



2023
GROWING CONDITIONS REPORT

Introducing the Growing Conditions Report

Purpose. The Growing Conditions Report was created to provide NVG members with a simple tool to review the past year’s growing conditions at a glance. The report employs three simple and widely understood climate measurements known to influence grapevine development, ripening, and crop loads: growing degree days (GDD), total frost hours, and rainfall.

Historical Perspective. Additionally, the report provides data for previous growing seasons (starting in 2009), allowing grape growers to compare conditions across vintages. Over time, a multi-year collection of reports will add to our understanding of regional climate conditions and help to identify climate trends.

*To generate **growing degree days**, the single sine method was used with a minimum temperature threshold of 50 F.*

How the Report Was Created

Overview of the process. John Duckhorn of Picovale Services, Inc. provided weather data for each growing season from ±24 stations located throughout the major growing areas across Napa Valley. Using GIS, Sarah Ferguson of Ruetd mapped the three individual climate factors across the region and employed spatial analysis methods to further analyze the data and derive climate values for the report. Justin Leigon of Piña Vineyard Management and Sarah Ferguson, reviewed the climate data, mapping, and analysis, and provided an interpretation of how the findings influenced grape growing throughout Napa Valley.

*To generate **frost hours**, the study looked at total number of hours with temperatures under 36 F.*

***Rainfall** is expressed as total number of inches of rainfall for the entire calendar year.*

About the Countywide Growing Condition Maps

Three different maps were made to illustrate the three growing conditions throughout Napa County mentioned above: growing degree days, frost hours, and rainfall. Values for each condition were calculated for each of the approximately 24 weather stations. This grid of known weather values was used to estimate (through the process of interpolation) similar values in areas located between weather stations. To simplify the data and provide more generalized climate conditions, five-mile diameter circles (centered on commonly known Napa Valley locations and growing areas) were used to extract the raw climate data and generate a mean value for each area.

Project Summary

This report is broken down into three different segments: an annual summary of frost, rainfall, and growing degree days, a monthly review of the growing season by general region, and a deep dive into two key weather events. For the monthly data we will run through each of the products; growing degree days, rainfall, and frost hours by month with comments about the general effect on fruit and wine quality.

We will attempt to dissect the key weather related issues and provide an overall summary of the 2023 vintage. We will also try to highlight what possible effect these key weather-related events have on the resulting fruit and wine quality.

For the purpose of this discussion we will try to focus on the observations and general trends of each vintage, keeping in mind that this data or discussion may not reflect or relate to each individual grower experience during this season. In general, discussions about fruit quality and wine quality will reference Cabernet Sauvignon as the primary variety.

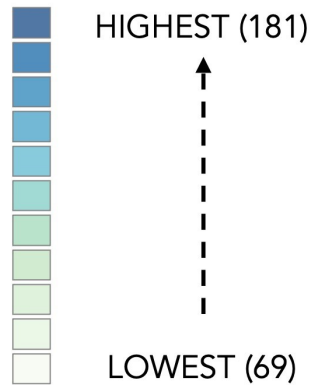
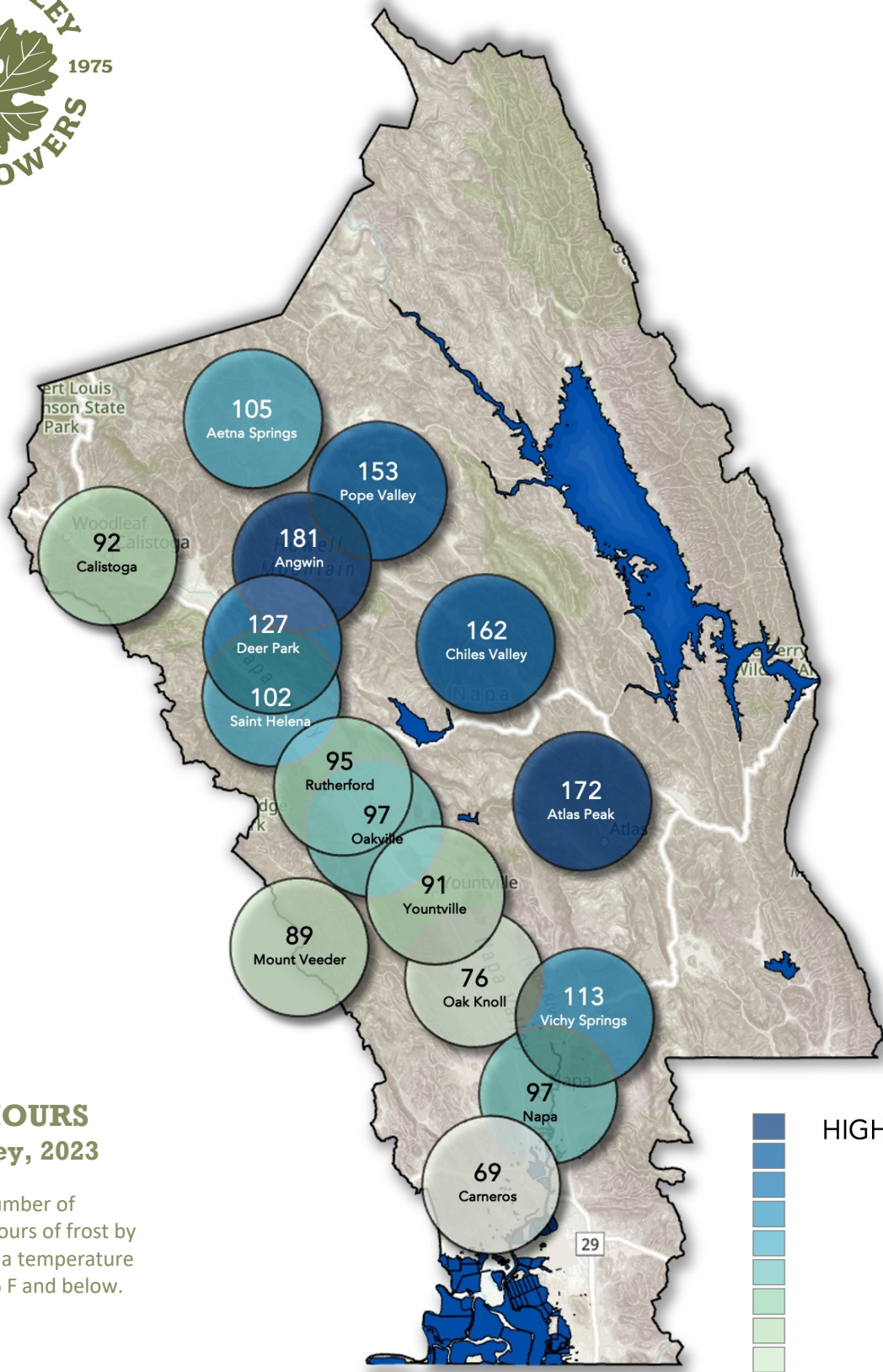
A few questions this project attempts to address:

1. Where might my vineyard fall in relation to other AVAs throughout Napa in terms of Growing Degree Days (GDD), Frost Hours, and Rainfall?
2. How did previous seasons compare to the 2023 season based on these parameters?
3. Just how “perfect or challenging” was the 2023 season, and what implications did that have for growers?
4. How did the weather at bloom affect set and overall crop yield?
5. What does a “more normal” season do for disease pressure? What was the general disease pressure in 2023?
6. What effect did spring soil moisture have on berry development and wine quality?
7. How can I be better prepared for the challenges posed by late season extreme weather events?
8. How does the timing and quantity of rainfall affect fruit and wine quality; did this have an effect on my overall yields?
9. How did we go about collecting and analyzing this data?
10. What are some resources to learn more about weather related issues in the vineyard?

How can you help us?

Consider installing a weather station and donating your data anonymously to this project. Contact John Duckhorn at Picovale Services (530) 889-8845

Would you like to see more parameters in our analysis? Please contact NVG if you are interested in helping with the next Growing Conditions Report.



FROST HOURS Napa Valley, 2023

The average number of accumulated hours of frost by area, based on a temperature threshold of 36 F and below.

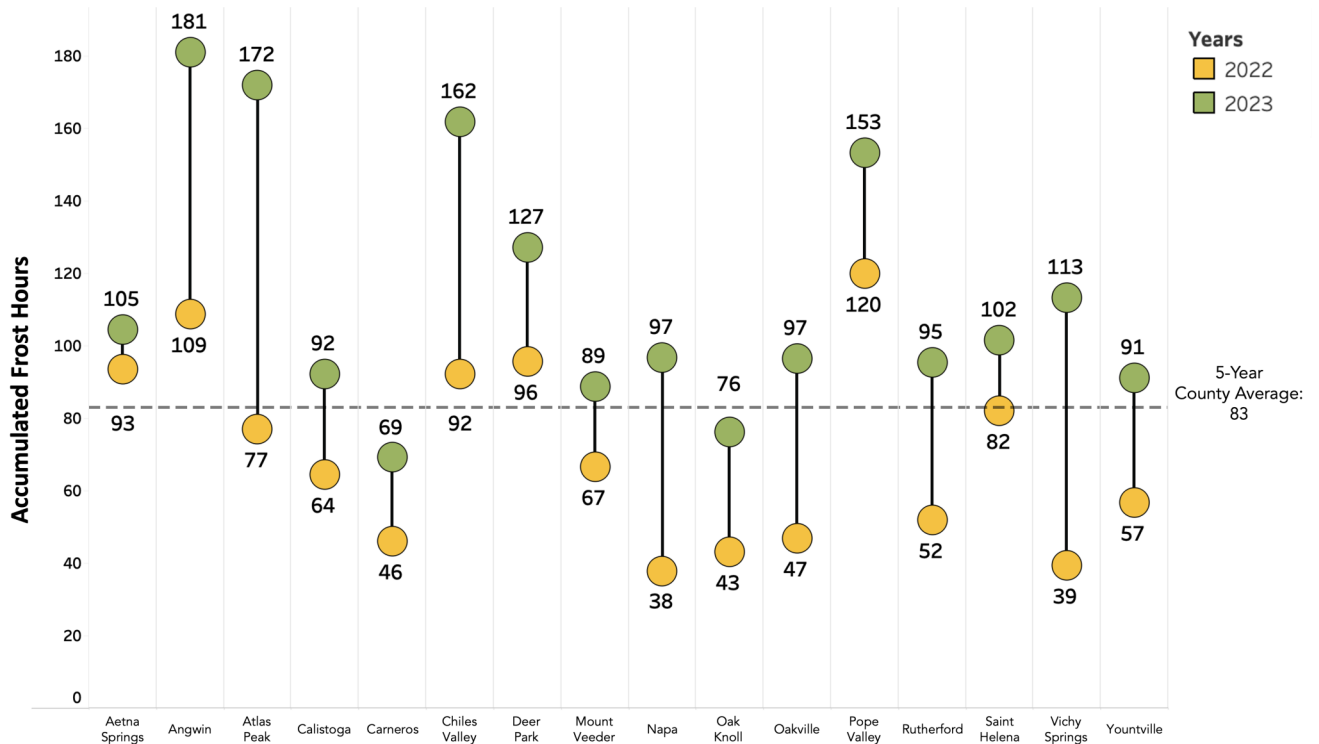


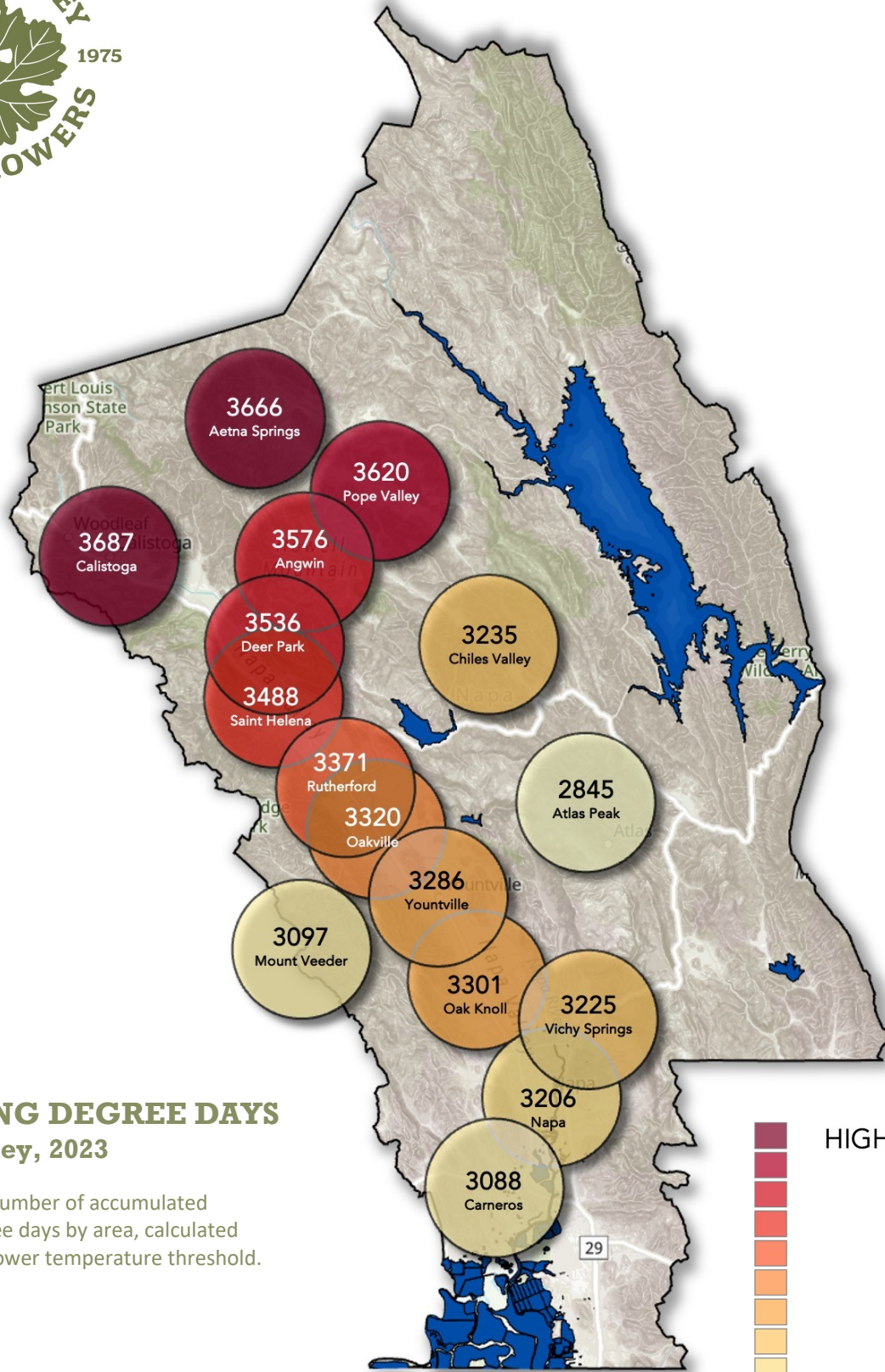
Frost hour data can be very useful for growers, specifically in planning for new vineyard developments, deciding what varieties to plant, etc. They can also have a dramatic impact on energy use, water use, and many grower's sleep patterns in any given year. Frost hours will vary greatly by location, and especially throughout different vineyard conditions. Low spots and poorly drained areas will always see a greater risk of frost, so vineyard-specific readings are very important when assessing your frost risk.

Overall frost hours for 2023 were significantly higher than in

2022, with an average of 114 hours across the Napa Valley. The largest percent increase came from Vichy Springs in Napa—113 hours in 2023 vs 39 hours in 2022. Angwin saw the highest number of total frost hours with 181, and close behind were Atlas Peak with 172 hours, Chiles Valley with 162 hours, and Pope Valley with 153 hours. Carneros had the lowest number of frost hours recorded with 69 hours total. On average, monitored sites across the valley saw a 73% increase in total frost hours compared with 2022. Fortunately, budbreak was delayed due to the wet and cold winter soils, and no major frost damage was reported.

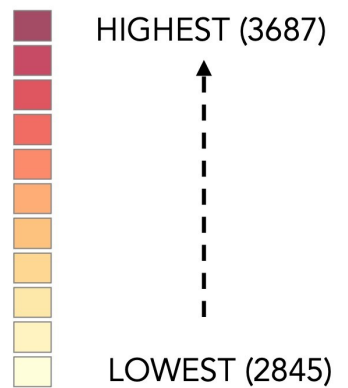
Area	2019	2020	2021	2022	2023	% change: 2022/2023
Aetna Springs	72	142	156	93	105	+ 12%
Angwin	71	129	160	109	181	+ 67%
Atlas Peak	38	112	119	77	172	+ 123%
Calistoga	46	69	82	64	92	+ 43%
Carneros	7	33	81	46	69	+ 50%
Chiles Valley	53	121	143	92	162	+ 76%
Deer Park	61	87	133	96	127	+ 33%
Mount Veeder	27	60	112	67	89	+ 33%
Napa	7	35	63	38	97	+ 156%
Oak Knoll	14	44	78	43	76	+ 77%
Oakville	26	51	120	47	97	+ 106%
Pope Valley	81	153	184	120	153	+ 28%
Rutherford	35	49	106	52	95	+ 84%
Saint Helena	53	59	112	82	102	+ 24%
Vichy Springs	7	33	46	39	113	+ 189%
Yountville	24	54	133	57	91	+ 61%
Countywide Average	39	77	114	70	114	+ 73%





GROWING DEGREE DAYS Napa Valley, 2023

The average number of accumulated growing degree days by area, calculated using a 50°F lower temperature threshold.



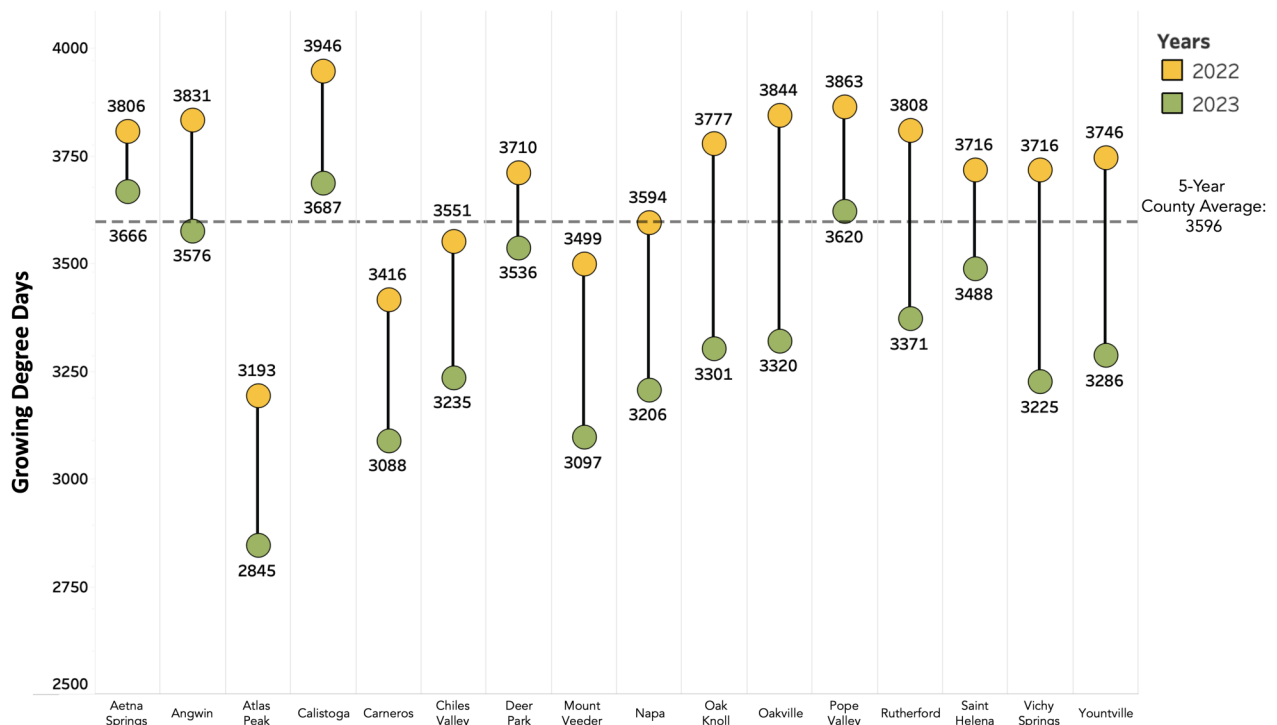


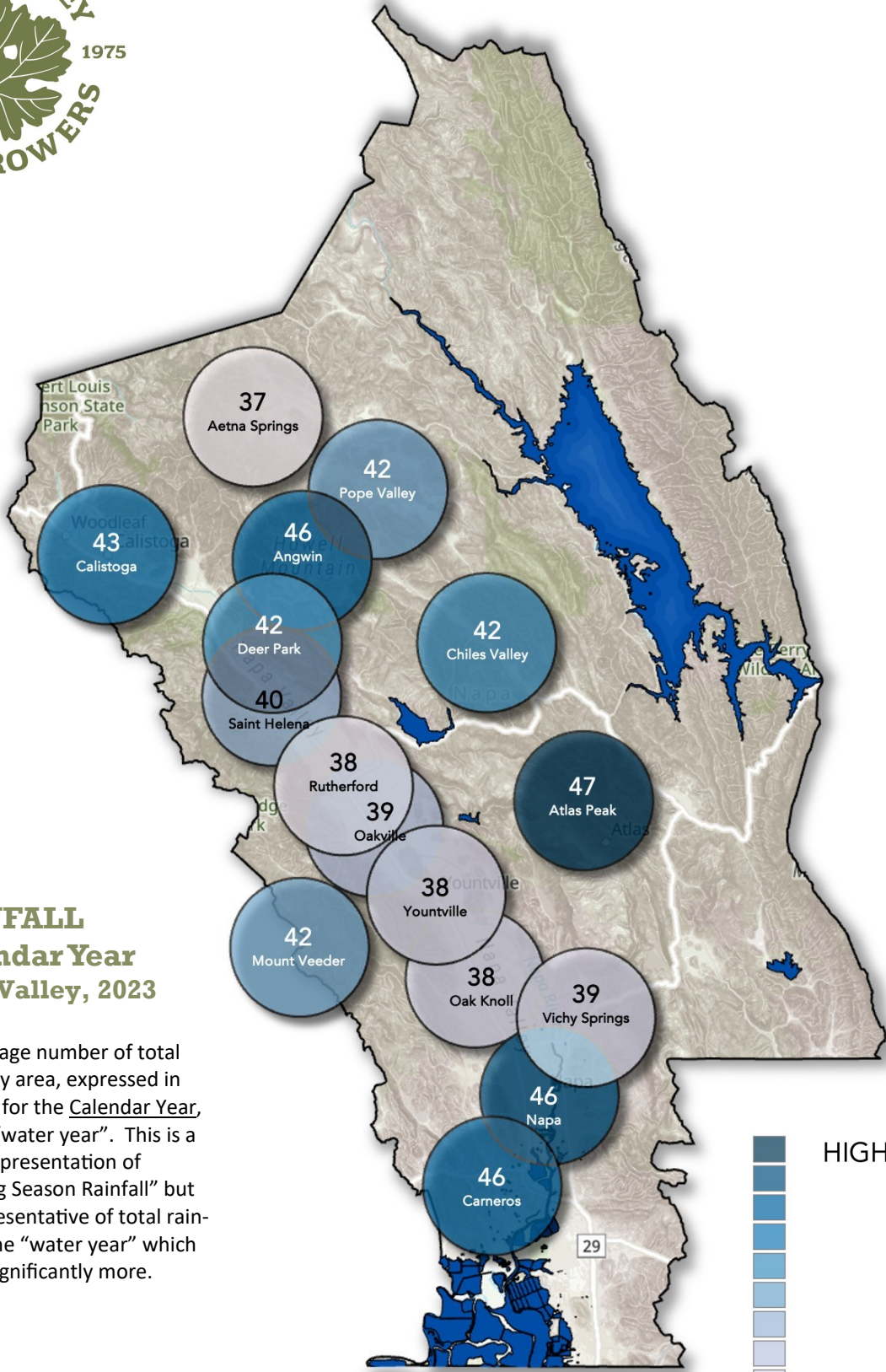
In 2023, Growing Degree Days (GDD) marked the lowest figures in recent years, averaging 10% below 2022 and reminiscent of the cooler vintages of 2010, 2011, and 2016. The year commenced with a sluggish accumulation in early spring, leading to a delayed start to the growing season that trailed the average by 1-2 weeks. This delay extended from budbreak, an elongated bloom period, and persisted throughout the season. Despite warm temperatures in July and August, which brought GDD figures comparable to the long-term average for these months,

Area	2019	2020	2021	2022	2023	% change: 2022/2023
Aetna Springs	3665	4031	3875	3806	3666	- 4%
Angwin	3440	4128	3634	3831	3576	- 7%
Atlas Peak	3193	3635	3111	3193	2845	- 11%
Calistoga	3710	4310	3875	3946	3687	- 7%
Carneros	3236	3489	3192	3416	3088	- 10%
Chiles Valley	3450	3841	3444	3551	3235	- 9%
Deer Park	3458	3982	3524	3710	3536	- 5%
Mount Veeder	3341	3648	3398	3499	3097	- 12%
Napa	3461	3730	3278	3594	3206	- 11%
Oak Knoll	3624	3948	3524	3777	3301	- 13%
Oakville	3601	3970	3646	3844	3320	- 14%
Pope Valley	3599	3967	3814	3863	3620	- 6%
Rutherford	3559	4007	3613	3808	3371	- 11%
Saint Helena	3509	4026	3583	3716	3488	- 6%
Vichy Springs	3554	3937	3390	3716	3225	- 13%
Yountville	3623	3932	3583	3746	3286	- 12%
<i>Countywide Average</i>	3501	3911	3530	3689	3347	- 9%

they weren't sufficient to close the gap or accelerate phenological development. As a result, veraison lagged behind the previous year by 2 weeks and trailed the long-term average by 3-5 days.

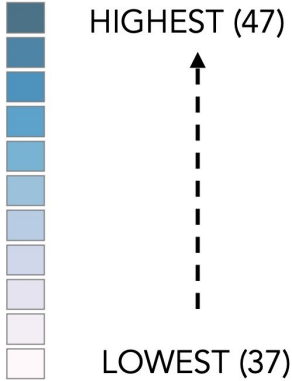
Overall, GDD accumulation for 2023 was significantly lower than in 2022, with a notable difference of 342-degree days. Calistoga recorded the highest GDD, totaling 3,687 putting it in Region IV of the Winkler Index, while Carneros registered the lowest GDD at 3,088, Region III. With a substantial variance of almost 600-degree days between the warmer and cooler areas of Napa, each region had its distinctive experience with the conditions of 2023.





RAINFALL
Calendar Year
Napa Valley, 2023

The average number of total rainfall by area, expressed in inches is for the Calendar Year, not the “water year”. This is a better representation of “Growing Season Rainfall” but not representative of total rainfall for the “water year” which can be significantly more.

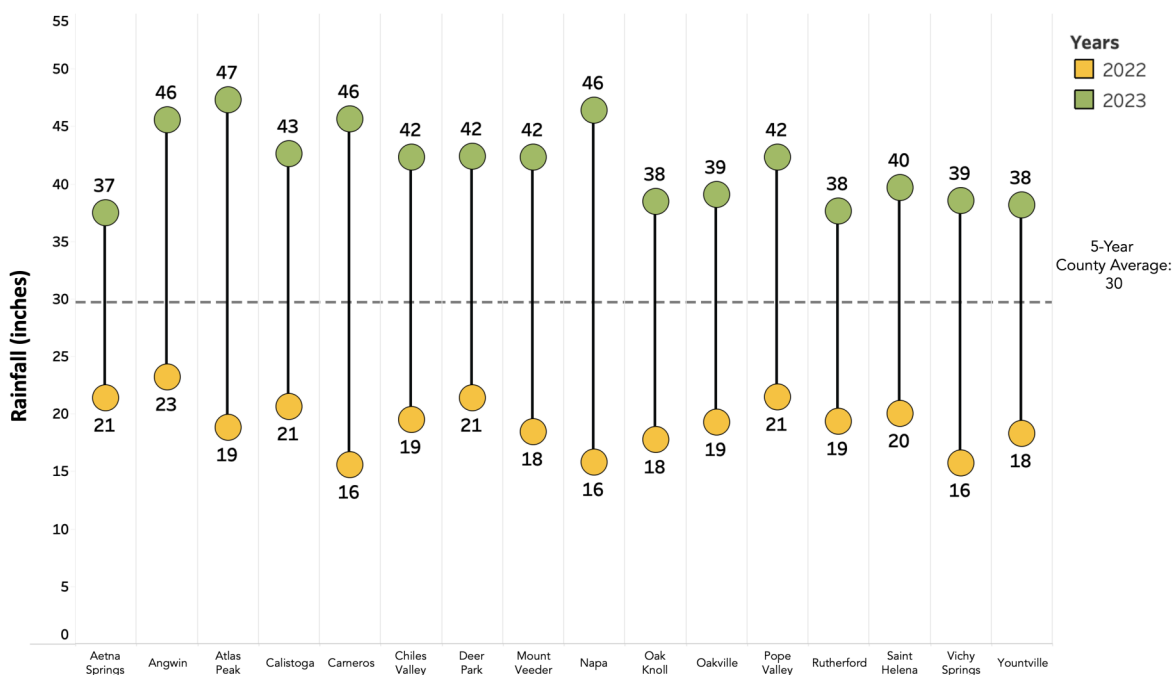




The 2022-2023 water year (calculated from July 2022-June 2023) was significantly wetter than the previous water year—most notably for December, January, and March. Classic winter storms and an atmospheric river brought widespread rains during the final days of 2022 and set the tone for the rest of winter. Even though most areas of the valley received over 10” of rain during December 2022, the soil was able to absorb the much-needed moisture since it occurred over the span of approximately twenty days. During January 2023, a new

Area	2019	2020	2021	2022	2023	% change: 2022/2023
Aetna Springs	52.2	9.6	31.9	21.4	37.5	+ 76%
Angwin	52.3	12.2	34.7	23.2	45.6	+ 96%
Atlas Peak	55.1	12.5	38.7	18.8	47.3	+ 151%
Calistoga	51.6	13.4	37.1	20.6	42.6	+ 106%
Carneros	31.4	10.3	24.2	15.6	45.6	+ 193%
Chiles Valley	51.5	11.1	32.6	19.5	42.3	+ 117%
Deer Park	48.8	11.0	36.1	21.4	42.4	+ 98%
Mount Veeder	36.4	11.4	28.5	18.4	42.3	+ 129%
Napa	34.9	10.6	26.2	15.8	46.4	+ 194%
Oak Knoll	44.6	12.1	30.8	17.8	38.5	+ 117%
Oakville	45.8	10.0	27.3	19.3	39.0	+ 102%
Pope Valley	49.9	10.6	31.3	21.5	42.3	+ 97%
Rutherford	45.6	9.6	28.0	19.4	37.7	+ 94%
Saint Helena	46.1	10.2	34.1	20.0	39.7	+ 98%
Vichy Springs	38.5	10.3	28.6	15.7	38.5	+ 145%
Yountville	47.7	10.7	29.1	18.3	38.2	+ 109%
<i>Countywide Average</i>	<i>45.8</i>	<i>11.0</i>	<i>31.2</i>	<i>19.2</i>	<i>41.6</i>	<i>+ 120%</i>

phrase appeared in headlines across California, “State simultaneously in a drought and flood emergency.” December 2022 and January 2023 accounted for nearly 50% of the entire water year’s rainfall. March was also exceptionally wet, with eighteen days of registered precipitation that accounted for another 25% of the water year’s rainfall. Growers talked of a return to normality and a general sense of optimism around potential crop yield spread across the valley. On average, the valley received 41.6” of rainfall and 120% more than in 2022. Totals for the water year across Napa Valley were 36” in Carneros, 51” in St. Helena, 50” in Howell Mountain, 50” in Calistoga, 53” in Atlas Peak, and 40” in Oak Knoll.



2023 Vintage Summary

The 2023 vintage yielded a bountiful crop, offering deeply colored wines of promisingly high quality. The abundance of rainfall at the outset of the season filled reservoirs, secured a historic snowpack in the mountains, and ushered in one of California's coldest winters on record.

The cold winter, coupled with above-average rainfall, resulted in delayed activities in the vineyard for both vineyard crews and machinery, as well as in grapevine phenology. However, this delay proved fortuitous and minimized the risk of frost damage. The most critical period for frost prevention occurred during the lows of March 26-27, when temperatures plummeted below 30F across the valley.

The summer of 2023 unfolded with remarkably mild temperatures. Below-average temperatures in late May prolonged the bloom period for Cabernet Sauvignon by at least 2-3 weeks. However, the mild season also fostered more favorable conditions for powdery mildew growth, necessitating additional fungicide sprays for disease control.

Although globally, 2023 was reported as the hottest year on record, locally in Napa Valley, conditions were relatively mild, with a 10% reduction in growing degree days compared to the previous year. Nonetheless, heatwaves persisted across the valley, with Calistoga experiencing 25 days over 100 degrees, albeit fewer than the previous year's count of 28 days. Similarly, St. Helena saw 11 days over 100F compared to 15 last year, while Howell Mountain reported 8 days for both years and Atlas Peak had 5 days this year compared to 8 in 2022.

Most of the 100-degree days occurred during the summer months of July and August, followed by a surprisingly cool and dry September. The contrast between September 2023 and the scorching 120F heat of September 2022 was astonishing, with the latter month devoid of any 100-degree temperatures.

The lack of major heatwaves during the fruit maturation period prevented late-season dehydration. However, a few late-season showers, coupled with these mild temperatures, necessitated additional fungicide sprays against botrytis.

While early cultivars were sporadically picked in September, the bulk of the 2023 harvest season extended through October and into November, making it one of the longest harvest periods in recent memory. Yields were up by about 20%, with early reports indicating exceptional wine quality.

Resumen de la Cosecha del 2023

La cosecha de 2023 fue abundante y ofreció vinos de gran color y calidad. La abundancia de precipitaciones al inicio de la temporada llenó los embalses, garantizó una capa de nieve histórica en las montañas y dio paso a uno de los inviernos más fríos registrados en California.

El frío invierno, unido a unas precipitaciones superiores a la media, provocó retrasos en las actividades en el viñedo, tanto para el personal como para la maquinaria, así como en la fenología de las vides. Sin embargo, este retraso resultó fortuito y minimizó el riesgo de daños por heladas. El periodo más crítico para la prevención de las heladas se produjo durante las mínimas de los días 26 y 27 de marzo, cuando las temperaturas cayeron por debajo de los 30º F en todo el valle.

El verano de 2023 se presentó con temperaturas notablemente templadas. Las temperaturas inferiores a la media registradas a finales de mayo prolongaron el periodo de floración del Cabernet Sauvignon al menos 2-3 semanas. Sin embargo, la temporada de temperaturas templadas también propició unas condiciones más favorables para el crecimiento del mildiú polvoroso, lo que hizo necesarias las aplicaciones adicionales de fungicidas para el control de enfermedades.

Aunque a nivel mundial el 2023 fue el año con los registros más calurosos, a nivel local en el valle de Napa las condiciones fueron relativamente moderadas, con una reducción del 10% de los días-grado de crecimiento en comparación con el año anterior. No obstante, las olas de calor persistieron en todo el valle, y Calistoga registró 25 días de más de 100 grados, aunque menos que los 28 días del año anterior. Del mismo modo, en St. Helena se registraron 11 días por encima de los 100 grados, frente a los 15 del año pasado, mientras que Howell Mountain registró 8 días en ambos años y Atlas Peak tuvo 5 días este año, frente a los 8 de 2022.

La mayoría de los días de 100 grados se produjeron durante los meses de verano de julio y agosto, seguidos de un septiembre sorprendentemente fresco y seco. El contraste entre septiembre de 2023 y el calor abrasador de septiembre de 2022 fue asombroso, ya que en este último mes no se registraron temperaturas de 100 grados.

La ausencia de grandes olas de calor durante el periodo de maduración de la fruta evitó la deshidratación a finales de temporada. Sin embargo, algunas lluvias de final de temporada, junto con estas temperaturas templadas, hicieron necesarias aplicaciones adicionales de fungicidas contra la botritis.

Aunque en septiembre se recolectaron esporádicamente variedades muy tempranas, la mayor parte de la temporada de recolección de 2023 se prolongó hasta octubre y noviembre, lo que la convirtió en uno de los periodos de recolección más largos de los últimos tiempos. Los rendimientos aumentaron alrededor de un 20%, y los primeros informes indican una calidad excepcional del vino.

Breakdown by Month: 2023 Growing Season

JANUARY

Rainfall: The first half of January was characterized by strong storms, thanks in part to the Pineapple Express—a strong atmospheric river built by moisture from the tropical Pacific around Hawaii. The weather system stalled over California, leading to the formation of a “bomb cyclone” that resulted in as much as 15” of rain over parts of the valley! Vineyard crews—antsy to prune—could not make significant progress during the wet weather, but cover crops soaked up the moisture and were in great shape leading into the growing season. The low-pressure system also generated a strong cold front along with the atmospheric river, leading to impressive amounts of snowfall in the Sierra Nevada. The statewide snowpack reached ~200% of average at the end of January 2023. Like January 2022, the latter part of the month was unseasonably dry. Monthly average rainfall amounts for January ranged from 11.38” in Carneros, 14.41” in St. Helena, 15.04” in Calistoga, 14.51” in Howell Mountain, 5.10” in Oak Knoll, and 14.25” in Atlas Peak.

Temperature: Daily average temperatures for the month of January hovered around the mid-40s, with no frost during the first half of the month due to the strong subtropical atmospheric river. The latter half of the month was in stark contrast, and many regions of Napa Valley saw lows in the mid-20s. Weak ridges formed from the jet stream, and cold air settled across the valley through the end of January. The dry spell allowed growers to make quick progress with vineyard pruning. Except for Howell Mountain, the lowest temperatures recorded for the month occurred on January 21 and were 28.9F in Carneros, 27.7F in St. Helena, 24.4F in Calistoga, 27.6F in Oak Knoll, and 27.7F in Atlas Peak. Like recent past vintages, the mountainous regions deviated from the averages of the valley. January 2 was the coldest day registered in Howell Mountain with 33.3F, and then unexpectedly the area saw lows in the last week of the month above 55F! An impressive diurnal temperature variation happened on January 25 when daily highs peaked for the month with 68.5F in Carneros, 73.8F in Calistoga, 67.4F in Howell Mountain, 74.0F in Oak Knoll, and 66.2F in Atlas Peak.

FEBRUARY

Rainfall: February started unseasonably dry, with only a few showers arriving February 3-6. Weather stations across the valley registered a meager ~1.25” for the entire first half of the month. A strong persistent ridge in the Gulf of Alaska formed but stayed far enough off the coast of California to allow the state to remain in the path of a weak trough. The middle of February was bone-dry and made vineyard access easy for the crews. Growers enjoyed the sunshine as they measured their ponds and took stock of the vineyard soil water saturation levels. Weather patterns quickly shifted on February 23 and an additional 2”-3” of rain fell during the final week of the month. By the afternoon of February 24, the valley looked like a Winter Wonderland—over 10” of snow fell in the mountains! Winemakers and growers strapped into their skis, snowboards, and snowshoes to survey the vineyards and speculate on the timing of budbreak. Compared with the previous year, February 2023 was significantly wetter with monthly totals of 3.92” in Carneros, 4.86” in St. Helena, 4.72” in Calistoga, 3.86” in Howell Mountain, 2.01” in Oak Knoll, and 6.33” in Atlas Peak.

Temperature: The ridge pattern over the Gulf of Alaska kept temperatures seasonably low for most of February. All regions of Napa Valley had daily average temperatures in the mid-40s, and daily lows fell into the 30s for more than 23 days during the month. February weather in 2023 was opposite to that

of the previous year, with daily highs ~10F lower than February 2022. The highest temperatures recorded for the month occurred on February 20 and were 69.4F in Carneros, 72.6F in St. Helena, 76.7F in Calistoga, 72.4F in Howell Mountain, 71.4F in Oak Knoll, and 70.4F in Atlas Peak. Fortunately, the grapevines remained dormant during the entire month of February, and there was no risk of frost damage to vineyards.

MARCH

Rainfall: The Pineapple Express continued to influence California during March 2023. The strong atmospheric river brought significant rainfall, and unlike earlier in the winter, these storm systems brought warm weather. In combination with the snowpack levels, snowmelt was substantial, and the rivers rose quickly. Vineyard crews swiftly pruned the grapevines in between days of precipitation as budbreak approached. Thankfully, much of the rain fell during the first two weeks of March, and growers were able to prepare for the growing season to begin. For the Water Year to date (beginning July 1, 2022), cumulative precipitation amounts were well above normal with 35.6" in Carneros, 50.1" in St. Helena, 48.5" in Calistoga, 48.8" in Howell Mountain, 39.4" in Oak Knoll, and 51.7" in Atlas Peak.

Frost: Total frost hours for March 2023 were significantly higher than March 2022. Roughly 60% of the month's daily lows were below 38F. While the month started with lows in the high-20s, vineyards had not started budbreak yet and were not vulnerable to frost damage. The highest risk for frost damage occurred during the lows of March 26-27 when temperatures dropped below 30F across the valley. Budbreak was underway in many parts of the valley during the last week of March and sleep-deprived growers ran frost protection across the Napa Valley. Average daily lows ranged for March with 39.1F in Carneros, 36.8F in Calistoga, 37.9F in St. Helena, 38.1F in Howell Mountain, 37.3F in Oak Knoll, and 35.1F in Atlas Peak.

Temperature: Compared with the previous year, March 2023 was considerably cooler. Average daily highs were 10-13F lower, daily lows were ~1.5F lower, and daily average temperatures were 5-8F lower. The cold weather—along with fully saturated soil—delayed budbreak significantly. Some early cultivars came out of dormancy during the end of the month and the season began 2-3 weeks later than the five-year average. Daily highs peaked on March 17 with 68.0F in Carneros, 68.6F in St. Helena, 71.4F in Calistoga, 65.7F in Howell Mountain, 69.4F in Oak Knoll, and 62.0F in Atlas Peak. The warm weather on St. Patrick's Day kicked off the 2023 growing season for most regions in the Napa Valley.

APRIL

Rainfall: April had noticeably decreased storm activity compared to previous months. An early morning storm on April 7 brought around half an inch of rain to the valley. Following this, the weather remained relatively calm for the rest of the month, with only 1-2 light showers occurring sporadically. These drier conditions allowed vineyard work to resume in time for budbreak and early farming activities. Rainfall totals for April were as follows: 0.7" in St. Helena, 0.64" in Atlas Peak, 0.54" in Calistoga, 0.47" in Howell Mountain, and 0.3" in Carneros.

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Temperature: Temperatures gradually warmed up throughout April, with the last week and a half seeing temperatures soar into the 80s and even low 90s in some areas like St. Helena and Calistoga. Record highs of 94F were observed in Calistoga on April 27. This warm weather coincided well with the budbreak of most Cabernet Sauvignon vines in the valley. Warm temperatures just before and during budbreak create optimal conditions for flower formation, potentially leading to increased clusters and berries per cluster. However, it's worth noting that historically, higher temperatures during budbreak have not necessarily correlated with higher yields for Napa Cabernet, though for 2023 it may have set up the potential for above-average yields.

MAY

Rainfall: May brought late-season storm systems, including rain and a few thunderstorms between May 1 and 8, with accumulations of about a quarter of an inch each day. Rainfall totals for the month added approximately an inch to the water year across the region.

Temperature and GDD: After a brief early-season heatwave, temperatures cooled to below-average levels for the latter half of May. Memorial Day weekend was notably cold for the time of year, with temperatures reaching only into the upper 60s until finally climbing to the low 70s by May 27. This period coincided with bloom for Cabernet Sauvignon vines, which lasted longer this year—between 2 to 4 weeks. Daily high temperatures during this period fell within the optimal range for pollen tube growth and fertilization, ranging from 68F to 77F. The highest temperatures recorded in May occurred on May 13, with 96.9F in Calistoga, 95F in St. Helena, 90.8F in Howell Mountain, 88.5F in Carneros, and 88.4F in Atlas Peak.

JUNE

Temperature and GDD: June 2023 brought an unusual coolness, with the average daily high temperature settling at a modest 76.6F—a notable 5F lower than the 10-year average. This cooling trend evoked memories of the temperatures from June 2011. Similarly, the accumulation of Growing Degree Days (GDD) fell below average, with June 2023 registering 100 degree days less than the decade-long average, totaling 403 GDD compared to the expected 505. This discrepancy equated to roughly 7 calendar days behind the usual June pace. By the month's end, the accumulated GDD for the season stood at 940, significantly trailing the 10-year average of 1,143, roughly a lag of 17 calendar days behind the average.

The cooling trend characterized a notably mild spring and early summer across all of California. NOAA's earlier El Niño watch in 2023 hinted at potential weather patterns, and by mid-summer, conditions seemed to align favorably for a strong El Niño period (Daniel Swain, Weather West). Meanwhile, high-elevation snowpacks lingered into June, sustaining rivers and streams at elevated levels.

At the close of June, a sudden heatwave marked the highest temperatures recorded thus far. The mercury soared, with Calistoga reaching a scorching 105.9F, St. Helena at 103.8F, Howell Mountain at 99.5F, and Atlas Peak at 97F, signaling the onset of the first significant heatwave of the season.

JULY

Temperature and GDD: The summer of 2023 was remarkably mild, with practically no fungicide spray cancellations due to high temperatures. The most notable exception is the first week of July. Globally, the beginning of the month was the warmest week on record! Fortunately for growers in the Napa Valley, the heatwave was “inland-aligned” and the coastal areas were spared for the most part. The hottest day of the month occurred on July 1 with sweltering temperatures reaching 92.9F in Carneros, 105.7F in St. Helena, 110.3F in Calistoga, 104.2F in Howell Mountain, 108.0F in Oak Knoll, and 101.4F in Atlas Peak. Temperatures quickly dropped back down into the 80s shortly after the 4th of July holiday. While the mild season was a nice reprieve for vineyard crews, it created favorable conditions for powdery mildew growth. Many growers needed a few additional fungicide sprays to maintain good disease control. Unlike the previous year, mowing and cultivation passes were delayed due to the wet spring and a valley-wide dance of crews and equipment meant long hours were needed to stay ahead of the workload. *Véraison* arrived approximately 12-14 days behind 2022 and 3-5 days behind the five-year average. The mild weather gave ample time for crucial compounds to develop in the wine grapes and foreshadowed exceptional potential for wine quality. Accumulated growing degree days were significantly lower than the previous recent vintages—reminiscent of 2010 and 2011—and for the season through July were at 1,351 GDD in Carneros, 1,813 GDD in St. Helena, 1,901 GDD in Calistoga, 2,167 GDD in Howell Mountain, 1,770 GDD in Oak Knoll, and 1,299 in Atlas Peak.

AUGUST

Temperature and GDD: After weeks of mild summer conditions, the unseasonably cool weather gave way to more traditional heat during the month of August. This was due to a strong ridge of high pressure that developed over the Pacific Northwest. Fortunately, the high temperatures were precisely what was needed to stress the grapevines during cane lignification. Banana-colored canes are an indicator of the vine’s transition from vegetative growth to fruit ripening. The average daily highs and lows were like 2022, and most regions of the valley only recorded triple digits for 3-5 days for the entire month. Calistoga experienced the highest temperature on August 15 with 106.0F. Average daily highs by region were 82.3F in Carneros, 91.6F in St. Helena, 95.4F in Calistoga, 89.3F in Howell Mountain, 91.6F in Oak Knoll, and 87.5F in Atlas Peak. Most monitored sites were lower than the previous vintage in GDD by the end of August with Carneros at 1,935 GDD, St. Helena at 2,563 GDD, Calistoga at 2,690 GDD, Oak Knoll at 2,513 GDD, Atlas Peak at 1,923 GDD. Howell Mountain was the exception with significantly higher GDD in 2023 compared with 2022, 3,132 GDD and 2,838 GDD, respectively.

SEPTEMBER

Temperature and GDD: Summer came to an end without any remarkable heatwaves and was anomalous compared to the previous recent vintages. The juxtaposition of September 2023 and September 2022 was astounding. In 2022, parts of the valley peaked at around 120.0F and experienced over seven consecutive days of triple-digit temperatures. In 2023, not a single day recorded triple digits! The picturesque Napa Valley bustled with tourists, but the winery’s crush pads remained quiet for most of the month. Winemakers took advantage of the hang time weather and while early cultivars were sporadically picked, most of the harvest would be later in the fall. Compared with 2022, September 2023 daily highs for the valley were ~7F lower, daily lows were ~3F lower, and daily average temperatures were ~5F lower. All regions of the valley had significantly cooler daily highs compared

with the previous year. Temperatures for the month peaked September 8-11 with 85.2F in Carneros, 92.3F in St. Helena, 96.4F in Calistoga, 90.7F in Howell Mountain, 93.9F in Oak Knoll, and 87.0F in Atlas Peak. Average daily temperatures were 63.5F in Carneros, 64.8F in St. Helena, 65.6F in Calistoga, 67.6F in Howell Mountain, 65.2F in Oak Knoll, and 60.7F in Atlas Peak. Accumulated degree days fell significantly behind 2022 by the end of September with Carneros at 2,314 GDD, St. Helena at 3,080 GDD, Calistoga at 3,242 GDD, Howell Mountain at 3,675 GDD, Oak Knoll at 3,042 GDD, and Atlas Peak at 2,309 GDD.

OCTOBER

Rainfall: Early in the month, a few refreshing showers swept through, clearing off any accumulated dust and prompting some growers to initiate late-season sprays for botrytis prevention and treatment. However, these initial showers only amounted to a fraction of an inch until the final stretch of the month where 0.5” fell across the valley. In total, rainfall was below the long-term average of 1.5” for the month.

Temperature and GDD: October brought a return to more seasonally warm temperatures, with two notable heatwaves pushing temperatures into the upper 90s across the valley. In Calistoga, the mercury even soared past the 100F mark. Against this backdrop, harvest operations were in full swing throughout the month. The warm and predominantly dry conditions provided an ideal environment for extended hang time.

Overall, most regions of the valley concluded the season with approximately 10% fewer accumulated Growing Degree Days compared to the previous year. This reduction in GDD explained the delayed phenological events and late harvest experienced in the 2023 vintage. Despite these challenges, the year yielded a remarkable outcome, with yields surging upwards of 20% compared to the 10-year average. Early assessments suggest that the quality of the 2023 vintage is nothing short of superb, eliciting enthusiastic acclaim.

NOVEMBER

Rainfall: Winter's inaugural storm of the 2023/2024 season arrived on the evening of November 17 and persisted through the afternoon of November 18, unleashing nearly 2” of rain across the valley. Throughout the month, several smaller storms sprinkled additional precipitation, with the first occurring in the opening week on November 4, yielding 0.25” of rainfall. The Oakville CIMIS station recorded a total of 2.5” for November, marking an increase in rainfall compared to the past four years and edging closer to the long-term average of 3” for the month.

Temperatures: November commenced with temperatures lingering in the low 80's, maintaining the balmy warmth of preceding conditions. With no significant weather events prompting the end of harvest, the 2023 season extended into November. However, frigid overnight temperatures eventually triggered leaf fall and signaled the gradual conclusion of one of the longest harvest seasons in recent memory with final picks completed by mid-month.

DECEMBER

Rainfall: December saw a noteworthy 19 days of recorded precipitation, indicating there were more days with than without rainfall in December. While the total rainfall was less than in 2022, most locations totaled between 4" – 7". The most significant rains occurred on December 18 delivering 1.5" of precipitation.

Temperatures: December unfolded as an unusually warm month globally, shattering temperature records in various regions of California. Likewise, December in Napa surpassed the warmth experienced during the first three months of the year. Despite the light precipitation, daily highs lingered in the upper 50s to lower 70s. A similar notable deviation from 2022 was the reduction in nights with temperatures dipping into the 20s, with only 3 such occurrences in 2023 compared to 9 in the previous year. Expanding this comparison to encompass the onset of fall, 2023 had merely 6 nights with temperatures in the 20s, in stark contrast to the 17 nights recorded in 2022.

Key Weather Events of the 2023 Vintage

Every vintage has unique characteristics that drive the growing season, management practices, and ultimately, quality. Some years, these characteristics only have ramifications in the vineyard, i.e., high mildew pressure in the spring or low soil moisture early in the season which requires earlier irrigation. Other years, these vintage characteristics cross over from the vineyard to the winery, i.e., late ripening curves or large crops which create logistical pressures.

Anthocyanins

By Justin Leigon, Piña Vineyard Management

Every vintage in the Napa Valley is unique, and the wines produced tell a story of how the year unfolded. In 2023, the wet winter and unseasonably cool weather led to a delay in budbreak and pushed back the phenological timeline to match a more classic growing season. By the end of May, growers and winemakers were able to forecast the likelihood of a late harvest—bloom occurred 7-10 days behind the five-year average for many parts of the valley. While a late harvest poses significant risks to growers, longer hang time can bring potential benefits regarding winegrape flavor development and finished wine quality.

Phenolic compounds that develop during the growing season are an essential component for winegrape ripeness and future wine quality (Hornedo-Ortega, 2021). The classes commonly found are flavan-3-ols (tannins), anthocyanins (flavonoid pigment compounds), hydroxycinnamates (non-flavonoid phenolics), and flavonols (Adams, 2006). These compounds belong to the polyphenol family and are plant secondary metabolites generally involved in defense against pathogens and ultraviolet radiation.

Anthocyanins are synthesized via the flavonoid pathway and begin accumulating at véraison (Allegro et al., 2021). Red cultivars will start to turn pink and then red during berry ripening due to the biosynthesis of anthocyanins in the skins. The stability and composition of these important compounds are dependent on solar exposure during the final months of the growing season. A distinctive feature of the 2023 vintage was the impressive berry skin integrity at the time of harvest. This prevented late-season dehydration and improved yields. A study conducted in Oakville during the 2017 vintage found that skin degradation and overexposure of Cabernet Sauvignon during ripening can significantly lower total anthocyanins in the fruit at the time of harvest. Clusters that experienced skin degradation had 70% less total anthocyanins at harvest than similarly exposed clusters with berry skins still intact (Torres et al., 2020). A signature feature of red wines made in 2023 will be their eye-popping brilliance as they are swirled in wine glasses around the valley.

Another seasonal factor that enhanced anthocyanin accumulation was the elevated daily high temperatures during July and August leading into véraison. The hot weather, along with drying soils, helped with cane lignification and the grapevine's physiological shift from vegetative to reproductive. The timing was ideal, and in addition, studies have shown that appropriate water deficit is beneficial to the accumulation and synthesis of anthocyanins (Ju et al., 2019). Fortunately, daily temperatures dropped significantly off the season highs leading into the fall. If temperatures are too extreme during berry ripening—like a Labor Day scorcher—there can be anthocyanin degradation and the resulting wine's color will be impacted (Cheng et al., 2014).

Mother Nature smiled upon growers in the Napa Valley during the 2023 vintage. Crews were able to prudently perform canopy management tasks for improved airflow and cluster development without the negative impact of solar overexposure. Winemakers took advantage of the hang time and called picks as blocks were ready. As a result of these strategic actions, silky tannins and extraordinary color will be the quintessential characteristics of the vintage.

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Winter Dormancy

By Sarah Ferguson, Rueta

In this deep dive, we will summarize one of the more mysterious physiological stages during the growing season: dormancy. By highlighting some of the complexities involved when no obvious changes are occurring to the vines to the casual observer, and discussing management practices that impact vine health regarding dormancy.

Dormancy Triggers: Temperature & Photoperiod

Dormancy is an essential part of the growing season for the survival and subsequent growth of the vines. Fulfilling the main evolutionary purpose of allowing vines to withstand the harsh winter conditions by entering a dormant state.

The transition to dormancy starts as vines stop growing and begin undergoing physiological changes in response to both decreasing day length and decreasing temperatures. In Napa, vines typically stop growing by late summer, accompanied by cane lignification as energy is focused on ripening fruit.

It's common for late fall daytime temperatures to remain in the 70's - 90s, still ideal temperatures for growth, but even under these conditions, an internal network of signals has begun in the vines preventing further growth and transitioning to dormancy. These signals are induced by the environmental conditions: colder nighttime temperatures and shorter photoperiod (day length) in the fall.

The specific day length and temperature triggers are affected by grapevine variety and likely also region. One study suggested the photoperiod changing from 13.3 hours to 12.9 hours is effective for triggering dormancy in Chardonnay in Washington (Camargo-Alvarez 2020). This study also found differences between Chardonnay and Cabernet Sauvignon's sensitivity to photoperiod and length of dormancy. Similarly, genes have been identified that may be responsible for explaining cultivar differences in response to photoperiod and temperature triggering dormancy (Iniga 2018).

Hormones & Biochemical Factors

The transition to dormancy in terms of biochemical factors and hormonal regulation is well understood and complex.

These internal biochemical relationships induce dormancy and provide natural protection against freezing injury, specifically by the production of and accumulation of cryoprotectants. These are substances that protect tissues and cells from cold damage.

Some key examples include sugars, sugar alcohols (sorbitol and glycerol), amino acids (proline and arginine), and proteins such as ice-binding proteins. Specific timing and intensity of cryoprotectants can vary depending on variety, environmental conditions, and management practices.

Abscisic acid (ABA), Gibberellins (GA), and Cytokinins play an important role in dormancy induction and breaking dormancy. In very simple terms, ABA induces dormancy while GA breaks dormancy and promotes active growth. The regulation of these hormones during dormancy involves intricate

interactions between environmental cues, signaling pathways, and genetics, which is beyond the scope of this deep dive.

Modeling for Budbreak Prediction

Temperature models can assist growers with planning during the growing season by knowing key phenological events that occur relative to an accumulated amount of heat (GDD).

Being able to predict the timing of budbreak would also be beneficial for planning. Grapevine varieties have different chilling hour requirements to enter into and out of dormancy, impacting the timing of budbreak.

Once chilling hours have been reached they are ready to start growing when environmental conditions become favorable. After vines start growing they no longer can adjust for cold temperatures and lose the protection of dormancy.

Chilling hours are defined as hours between 32 – 45F (0 – 7.2C). But the relationship of variety-specific chilling hours required is not so straightforward... temperatures below 32F increase cold hardiness and aren't thought to "count" toward chilling requirements. Temperatures just above freezing and above 50F may be less effective towards chilling requirements and temperatures above 60F may have negative effects on chilling requirements. Most effective temperatures are believed to be between 40 – 50F, or specifically 5.6C for both Cabernet Sauvignon and Chardonnay (Camargo-Alvarez 2020).

Work by Markus Keller's lab described this as a dynamic cycle, where, based on temperatures vines begin to de-acclimate in response to warm temperatures, and then will switch back to acclimation when temperatures drop again. This cycle continues throughout dormancy impacting the level of cold hardiness until the changes lead up to budbreak, and thus make the de-acclimation process irreversible.

The key budbreak prediction models being used today include Weinberger 'hours of chilling' (Weinberger 1950), the Utah weighted 'chill units' (Richardson et al. 1974), the Dynamic Model 'chilling portions' (Fishman et al. 1987), and the numerical Hc model from Markus Keller's lab.

Some factors that are difficult to account for in prediction models would include rootstock interactions, timing of pruning, water stress, vine age, and vine health.

Cold Hardiness

Vines can survive in dormancy at low temperatures, typically for European varieties this range is: -11F (-25 C), well below typical Napa winter temperatures. The caveat here is that vines can survive at these low temperatures once they become cold hardy and are dependent on the level of cold hardiness for that varietal.

During dormancy, vines acclimate to cold weather after gradual exposure to cold and being exposed to below-freezing temperatures for several days or more. If vines aren't acclimated yet or temperatures drop significantly, this is when bud damage can occur and even death of the vines.

Napa rarely drops to frigid winter temperatures, and temperatures below 20F are very rare. Cold

damage can still occur, depending on the timing and duration of freezing temperatures and the acclimation levels of the vines.

Vineyards become a lot quieter during dormancy and especially after the conclusion of all winter prep work with cover crop and erosion control in place. It's still important to keep an eye on soil moisture leading into and throughout dormancy since environmental stresses, including water deficit, can impact factors relating to inducing dormancy as well as breaking out of dormancy, "budbreak".

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