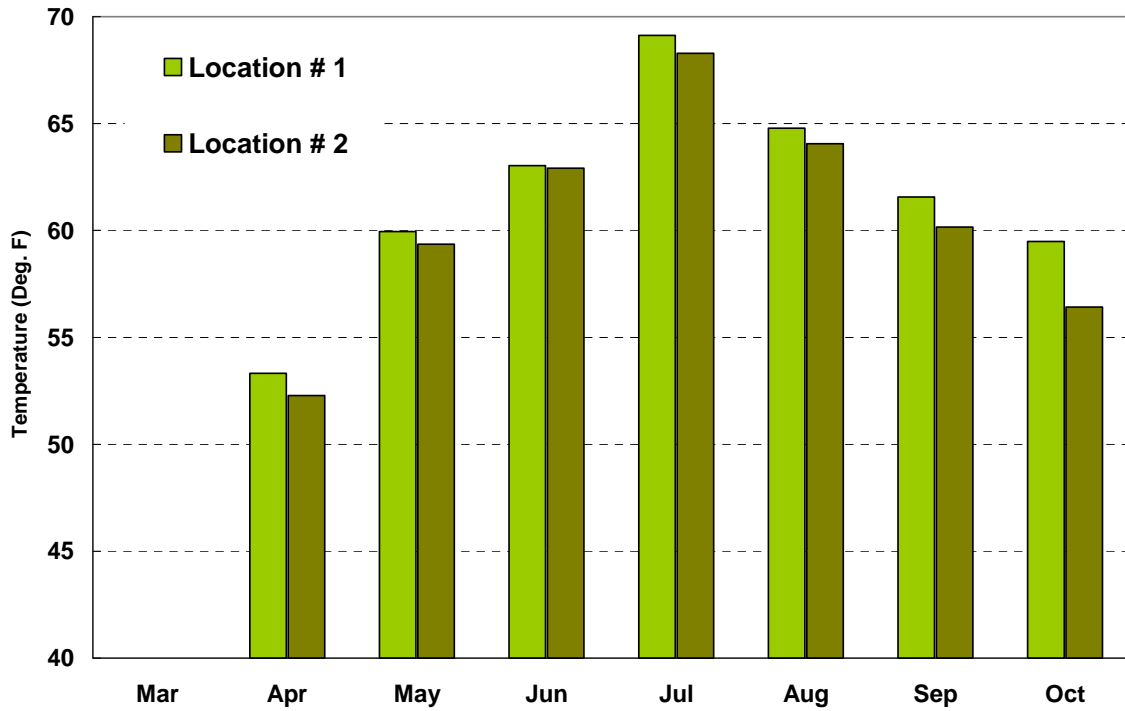
Figure 5: 2005 Monthly averages of daily maximum temperatures for two contrasting locations – 2005 data.

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hobos installed 3/30/05

Figure 6: Monthly averages of daily minimum temperatures for two contrasting locations – 2005 data.



hobos installed 3/30/05

Figure 7: Monthly averages of daily mean temperatures for two contrasting locations – 2005 data.

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 8 for 2005. That figure, along with the average diurnal temperature pattern during ripening (Fig. 9) reveals that the primary differences in the temperature regimes between these two location as well as all locations were in the night time temperatures. The lower the elevation, the lower the minimum temperature and the lower was the night temperature. Daytime temperatures were not very different among the five locations.

The warmer nighttime temperatures of the upper locations will accelerate acid metabolism of the fruit, causing the acidity to drop more rapidly. Day-night temperature differences would have additional effects on berry ripening and vine sugar production, as photosynthesis and the fruit’s secondary metabolism (which produces flavor, aroma and mouthfeel components) are also strongly influenced by temperature.

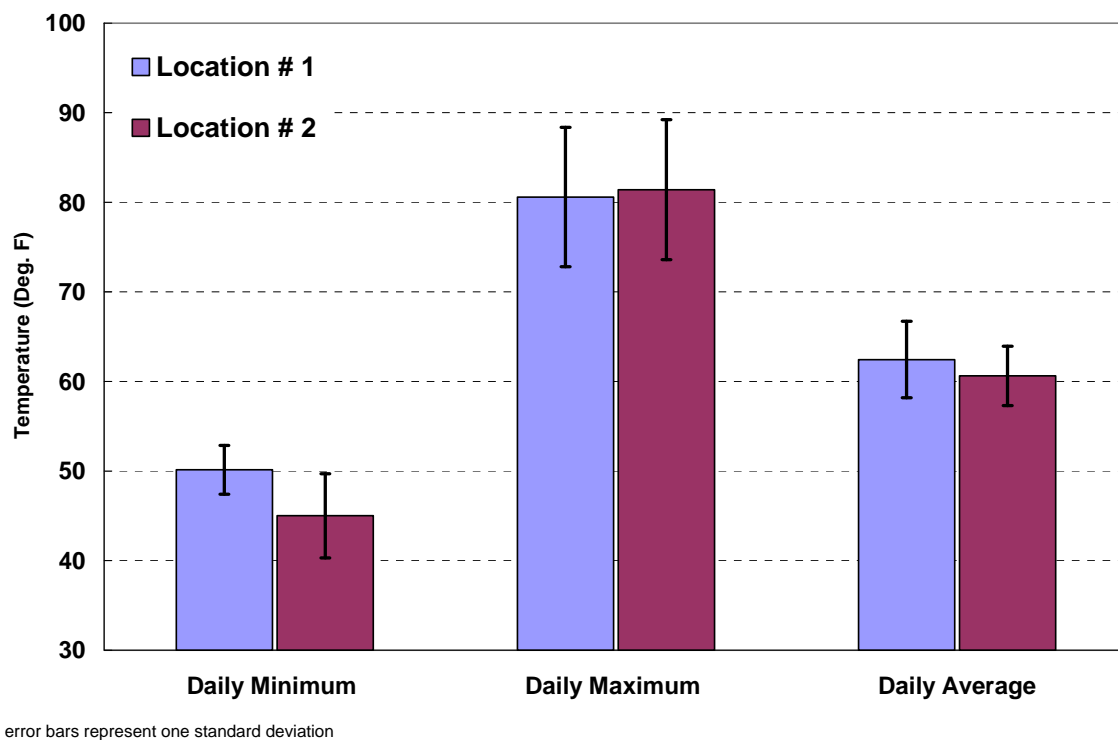


Figure 8: Average daily minimum, maximum and average temperature during the 2005 ripening period for two contrasting locations.

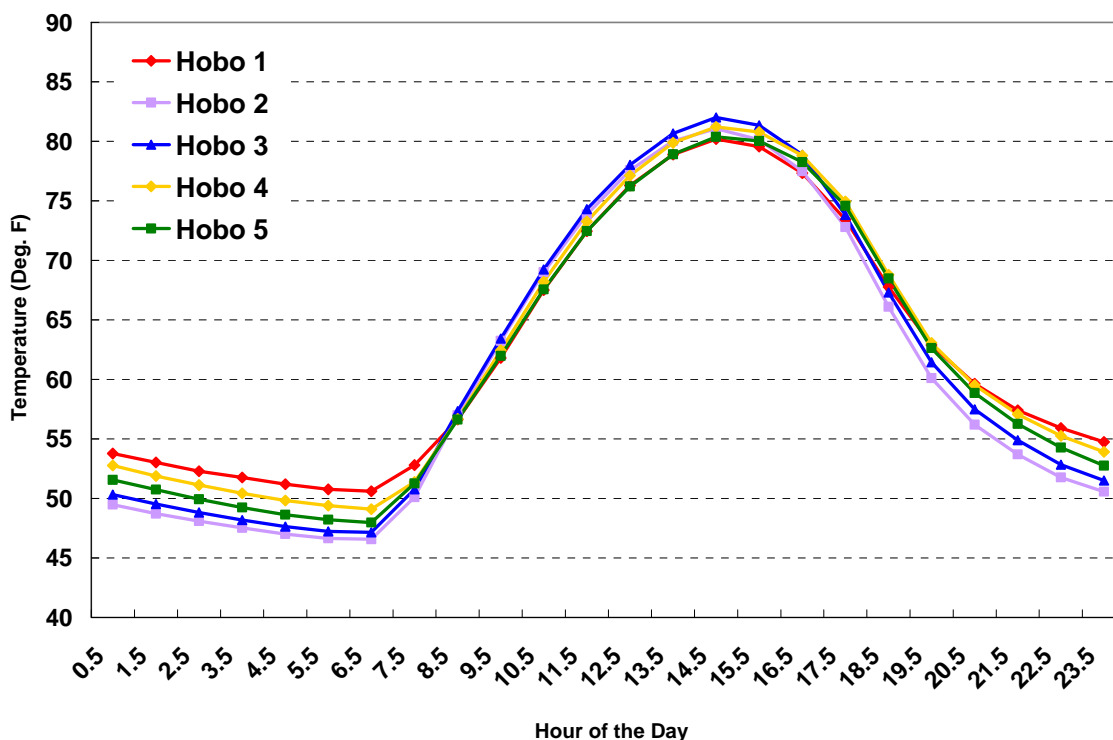


Figure 9: Average diurnal temperature cycle for five XYZ Ranch locations during the 2005 ripening period (mid-August through mid-October).

The diurnal temperature difference, about 30 to 33 °F is typical of a valley location. Generally, Syrah performs better in locations with smaller diurnal temperature swings. At this property, it would be best to locate any Syrah in the lower-lying areas, where night temperatures dip below 50 degrees during the ripening period. Below 50 °F, metabolism slows down to a halt, which will allow for acid retention in the Syrah. Locations near hobo station #2 and #3 (and possibly #5) would be best suited for Syrah.

Day-to-day weather variability can wreak havoc on a grape crop during the ripening period, especially when heat spikes and heat waves occur. On the other hand, a relatively constant weather pattern (primarily with regard to temperature) generally allows for slow and steady sugar accumulation in the grape which, in turn, facilitates the coincidence of flavor development alongside proper sugar concentration. Analyses of temperature variability were done for the daily maxima, minima and average temperatures during the ripening period (Fig. 10). The standard deviation statistic (SD) was used to describe the variability in the daily temperature data. Roughly 63% of the values will fall within ± 1 SD of the mean and 95% will fall within ± 2 SD of the mean. As this is the first season during which temperature data was being collected, there is not the ability to compare 2005 to a previous vintage. However, 2005 was characterized by a very steady temperature pattern, with essentially no heat spikes. The weather was generally mild, which should have promoted high quality fruit for winemaking. It is not clear at this time what an ideal value of temperature standard deviation is, as this statistic has not been previously used as a vintage quality indicator. However, by building up a knowledge base over time, the index may be used to identify superior and inferior vintages. If expectations of a high quality vintage persist regarding 2005, values shown here might be a valuable target in years to come.

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It should also be noted that there are some differences in the temperature variability between the two contrasting locations. However, the variability in the daytime (maximum) temperatures are identical for the two sites. All variability in temperature is due to the nighttime (minimum) temperature of the site. The bottom location (#2) has a higher variability than the upper location (#1). However, daytime temperature variability is more important than nighttime variability, so there should not be any reason that the lower locations should be considered inferior in this respect.

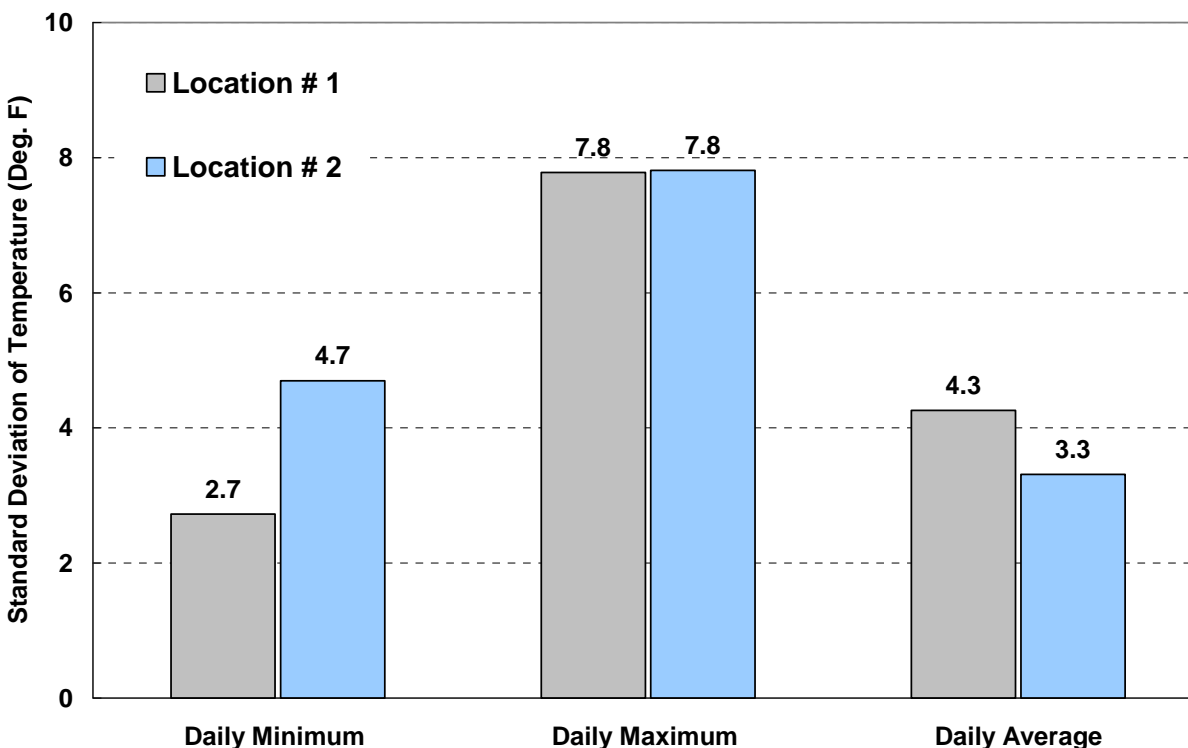


Figure 10: Standard deviation of max., min, and mean daily temperatures during the ripening stage (mid August through mid October) in 2005 for three locations at XYZ Ranch.

Finally, it is instructive to evaluate the time during which the temperatures exceeded given threshold levels during the ripening period (Fig. 11). While foliage and fruit temperatures are of primary importance (not ambient temperatures), we can estimate that foliage temperature roughly tracks air temperature \pm 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. As expected, the two contrasting sites had approximately the same number of hours when the temperature thresholds were exceeded. This is not unexpected, due to the similar daytime temperature patterns.

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

2005 SAMPLE WEATHER SUMMARY AND CLIMATE EVALUATION FOR XYZ RANCH 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. 2005 exhibited very few hours of fruit-degrading temperatures above 95 °F and no hours above 100 °F. Having zero hours of temperatures above 100 °F is very rare in this region, further indicating the exemplary weather characteristics of 2005 for potential wine quality. Since 2005 was an unusual year, a more comprehensive analysis was performed using the ABC reference station temperature data scaled to the XYZ locations using the respective 2005 data sets. Number of days for which the temperature thresholds were exceeded during the ripening period was computed over the 1991 through 2005 ripening periods (Figure 12). Again, it is clear that the differences in the maximum temperatures were not high among the five locations represented at the XYZ property. There are typically on the order of 20 days during ripening for which the temperature exceeds 90 °F, about 10 days exceeding 95 °F and about 5 days where 100 °F is exceeded. It would be beneficial for wine quality to provide protection for fruit against the afternoon sun, so that the hot days do not harm fruit through sunburn, shrivel or bleaching of pigment. The best means to protect fruit is through row orientation in a northeast-southwest angle, so that the sun is directly in line with the vine row during the hottest times of the day (about 3:00 pm).

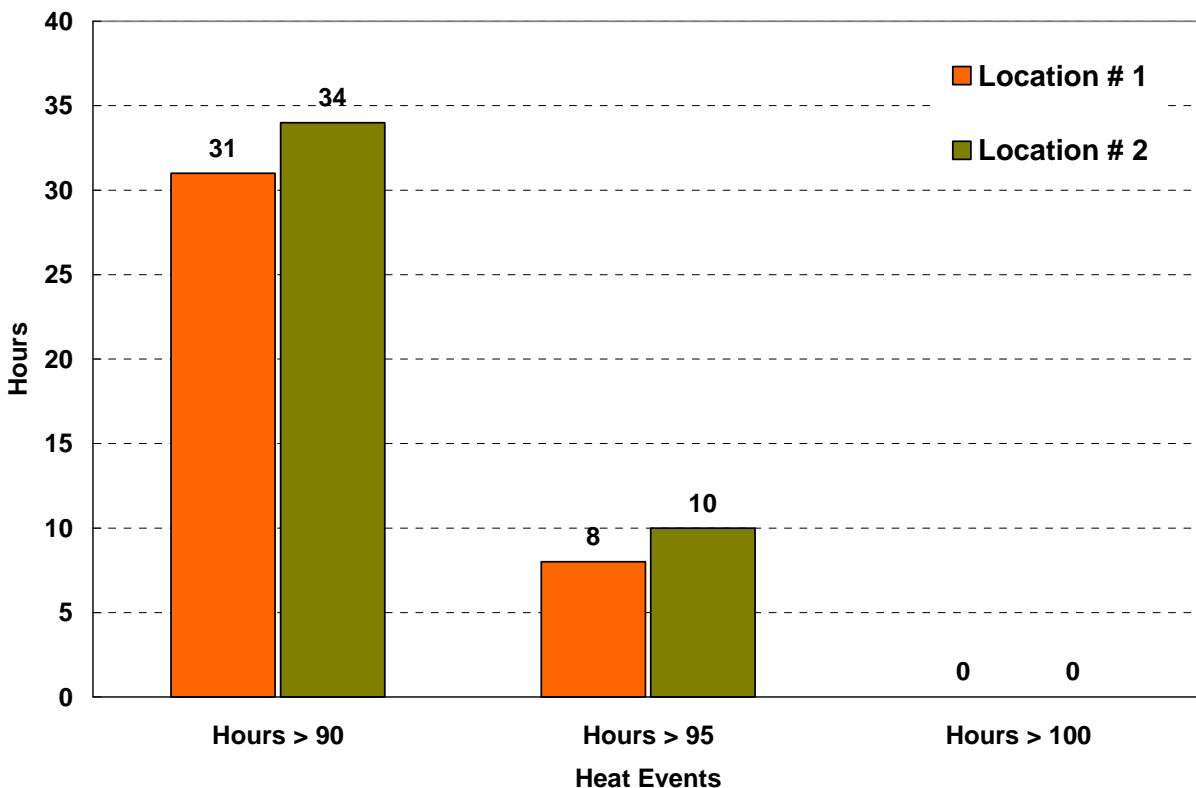


Figure 11: Hours above given critical temperatures during the ripening stage in 2005 for two contrasting locations at XYZ Ranch.

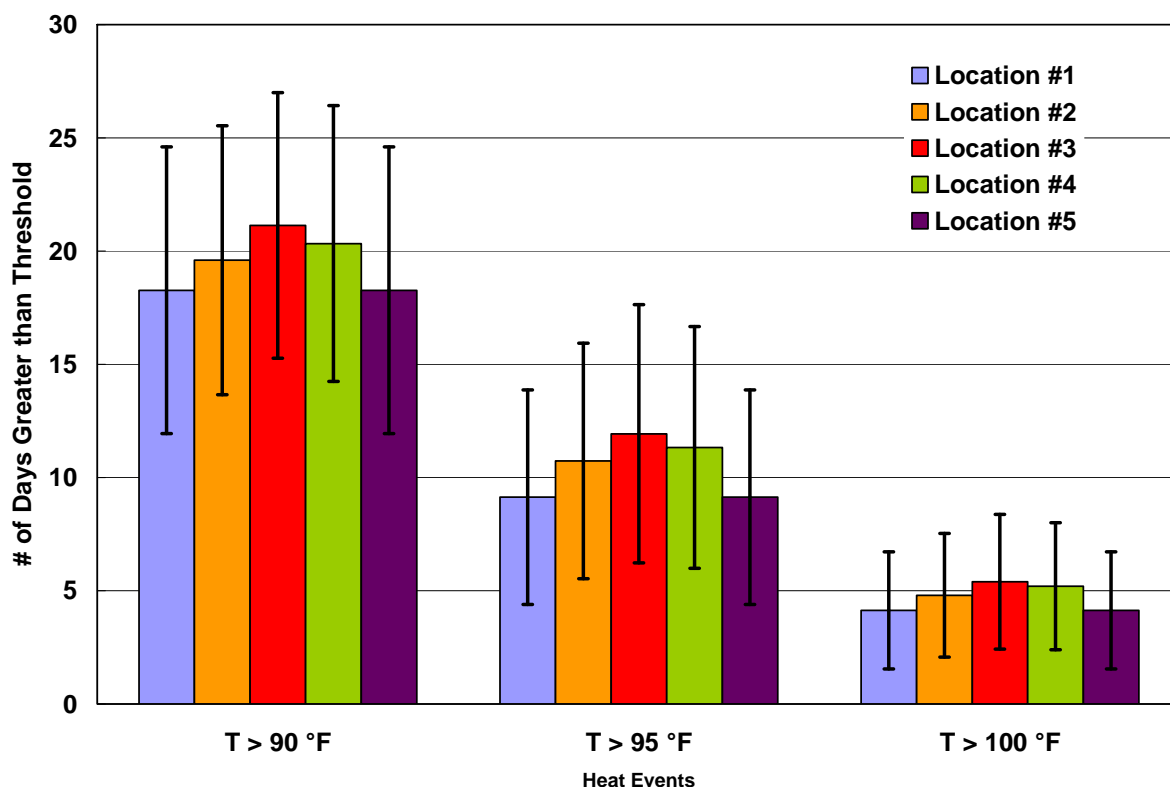


Figure 12: Number of days above several critical temperatures during the ripening stage at five locations at XYZ Ranch. Data were modeled using the ABC weather station by scaling the 2005 data sets. The data represent the years 1991-2005.

III. Frost Risk Analysis

Hobo temperature loggers were installed late in March, so data for frost events in March were not available. However, it is best to evaluate frost risk over an extended number of years, as frost events occur in variable numbers year after year. Long-term spring minimum temperatures were estimated for XYZ by scaling the 2005 spring temperature minima to those for the ABC reference station. Data from 1991 through 2005 were used to evaluate the number of days for which temperatures fell below 32 °F and 34 °F. Freezing of tissue occurs at 32 °F, but is possible (though unlikely) to occur at 34 °F if the dew point is very low. Nevertheless, the 34 °F threshold was evaluated to indicate days when overhead sprinklers may need to be activated in anticipation of possible frost.

Locations #1 and #4 are generally frost-free, but the other three locations have significant chances of spring frost, each having from 4 to 6 days for which temperatures fell below 32 °F.

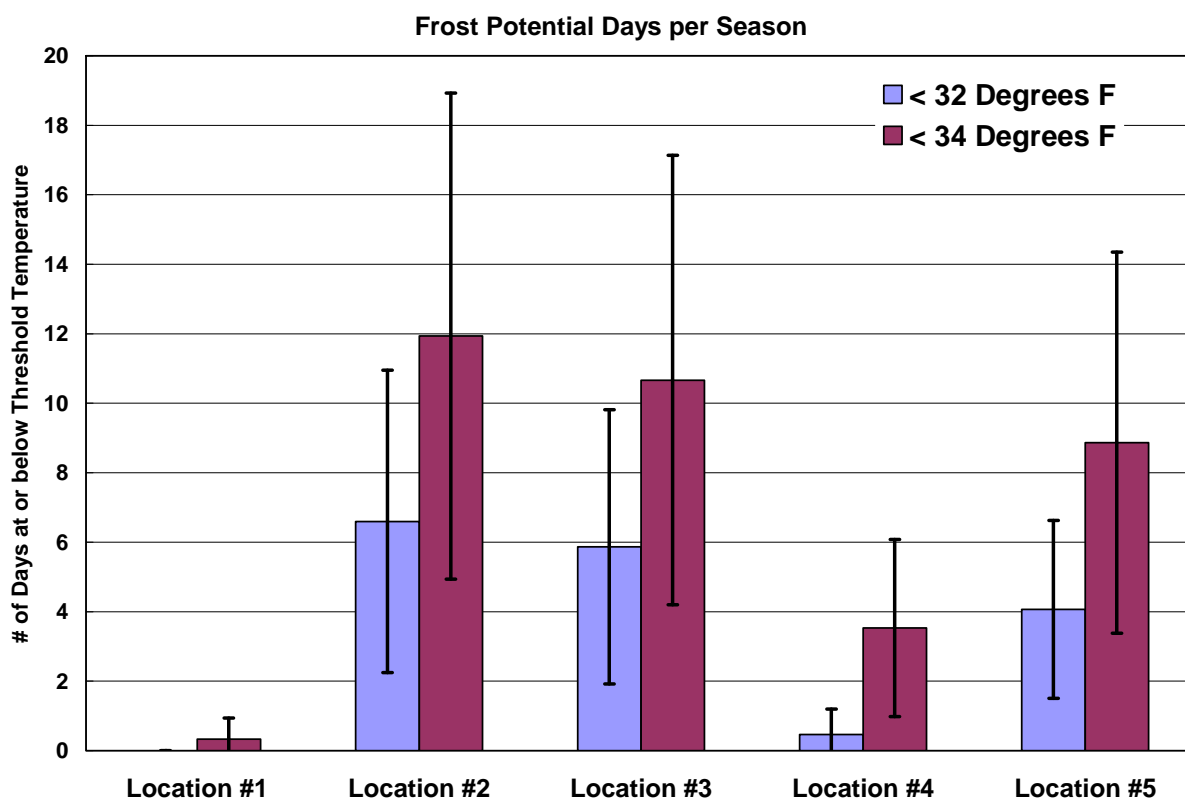


Figure 13: Average number of days below given threshold temperatures during March-May for five locations at XYZ Ranch. Data were modeled using the ABC weather station by scaling the 2005 data sets. The data represent the years 1991-2005.

IV. Conclusions

Daytime temperatures are uniform across the property. Only nighttime temperatures differ, with cooler temperatures found in the low-lying locations.

This data evaluation indicates that there is ample heat to ripen Bordeaux and Rhone grape varieties, amongst others. On the extreme, Cabernet Sauvignon will ripen in most years, but will have some herbaceous character in the cooler years, such as 2005. The other difficult variety, Syrah, will perform well at this ranch if situated in a low-lying region of the property. These locations will provide cool night temperatures necessary for acid retention by Syrah.

There are infrequent, but consistent periods of temperature extremes, with some hot days occurring during the growing season and some frost days occurring during the spring. Heat should be dealt with by proper row orientation and by not leaf pulling around the afternoon side of the fruit zone. Frost events will require the use of frost protection equipment, such as overhead sprinklers, in some of the locations of the property.