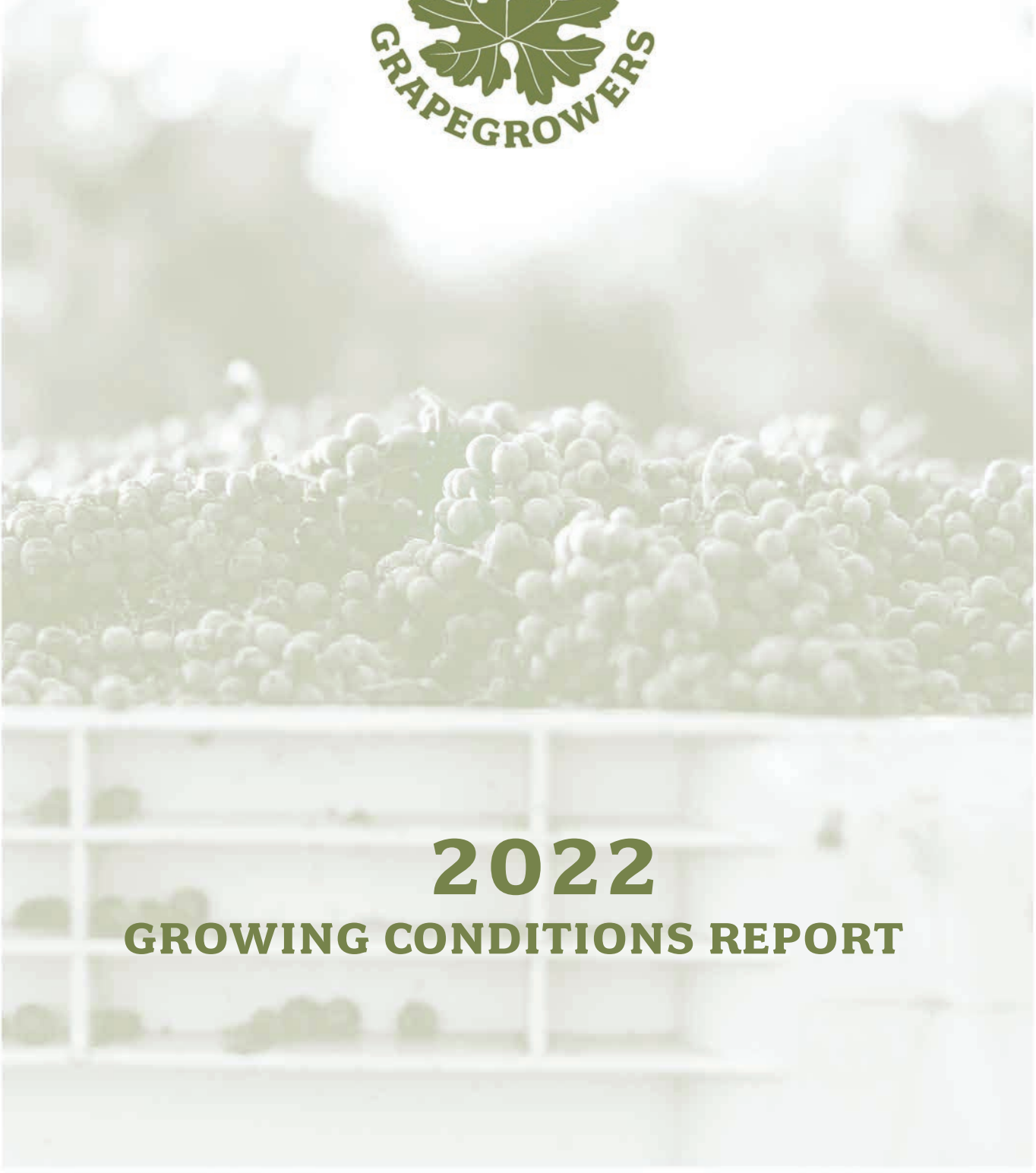
NAPA VALLEY GRAPEGROWERS
EST. 1975



# 2022
# GROWING CONDITIONS REPORT

# 2022 GROWING CONDITIONS REPORT

Produced by:


831 Latour Court, Suite A
Napa, CA • 94558

*www.napagrowers.org*


In conjunction with:

**Pacific Geodata, LLC**
*www.pacgeodata.com*

**Picovale Services, Inc.**
*www.picovale.com*

**Piña Vineyard Management**
*http://www.pinavineyards.com/*

**Silverado Farming Company, Inc.**
*http://www.silveradofarming.com/*

## 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, Matt Lamborn of Pacific Geodata, LLC 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 of Ruetd, formerly Silverado Farming Company, 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 2022 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:

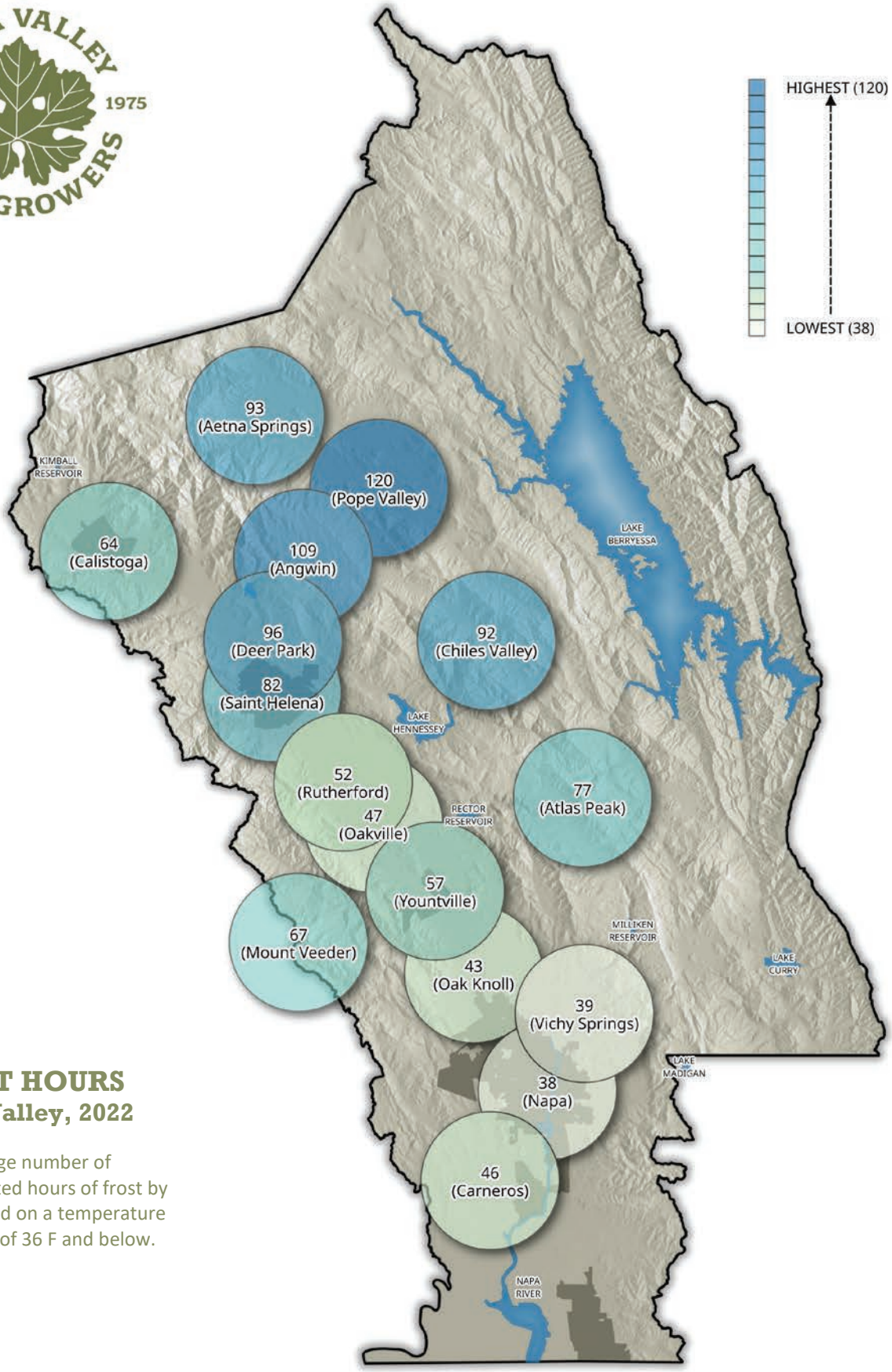
1. Where might my vineyard fall in relation to other AVAs throughout Napa in terms of Growing Degree Days (GDD), Frost Hours, and Rainfall?
2. How did previous seasons compare to the 2022 season based on these parameters?
3. Just how "perfect or challenging" was the 2022 season, and what implications 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 2022?
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

We are actively looking for access to stations in areas that are currently under-represented. These areas include Wooden Valley/Gordon Valley, Diamond Mountain, and Spring Mountain.

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.

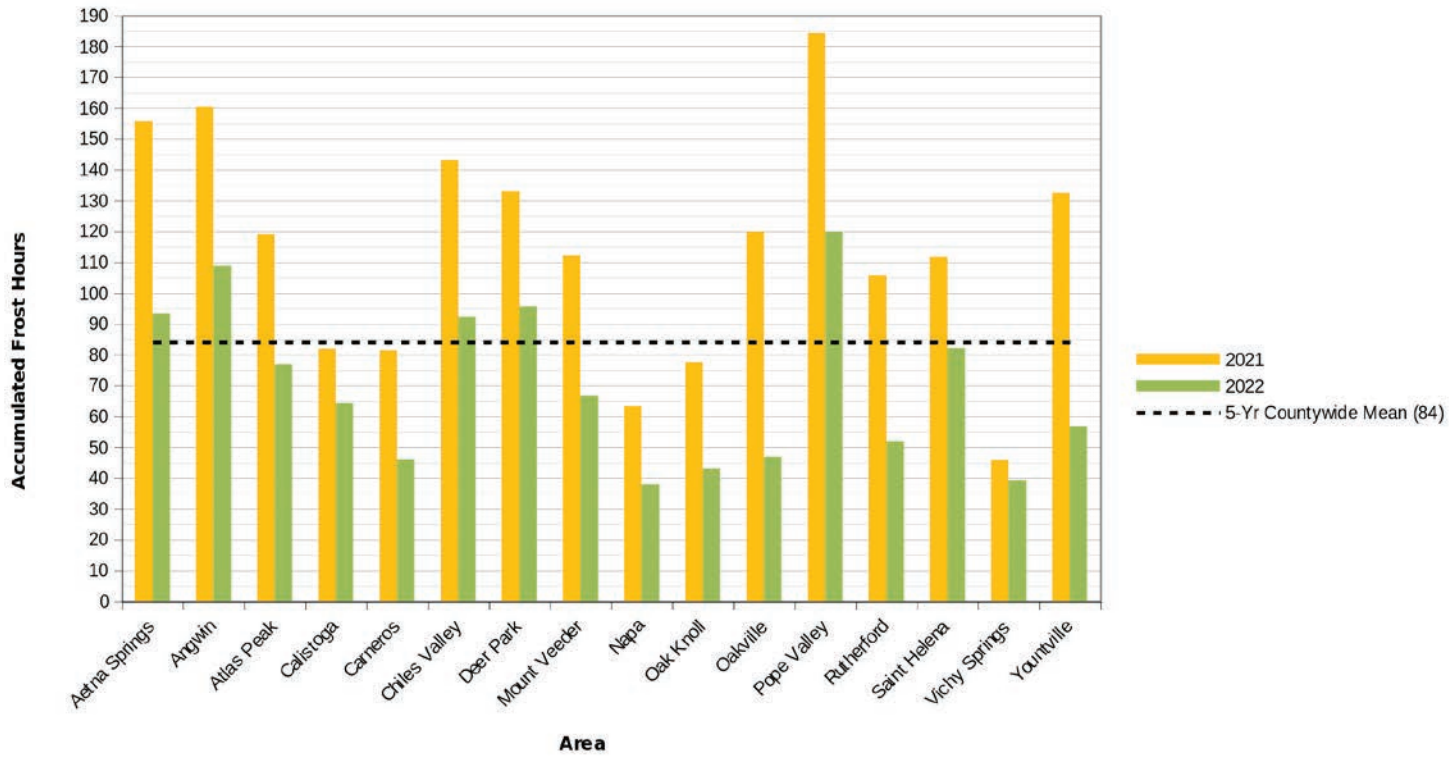


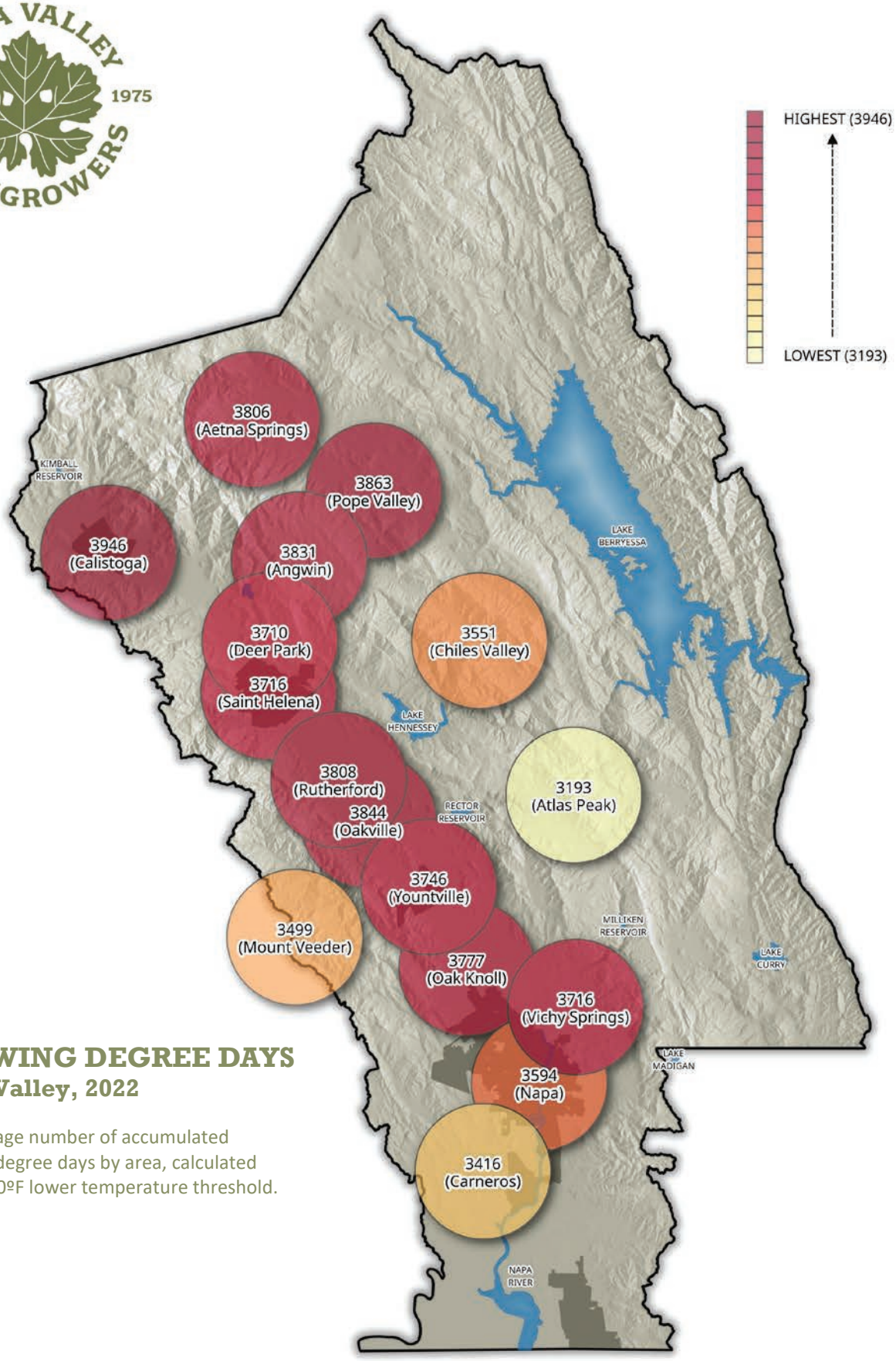

## FROST HOURS
### Napa Valley, 2022

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 2022 were like 2020, with an average of 70 hours across the Napa Valley, and were significantly less than 2021, which recorded 114 hours. The largest percent decrease came from Oakville—47 hours in 2022 vs 120 hours in 2021. On average, most monitored sites showed roughly a 37.9% decrease in frost hours in 2022 vs 2021. The highest number of frost hours were recorded in Pope Valley at 120 and the lowest in Napa proper with 38, whereas Pope Valley had 184 frost hours in 2021 and Napa 63. While frost hours in general were lower in 2022, cold pockets formed in unexpected areas, and minor frost damage was reported in vineyards that don't typically encounter frost events and were without protection.

| Area | 2018 | 2019 | 2020 | 2021 | 2022 | % change: 2021/2022 |
|---|---|---|---|---|---|---|
| Aetna Springs | 154 | 72 | 142 | 156 | **93** | -40.0% |
| Angwin | 156 | 71 | 129 | 160 | **109** | -32.2% |
| Atlas Peak | 108 | 38 | 112 | 119 | **77** | -35.4% |
| Calistoga | 159 | 46 | 69 | 82 | **64** | -21.4% |
| Carneros | 69 | 7 | 33 | 81 | **46** | -43.5% |
| Chiles Valley | 125 | 53 | 121 | 143 | **92** | -35.6% |
| Deer Park | 142 | 61 | 87 | 133 | **96** | -28.1% |
| Mount Veeder | 98 | 27 | 60 | 112 | **67** | -40.6% |
| Napa | 113 | 7 | 35 | 63 | **38** | -40.1% |
| Oak Knoll | 95 | 14 | 44 | 78 | **43** | -44.6% |
| Oakville | 92 | 26 | 51 | 120 | **47** | -60.9% |
| Pope Valley | 163 | 81 | 153 | 184 | **120** | -35.0% |
| Rutherford | 105 | 35 | 49 | 106 | **52** | -50.9% |
| Saint Helena | 128 | 53 | 59 | 112 | **82** | -26.5% |
| Vichy Springs | 122 | 7 | 33 | 46 | **39** | -14.4% |
| Yountville | 95 | 24 | 54 | 133 | **57** | -57.2% |
| *Countywide Average* | *113* | *37* | *77* | *114* | ***70*** | *-37.9%* |





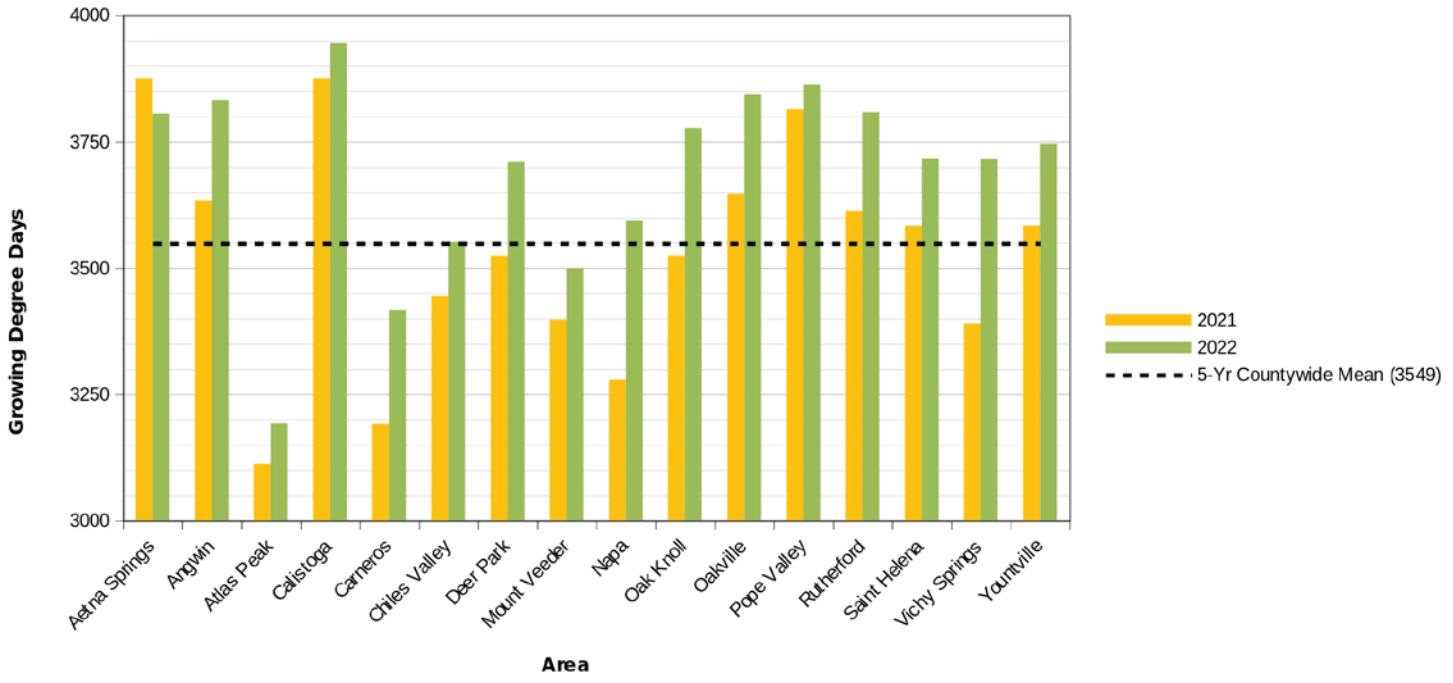

## GROWING DEGREE DAYS
### Napa Valley, 2022

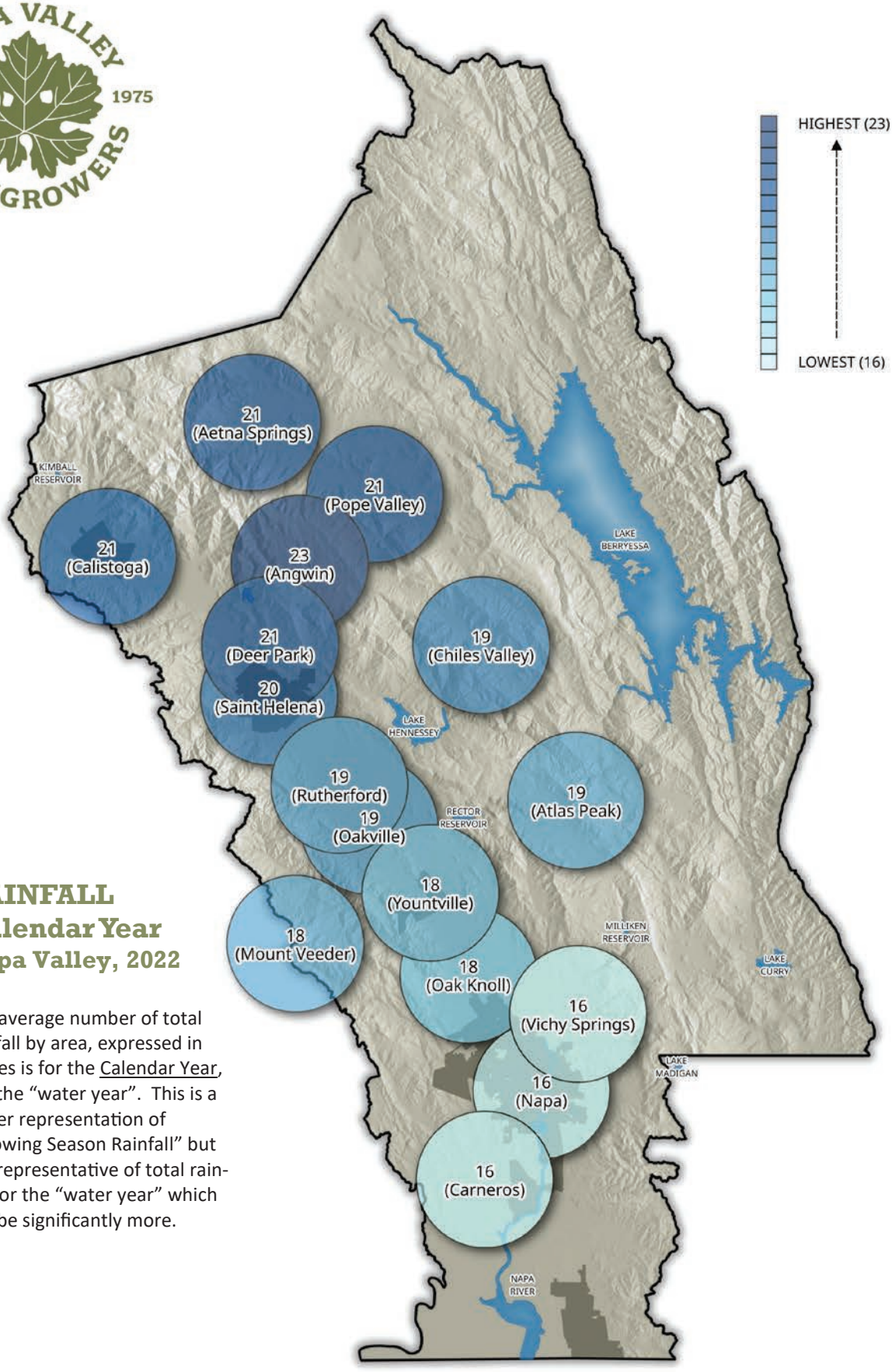
The average number of accumulated growing degree days by area, calculated using a 50ºF lower temperature threshold.

Growing Degree Days (GDD) measures the accumulated heat through the growing season, measured between April and October. Phenological events are impacted by GDD, and some of the differences in timing for harvest, bloom and veraison year over year can be explained in part due to differences in GDD. The Napa Valley has many micro-climates and GDD can vary between AVA's or even by elevation or aspect within a single AVA. For 2022, the differences in GDD between AVA's was a narrower window, which is usually seen in a warmer vintage.

| Area | 2018 | 2019 | 2020 | 2021 | 2022 | % change: 2021/2022 |
|---|---|---|---|---|---|---|
| Aetna Springs | 3028 | 3665 | 4031 | 3875 | **3806** | -1.8% |
| Angwin | 3042 | 3440 | 4128 | 3634 | **3831** | 5.4% |
| Atlas Peak | 2913 | 3193 | 3635 | 3111 | **3193** | 2.6% |
| Calistoga | 3311 | 3710 | 4310 | 3875 | **3946** | 1.8% |
| Carneros | 2865 | 3236 | 3489 | 3192 | **3416** | 7.0% |
| Chiles Valley | 3195 | 3450 | 3841 | 3444 | **3551** | 3.1% |
| Deer Park | 3138 | 3458 | 3982 | 3524 | **3710** | 5.3% |
| Mount Veeder | 3004 | 3341 | 3648 | 3398 | **3499** | 3.0% |
| Napa | 2997 | 3461 | 3730 | 3278 | **3594** | 9.6% |
| Oak Knoll | 3090 | 3624 | 3948 | 3524 | **3777** | 7.2% |
| Oakville | 3281 | 3601 | 3970 | 3646 | **3844** | 5.4% |
| Pope Valley | 3260 | 3599 | 3967 | 3814 | **3863** | 1.3% |
| Rutherford | 3221 | 3559 | 4007 | 3613 | **3808** | 5.4% |
| Saint Helena | 3153 | 3509 | 4026 | 3583 | **3716** | 3.7% |
| Vichy Springs | 3062 | 3554 | 3937 | 3390 | **3716** | 9.6% |
| Yountville | 3215 | 3623 | 3932 | 3583 | **3746** | 4.5% |
| *Countywide Average* | 3111 | 3501 | 3911 | 3530 | ***3689*** | *4.6%* |

For most locations, 2022 started with similar trends in GDD compared with 2021 but with a drastically hotter August and September. The spring GDD started slightly behind 2021 with the rainfall in April having a buffering impact on temperatures reducing the daily high's. Things changed in June with regular heat waves welcoming a very fast Cabernet bloom to berry set period. Mild July temperatures, reminiscent of classic Napa Valley ripening slowed down GDD accumulation compared to 2021. Most growers will not remember the mild start to the ripening period, as the overwhelming story during this period was the record breaking 7-10 day Labor Day heat that set records across the Western US and had a significant impact on harvest decisions. Overall, 2022 was a warm vintage, not as hot as the hottest vintages we've experienced recently though compared with 2020, 2017 and 2015. The 2022 vintage was most similar in GDD accumulation to 2019.





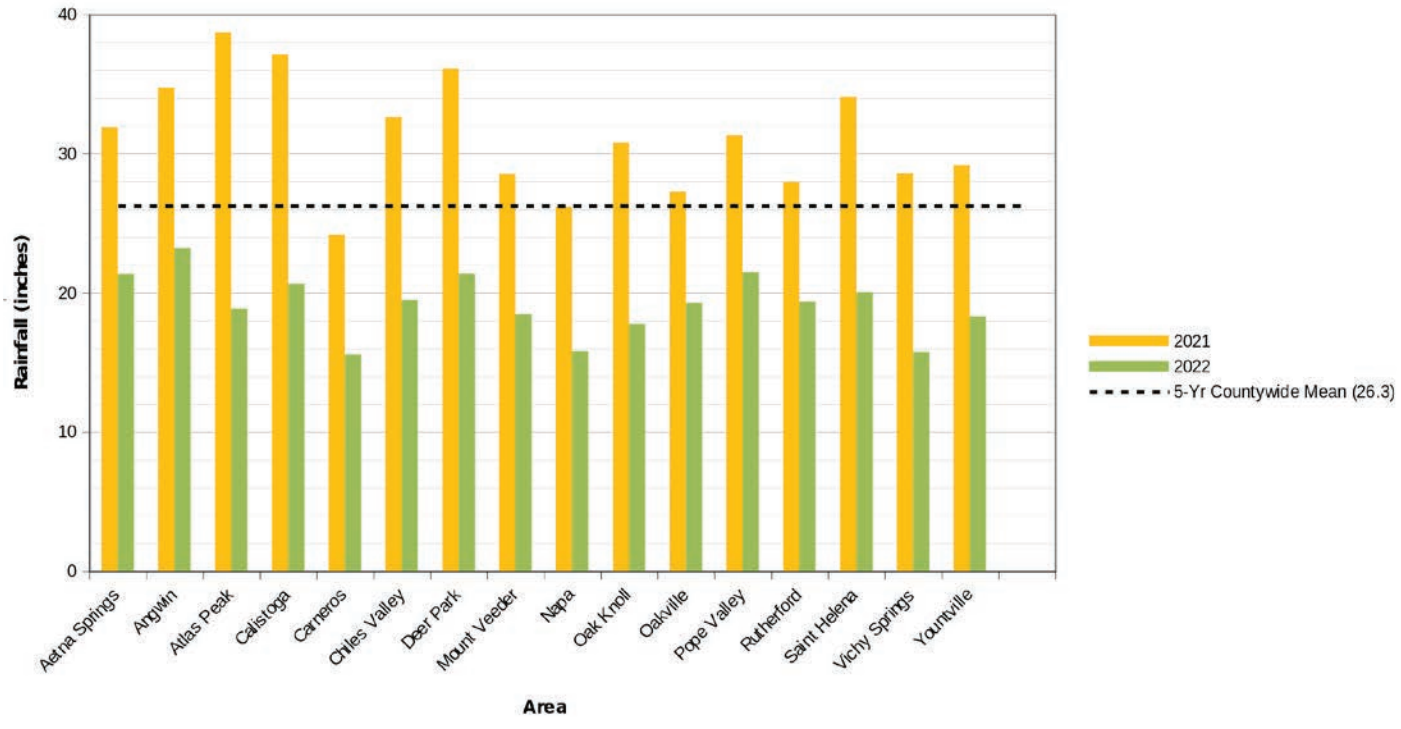

## RAINFALL
## Calendar Year
### Napa Valley, 2022

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 2021-2022 water year (calculated from July 2021-June 2022) was a story in two parts—October through December and post New Year's Day. Roughly 80% of the season's total rainfall arrived before the first day of 2022. Growers concerned about empty reservoirs were able to sleep better at night, but it was still far from adequate for overall drought relief. January through March were exceptionally dry, with only 2-5" being recorded across the Napa Valley. On average, the valley received 19.2" of rainfall and was 38.2% less than 2021.

| Area | 2018 | 2019 | 2020 | 2021 | 2022 | % change: 2021/2022 |
|---|---|---|---|---|---|---|
| Aetna Springs | 27.1 | 52.2 | 9.6 | 31.9 | 21 | -33.0% |
| Angwin | 27.2 | 52.3 | 12.2 | 34.7 | 23 | -33.2% |
| Atlas Peak | 27.4 | 55.1 | 12.5 | 38.7 | 19 | -51.3% |
| Calistoga | 28.1 | 51.6 | 13.4 | 37.1 | 21 | -44.4% |
| Carneros | 20.0 | 31.4 | 10.3 | 24.2 | 16 | -35.5% |
| Chiles Valley | 27.1 | 51.5 | 11.1 | 32.6 | 19 | -40.3% |
| Deer Park | 24.3 | 48.8 | 11.0 | 36.1 | 21 | -40.7% |
| Mount Veeder | 21.8 | 36.4 | 11.4 | 28.5 | 18 | -35.4% |
| Napa | 19.8 | 34.9 | 10.6 | 26.2 | 16 | -39.6% |
| Oak Knoll | 21.5 | 44.6 | 12.1 | 30.8 | 18 | -42.3% |
| Oakville | 24.6 | 45.8 | 10.0 | 27.3 | 19 | -29.3% |
| Pope Valley | 27.8 | 49.9 | 10.6 | 31.3 | 21 | -31.4% |
| Rutherford | 24.1 | 45.6 | 9.6 | 28.0 | 19 | -30.7% |
| Saint Helena | 22.5 | 46.1 | 10.2 | 34.1 | 20 | -41.2% |
| Vichy Springs | 20.0 | 38.5 | 10.3 | 28.6 | 16 | -45.0% |
| Yountville | 23.7 | 47.7 | 10.7 | 29.1 | 18 | -37.2% |
| *Countywide Average* | *22.8* | *43.1* | *11.0* | *31.2* | ***19.2*** | *-38.2%* |

Totals for the water year across the county were 16" in Carneros, 20" in St. Helena, 23" in Howell Mountain, 21" in Calistoga, 19" in Atlas Peak, and 18" in Oak Knoll. The record setting dry January was due in part to a persistent West Coast ridge of high pressure that blocked the coastal jet stream from bringing more typical storm systems to Northern California. The extremely dry winter allowed crews to make quick work of pruning, tractors were able to enter vineyards before bud-break, and the season got off to an early start. Fortunately, the abundant precipitation during the fall of 2021 helped vines store nutrients during dormancy and canopies looked noticeably healthier in 2022 compared with the previous growing season.



## 2022 Vintage Summary

The 2022 vintage in the Napa Valley was full of record-breaking extremes. Overall, the year brought conditions for great quality, but the roller coaster ride Mother Nature took us on will make it a year to be remembered.

Starting right after the 2021 harvest with heavy and record-breaking rainfall in October, the 2022 water year was off to an intense start. Fast forward three-months and it was a completely opposite story, with drought conditions from January through March, it was a record breaking period for being the driest for that time.

The dry conditions also meant ideal soil conditions for cultivation passes and tractor work to start much earlier in the year, up to a month ahead of 2021. Getting a head start on these activities was a relief during the April through June craze with one less activity to require tractor work, and allowed for timely execution of sprays and canopy work.

Early season, pre-bud break irrigations have become a consideration over the past 3 years with drought conditions. This year the rains in April alleviated much of this worry and provided enough soil moisture to support healthy early growth.

Canopies were healthier this year with balanced and healthy growth. With this brought higher pest pressure compared to the previous year for powdery mildew, as well as vine mealybug and leafhoppers. Maintaining timely spray intervals was important in the 2022 season. Leafhopper pressure has been increasing over the past 3-4 years with the rise of Virginia Creeper and Variegated leafhoppers in the area. Growers have been managing these pests with updated recommendations from the UC Cooperative Extension Viticulture team.

With steady consistent heat and “normal” extreme temperatures in June, July, and August, fruit was looking to be 5 – 7 days earlier than 2021, about 15% lighter than average, and of very high quality.

The 2-week period around labor-day could only be described as a whirlwind and the most intense period of the year. The entire valley worked extremely long hours, harvesting, hauling, and receiving fruit; checking on irrigations and overhead sprinklers; and making sure everything was set up for the next day’s harvest picks.

As these record-breaking conditions are becoming more normal characteristics of these reports, reflecting on the challenges and wins from the previous year will help prepare us for a more informed path forward.

## Resumen de la Cosecha del 2022

La cosecha del 2022 en el Valle de Napa estuvo llena de extremos que batieron récords. En general, el año trajo condiciones para una gran calidad, pero la montaña rusa en la que la Madre Naturaleza nos llevó en 2022 hará que sea un año para recordar.

Después de la cosecha de 2021, el año hidrológico 2022 empezó con lluvias intensas y récord en octubre. Tres meses más tarde, la historia fue totalmente opuesta: de enero a marzo, la sequía batió todos los récords al ser el periodo más seco de la historia.

Las condiciones de sequía también propiciaron unas condiciones del suelo ideales para que los pases de cultivo y el trabajo del tractor comenzaran mucho antes en el año, hasta un mes antes que en 2021. Adelantarse a estas actividades supuso un alivio durante la temporada de abril a junio, con una actividad menos que requería el trabajo del tractor, y permitió la ejecución oportuna de las pulverizaciones y el trabajo de la cubierta.

Los riegos tempranos antes de la brotación se han convertido en una consideración en los últimos 3 años debido a las condiciones de sequía. Este año, las lluvias de abril aliviaron gran parte de esta preocupación y proporcionaron suficiente humedad al suelo para mantener un crecimiento temprano sano.

Este año, las copas estaban más sanas, con un crecimiento equilibrado y sano. Esto trajo consigo una mayor presión de las plagas, en comparación con el año anterior, de oídio, cochinilla de la vid y chicharritas. En la campaña 2022 fue importante mantener los intervalos de pulverización a tiempo. La presión de la chicharrita se ha incrementado en los últimos 3-4 años con el aumento de las chicharritas parra virgen y chicharritas en la zona. Los productores han estado manejando estas plagas con recomendaciones actualizadas del equipo de viticultura de la UC Cooperative Extension.

Con un calor constante y temperaturas extremas "normales" en junio, julio y agosto, la fruta se presentaba entre 5 y 7 días antes de 2021, un 15% más ligera que la media y de muy alta calidad.

El periodo de 2 semanas alrededor del día del trabajo sólo puede describirse como un torbellino y el periodo más intenso del año. Todo el valle trabajó muchísimas horas, recolectando, transportando y recibiendo fruta; controlando los riegos y los aspersores aéreos; y asegurándose de que todo estaba preparado para las recolecciones del día siguiente.

Como estas condiciones que baten récords se están convirtiendo en características más normales de estos informes, reflexionar sobre los retos y las victorias del año anterior nos ayudará a prepararnos para un camino más informado hacia el futuro.

## Breakdown by Month: 2022 Growing Season

### JANUARY

**Rainfall**: The autumn months of 2021 were significantly wetter than recent years—especially October, which registered a staggering 10-14" of rainfall within a ten-day timeframe! December 2021 also had multiple storm systems that provided another 8-11" before year's end. On the other hand, January 2022 was relatively dry. January 3-4 saw a brief period of precipitation with 1.5-2.5" of rainfall, but the skies cleared up quickly after the first week of the month. The remaining days of January were bone dry, and the lack of rainfall allowed crews to get to work early for pruning without difficulty. Monthly average rainfall amounts for January ranged from 0.3" in Carneros, 1.1" in Calistoga, 2.7" in Atlas Peak, 1.0" in Wooden Valley, 1.3" in Oak Knoll, and 1.4" in Howell Mountain.

**Temperature**: On average, temperatures were warmer in January due to a resilient ridge of high pressure off the West Coast. This redirected the normal storm patterns for the Pacific region. Even so, night-time lows did reach sub-freezing for multiple days, with an average low temperature of 35F around the valley floor and 45F for higher elevation locations. The daily highs were in the high-50s to low-70s, with the hottest day registering above 73F on January 22. The exceptionally warm weather also dropped the Sierra snowpack to roughly 50% of its normal January level. All parts of the valley saw lower lows and higher highs than the previous year, which led to a diurnal temperature range that was significantly larger in 2022. Unlike the previous year, Howell Mountain had the highest average daily temperature of 50F. The lowest temperatures recorded for the month occurred on January 2 and were 25.6F in Carneros, 20.9F in Calistoga, 25.8F in Yountville, 34.0F in Howell Mountain, 26.9F in Oak Knoll, and 25.1F in Wooden Valley.

### FEBRUARY

**Rainfall**: January through February of 2022 was the driest on record for most of Northern California. The winter weather pattern for the growing season brought no drought relief to the Napa Valley, and while ponds had been filled by the fall rains, growers around the valley were nervous about the available water for the season's frost protection and irrigation needs. The unseasonably dry weather was once again due to a persistent ridge of high pressure over the Pacific Ocean. It was a repeat of February 2020 with weather stations not even registering 0.25". All areas of the Napa Valley experienced significantly less precipitation compared to 2021, with monthly totals of 0.06" in Howell Mountain, 0.05" in Atlas Peak, 0.00" in Carneros, 0.21" in Calistoga, 0.02" in Wooden Valley, 0.18" in Oak Knoll, and 0.06" in St. Helena. The exceptionally dry weather in February led to irrigations before bud-break and allowed for early season cultivation.

**Temperature**: With tractor work underway, irrigations running, and picturesque afternoons, the Spring weather had arrived early in February. Average daily highs were roughly 5F higher compared to February 2021, ranging in the high-60s to low-70s. Daily lows remained seasonably normal, in the low to mid 30s around the valley. Like January, the daily highs and daily lows were more extreme than 2021, but daily averages remained about the same, hovering around 50F. Howell Mountain was the most significant outlier for the daily average temperature at 4 degrees warmer than 2021. Calistoga was the coldest sub-AVA with an average daily low of 31F, and on February 24, temperatures dropped as low as 17F. The cold and dry conditions kept growers busy preparing for an early frost season. The lowest temperatures recorded for the month occurred during February 22-25 and were 24.9F in

Carneros, 17.7F in Calistoga, 19.5F in Yountville, 29.6F in Howell Mountain, 20.1F in Atlas Peak, 22.5F in Oak Knoll, and 20.0F in Wooden Valley.

### MARCH

**Rainfall**: Any hopes of a "Miracle March" were quickly abandoned by the middle of the month. An incredible, record-breaking dry spell, continued throughout most of California. January 1 – March 25 was the driest on record. The end of the month did see some relief with around 0.75" of rain arriving on March 27-28. For the Water Year to date (beginning July 1, 2021), cumulative precipitation amounts were below normal ranging from 13.5" in Carneros, 27.9" in Calistoga, 25.4" in Howell Mountain, 24.7" in Oak Knoll, and 31.3" in Atlas Peak. It was a tale of two winter seasons, with over 80% of the rainfall occurring before January 1 of 2022.

**Frost**: Total frost hours for March 2022 were significantly less than March 2021. Temperatures dropped below freezing on March 5-6 and then again on March 11-12, but many vineyards had not yet started bud-break. An unusual aspect of the 2022 frost season was cold temperatures in locations that typically don't experience frost, especially in Carneros. Early cultivars experienced minor frost damage during the first week of March 2022 in locations that didn't have frost protection systems in place. Average daily lows for March ranged from 39F in Carneros, 38F in Calistoga, 44F in Howell Mountain, 38F in Oak Knoll, and 37F in Atlas Peak.

**Temperature**: On average, the temperatures in March 2022 were higher than March 2021. Daily highs were in the mid-60s to mid-70s and 5-6 degrees warmer compared with the previous year. The daily averages and daily lows were a similar story, at about 3-5 degrees warmer across the valley. Unseasonably warm weather occurred throughout the latter part of the month, and bud-break quickly took off. During March 22-24 weather stations recorded 84F in Calistoga, 88F in Carneros, 77F in Howell Mountain, 88F in Oak Knoll, 86F in Wooden Valley, and 81F in Atlas Peak. Grapevines were able to store an abundance of carbohydrates during the previous fall's wet weather and combined with the copious amount of sunshine and Summer-like temperatures, nascent green shoots developed without trouble.

### APRIL

**Rainfall**: After a dry winter, the valley welcomed 7-10 days of rain showers in mid-April, totaling 2 – 3" of precipitation for the month, which is a little above average for April. There were three significant storm systems in April with daily precipitation averaging between 0.5 – 0.8" that occurred on April 14, 16, and again on April 21. These late rains helped to moisten surface soil profiles just in time for budbreak and early growth.

**Frost**: Compared to last year, there were fewer nights that threatened frost conditions, but the frost events this year were colder. For example, Atlas Peak, Howell Mountain and Coombsville each recorded temperatures as low as 25 – 26F this year, occurring on April 12 and 17. Whereas last year the lowest temperatures were between 29 – 32F in these same areas. Also, cold snaps occurred in areas that aren't typically affected by cold which may have seen some damage if not protected.

**Temperature and GDD**: For sites trying to get in early season oil applications, April proved to be a challenging month due to the drastic variations in temperatures. Temperatures reached 90F for 3 days

in a row early in the month (between the April 6 and 8) and then four days later frost conditions occurred intermittently over the period of a week. The last week of April was extremely pleasant with dry conditions and temperatures slightly warmer than average, providing plenty of warmth and sunshine to support ample growth. GDD accumulation for April was on par with 2021 throughout the valley. Using the Oakville Cimis station for reference, 2022 accumulated 250 growing degree days for the month which is exactly the average for April for this station since 1989.

### MAY

**Rainfall**: For the most part, May was a dry month. There was only 1 significant rain shower that crossed the valley during the afternoon and early evening of May 10. Depending on location, the rainfall totaled about a 0.25" to less than 1".

**Frost**: Between 4 and 5 back-to-back nights of frost events occurred between the May 8 – 13. Temperatures stayed in the 30's for these events but dropped early in the night on the May 10 following the brief rain showers. In Howell Mountain temperatures were already at 35F by 9:30 PM and in Coombsville they reached this temperature around 1:30 AM.

**Temperature and GDD**: Temperatures in May started out mild and cooled off during the second week just when some of the early varieties started bloom. We also had the small rain event and frost during this time. Luckily, it didn't stay cool for long and the warming the next week helped these varieties finish through bloom. Much of the Cabernet Sauvignon experienced bloom between May 15 – 30, by then the valley experienced temperatures in the 80's and 90's with at least 2 days above 95F. The heat helped bloom finish quickly and for some cases vines were in full bloom in a matter of days. In terms of growing degree days, this year was very similar to last year across the valley for the month of May.

### JUNE

**Rainfall**: Most of the valley experienced some rain on the morning of June 5, totaling about 0.5" in most locations and up to 0.9" in Atlas Peak. Totals for the "rain year" for 2022 were higher than the previous 2 years but were still below the long-term average. The Oakville Cimis station recorded 23" for 2022, versus 10" for 2021, 12" for 2020, compared to the 33-year average of 30".

**Temperature and GDD**: June weather brought several waves of heat above 100F and at the end of the month held consistently above 95F between the June 20 – 28. Oakville reached 110F on June 21, St. Helena and Calistoga recorded 105F and 107F respectively on this day. Even the mountain sites recorded temperatures just shy of or slightly above 100F during this event. The consistent heat provided ideal growing conditions for the month and combined with the low soil moisture led to balanced canopies where shoot growth slowed down by the end of the month and vines turned their energy to berry sizing and development. This June was warmer than last year and on average locations throughout the valley accrued about 65 more degree-days in June compared to 2021. Thinking about this in terms of calendar days is more complicated, but for reference the highest number of degree days accumulated in one calendar day for June varied between 28 – 40. Reasonably, this could relate to 2 – 4+ days ahead of last year. Similarly, the Oakville Cimis station accumulated 562 growing degree days for the month of June which was the second highest for this station, second to 2019.

## JULY

**Temperature and GDD**: The month of July was more typical for a La Niña year than previous years, and forecasters predicted a "Triple Dip" pattern would occur—three consecutive La Niña years. The canopy growth was healthier in general, which led to higher mildew pressure, but an early start to the season's vineyard activities allowed for crews to stay on top of suckering and canopy management. Also, with mowing and cultivation finished ahead of schedule, tractor drivers were readily available to keep spray intervals tight. The daily average temperatures were mild at around 70F for most parts of the valley. The week of the 4 of July saw daily highs barely reaching into the low 90s. A brief period of triple digit temperatures arrived during the middle of the month topping out at 104.8F in Calistoga, 100.2F in St. Helena, 101.3F in Wooden Valley, 102.2F in Oak Knoll, 96.1F in Atlas Peak, and 98.8F in Howell Mountain. Night-time temperatures hovered around the low-50s. It was a classic Napa Valley summer ripening period that benefited from the ~40-degree diurnal swings in temperature that produce ripe fruit characteristics in parallel with a preservation of high acidity. Véraison arrived approximately 2-3 days ahead of 2021 and 4-7 days ahead of the five-year average. A strong high-pressure system developed during the end of July and led to elevated temperatures arriving in Napa during the second half of the summer months. Accumulated growing degree days indicated a relatively mild summer with total GDD for the month of July at ~25 GDD less than 2021. Heat units for the season through July showed 1,595 GDD in Carneros, 1,962 GDD in St. Helena, 2,061 GDD in Calistoga, 2,091 in Wooden Valley, 2,036 GDD in Oak Knoll, 1,497 GDD in Atlas Peak, and 2,053 GDD in Howell Mountain.

## AUGUST

**Temperatue and GDD**: August was warmer than the previous year across all three daily metrics. Compared with 2021, the daily average, high, and low temperatures were higher by ~1.9F, ~2.2F, and ~2.4F, respectively. The largest outlier was the Howell Mountain area, with an average daily high of 91F—more than 5F higher than 2021! While the averages were higher in general, there were less triple digit days or extreme heatwaves and relatively pleasant weather for crews to finish all the final passes before harvest preparations began. A brief rain event occurred on August 1, but weather stations only record ~0.1" in total. It was the perfect amount of precipitation to keep the vineyard dust down and give the fruit a quick wash. Average daily highs by region ranged from 81F in Carneros, 93F in St. Helena, 96F in Calistoga, and 94F in both Oak Knoll and Wooden Valley. All monitored sites exceeded the previous vintage in GDD by the end of August with Carneros at 2,136 GDD, St. Helena at 2,697 GDD, Calistoga at 2,838 GDD, Wooden Valley at 2,849 GDD, Oak Knoll at 2,776 GDD, Atlas Peak at 2,076 GDD, and Howell Mountain at 2,838 GDD. The lack of extreme weather during August meant that vines worked efficiently to ripen fruit and foreshadowed an early harvest for 2022.

## SEPTEMBER

**Temperature and GDD**: The month of September was unprecedented, both in terms of extreme heat as well as the pace of harvest. The first week of the month experienced the most severe September heatwave on record, lasting 7-10 days—some weather stations recorded temperatures above 120F on September 6! Fortunately, with a bit of weather whiplash, the remnants of a West Coast Typhoon brought around 1.0" of rain during the middle of the month and allowed growers to catch their breath. Overall, the harvest of 2022 was the most condensed in recent memory. Most wineries reported having a majority—if not the entirety—of their grapes picked by the end of the month. Every macro bin and forklift was out in the field, crews picked for long hours, and trucks hauled fruit nonstop. It took

the entire valley working together to get through the resource crunch and reach the finish line for the 2022 harvest season. Average daily highs were in line with 2021, with the exception of Howell Mountain that continued to be ~5F above the previous year's average high. Average daily temperatures were a different story. All regions of the valley saw a 2-3F increase compared with the previous season. Average daily temperatures ranged from 67F in Carneros, 69F in St. Helena, 69F in Calistoga, 73F in Howell Mountain, 71F in Wooden Valley, and 70F in Oak Knoll. Most strikingly was the increase in average lows in 2022 vs 2021, ranging from 51F in Carneros, 52F in St. Helena, 50F in Calistoga, 61F in Howell Mountain, 55F in Wooden Valley, and 51F in Oak Knoll. Accumulated degree days continued to outpace 2021 through the end of September with Carneros at 2,701 GDD, St. Helena at 3,368 GDD, Calistoga at 3,496 GDD, Oak Knoll at 3,449 GDD, Atlas Peak at 2,641 GDD, Wooden Valley at 3,579 GDD, and Howell Mountain at 3,670 GDD.

### OCTOBER

**Temperature and GDD**: October weather was relatively consistent and warm with one last wave of 85-90F heat that happened over October 18 – 20. By the last week of October, morning temperatures started dropping into the mid to low 30's. Harvest was almost completely wrapped up by this point, in fact the mild to warm temperatures in early October helped extend the Cabernet Sauvignon harvest into mid-month, with most locations completing harvest by the second to last week of October. The Oakville Cimis station accumulated 382 growing degree days for the month of October, slightly above the average of 364 for this station since 1989. For the year overall though, 2022 had the third highest GDD coming behind 2015 and 2020 and was very similar to the 2019 and 1997 vintages.

### NOVEMBER

**Rainfall**: November brought several cold systems through the area from the Gulf of Alaska with rainfall over a 7 – 10-day period. The rainfall wasn't heavy but officially brought an end to any further risk of fire season for the year. Rainfall totaled between 1.3" on the valley floor and 3" in the mountain sites. The light rain helped get cover crops and grasses growing before any atmospheric events made their way through the valley.

**Temperatures**: In comparison with previous years, the night-time and morning temperatures were much colder across the valley even hitting the low 20's by mid-month following the storm systems. We've been so accustomed to noting the extreme heat and above average temperatures in the valley that it's rare to mention colder than average temperatures. In fact, looking at the Oakville Cimis hourly data, this period was the coldest mid-October to November period on record for this station. We had the greatest number of hours below 38F: 152 hours in 2022. Previously cold vintages were: 1994 with 139 hours and 2009 with 115 hours, for the same time period. Possibly even more noteworthy: for this same period last year only 15 hours were recorded below 38F in 2021.

### DECEMBER

**Rainfall**: Storms brought 13 days of rainfall and higher than average precipitation for December, totaling 10 – 18" for the month. Several of these storms brought heavy rainfall and high winds. Most notably, late December 26 through the morning of December 27 there was between 2.5 – 5" of rain that fell over a 14-hour period.

**Temperatures**: When it was dry in December, morning temperatures dropped to similarly cold temperatures that we experienced in late October and November but the storms brought mild and warmer air temperatures with them keeping most of December temperatures mild. The most notable weather patterns in December were the unusual high pressure systems that formed in the arctic resulting in the wet and stormy conditions we experienced in Napa Valley, and that other parts of the country experienced record breaking cold temperatures and storms that significantly impacted much of the holiday travel.

## Key Weather Events of the 2022 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.

### Grape Berry Ripening

*By Justin Leigon, Piña Vineyard Management*

The unprecedented heatwave during September 2022 posed many challenges for growers in the Napa Valley. One of which was the interruption of ripening during the final weeks of harvest. Each growing season, wine grapes transition through three stages: berry formation, lag phase, and berry ripening. It can be beneficial to periodically review the different stages to better understand the overall ripening curve and farm accordingly.

The first stage occurs immediately after flowering (anthesis or bloom) when self-pollination takes place. The pollination process begins when the flower cap detaches—exposing the stamens and pistil. The length of time it takes for pollination will depend on the weather, and if temperatures are too low, or windy conditions too extreme, many flowers may not set a berry, resulting in cluster "shatter" (i.e., less total berries per cluster). Statistically speaking, most flowers do not result in berry development, with normal success rates between 20-30% for each cluster (Dokoozlian, n.d.).

After pollination, a period of rapid berry growth commences. During this period, berries develop by both cell division and cell expansion (Kennedy, 2002). Although the berries are still firm and green, most of the important and desirable components of the grape composition accumulate and are formed during the first phase of berry development. This includes, tartaric acid, malic acid, as well as both skin and seed tannins.

The second stage of development is called lag phase—typically occurring during early summer. Canopy management practices are done during this period when berries are around pea-size. It's also an important time for the skin to acclimate to the season's heat. The pace of berry sizing slows down and proceeds only through cell expansion. Both stages I and II occur before berry ripening, and by the end of lag phase the berries will have their highest levels of organic acids and tannins. According to Dokoozlian and Kliewer (1996), "light exposure during stages I and II appears necessary for maximum pigment production during stage III."

The final stage of development is berry ripening. This begins at véraison and is characterized by berry softening and coloring (Kennedy, 2002), usually around the end of July or early August for Napa. A critical component for berry growth and development is water, which is normally 70%-80% of the final fresh weight at harvest. Although berries do not have functional stomata like neighboring leaves, they also transpire water during their development (Dokoozlian, n.d.).

An important physiological change occurs at berry softening. Before this stage, most of the water movement takes place within the xylem (vascular tissue for conducting water). After véraison, the

vessels that carry the water via the xylem are blocked, and the phloem (vascular tissue for transporting soluble organic compounds and sugars) takes over as the dominate pathway (Greenspan et al., 1994). An important difference between xylem and phloem is that the primary tissue of the former functions with dead cells, while the latter uses living vascular tissue. If an extreme heatwave occurs, the living tissue can be impacted by the high temperatures—potentially resulting in cellular damage (Qaderi et al., 2019). This is likely one of the factors that led to stalled sugar accumulation that was reported by some growers after the Labor Day scorcher.

Another critical piece of berry ripening is the uptake of potassium (K+). It is highly mobile within the phloem vascular tissue. Rogiers et al. (2006) found that, "after root uptake and transport through the xylem to the shoots, berry pedicel girdling studies confirmed that the phloem is the predominant route for K+ entry into the berry after veraison." Potassium is essential for all plants and plays an important role in enzyme activation and translocation of sugars via proton pumping in the phloem. A disruption in this process can also impact normal berry ripening.

Each season, growers in the Napa Valley are faced with many challenges. Preparing for these unforeseen events means cultivating the most resilient grapevines possible. This includes tracking the nutrient needs of a given vineyard site, as well as utilizing irrigation in a way that is efficient and most impactful. If sufficient water is available, misters or overhead sprinklers can be used to reduce berry transpiration and lower the ambient temperature during heatwaves. Also, plant samples can be taken annually during bloom or véraison to correct any potential nutrient imbalances.

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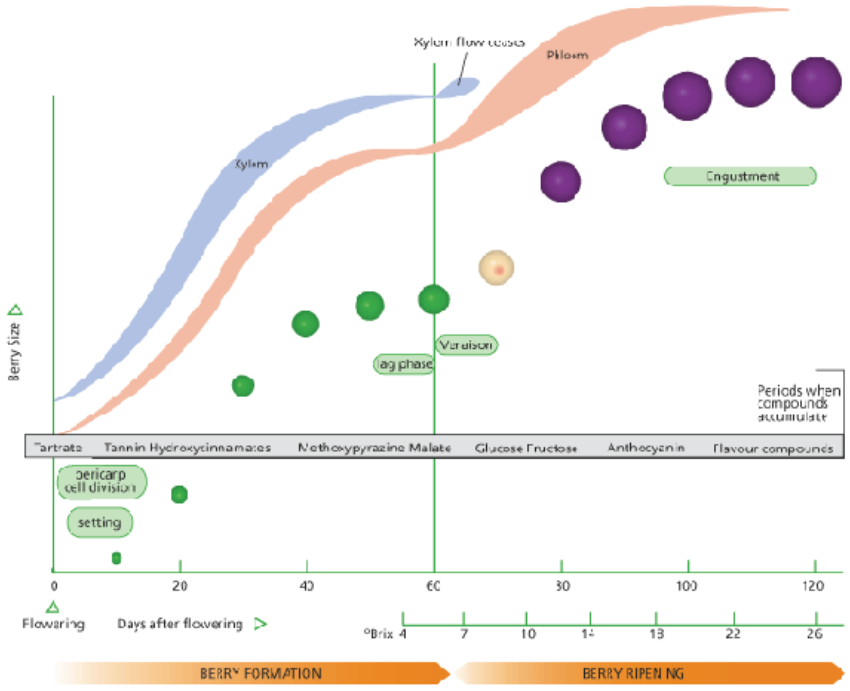



**Figure 2: Diagram showing relative size and color of berries at 10-day intervals after flowering, passing through major developmental events (rounded boxes). Also shown are the periods when compounds accumulate, the levels of juice °brix, and an indication of the rate of inflow of xylem and phloem vascular saps into the berry. Illustration by Jordan Koutroumanidis, Winetitles.**

**Deep Dive on Rain and Early Season Soil Moisture Levels**

*By Sarah Ferguson, Ruetd*

With the deluge of rain in late October 2021 reservoirs were filled overnight! It was one of the heaviest single day storms on record in Napa. Sighs of relief were felt throughout the valley seeing full reservoirs at the very start of the rainy season, and December rains kept reservoirs full. After two back-to-back drought years growers started dusting off their playbooks for how to manage in a rainy vintage.

As the year went on though, with little rain in January, February, and start of March, soils started drying out and for the third year in a row we were once again confronted with the question of whether to start irrigating pre-bud break or not.

Typically, the decision of when to start irrigating happens after vines have not only started growing but also started experiencing water stress post berry development due to soil profiles drying out, increased evapotranspiration, and increasing temperatures.

In the start of the 2022 season, soil moisture levels started drawing down due to the lack of early spring rainfall. Similar to the previous 2 years, starting the season with less than full soil profiles required more monitoring and potential intervention to ensure good early growth.

**How to monitor soil profiles:**

If you have soil moisture probes present in your vineyard, this is a direct measurement of soil moisture at different depths through the soil profile, usually in increments of 6 or 8 inches. Not all soil types are the same and vary by the amount of clay, sand, silt, gravel and rock. Soil moisture probes give information about how quickly water moves through the soil and when soils dry down. Similarly, having soil pit analysis conducted by soil scientists will identify areas in the vineyard that dry out more quickly compared to others. Using a shovel to dig around the vines will give visual confirmation on soil moisture available at a sub-surface level.

**Timing of low soil moisture:**

There are three main stages of vine growth where monitoring stress and low soil moisture are important:

**1. Bud break through bloom:** this stage is characterized by rapid shoot growth. Canopy and flower potentials are developing. Vines use stored carbohydrates and available water to start rapidly growing and start producing its own energy through photosynthesis. Stress during this period results in stunted shoots and poor set. Under severe water stress, growing tips as well as flowers dry up and future growth is tough to restart, coming mostly from lateral growth. Little to no stress is desired during this stage.

To monitor early stress, you can use similar tools as would be used later in the season. The main difference here is to use a lower threshold, meaning the stress level allowed should be considerably lower than late season triggers. Visual assessments include growing tips, internode length, and measuring shoot growth on marked vines which can show whether growth is slowing due to early stress.

**2. Post fruit set to veraison:** Canopy growth starts to slow down and berry development starts to rev up. This is the period that some water stress is desired to reduce vegetative growth and achieve balanced canopies and fruit development. Excess vigor can lead to green flavors and reduce quality.

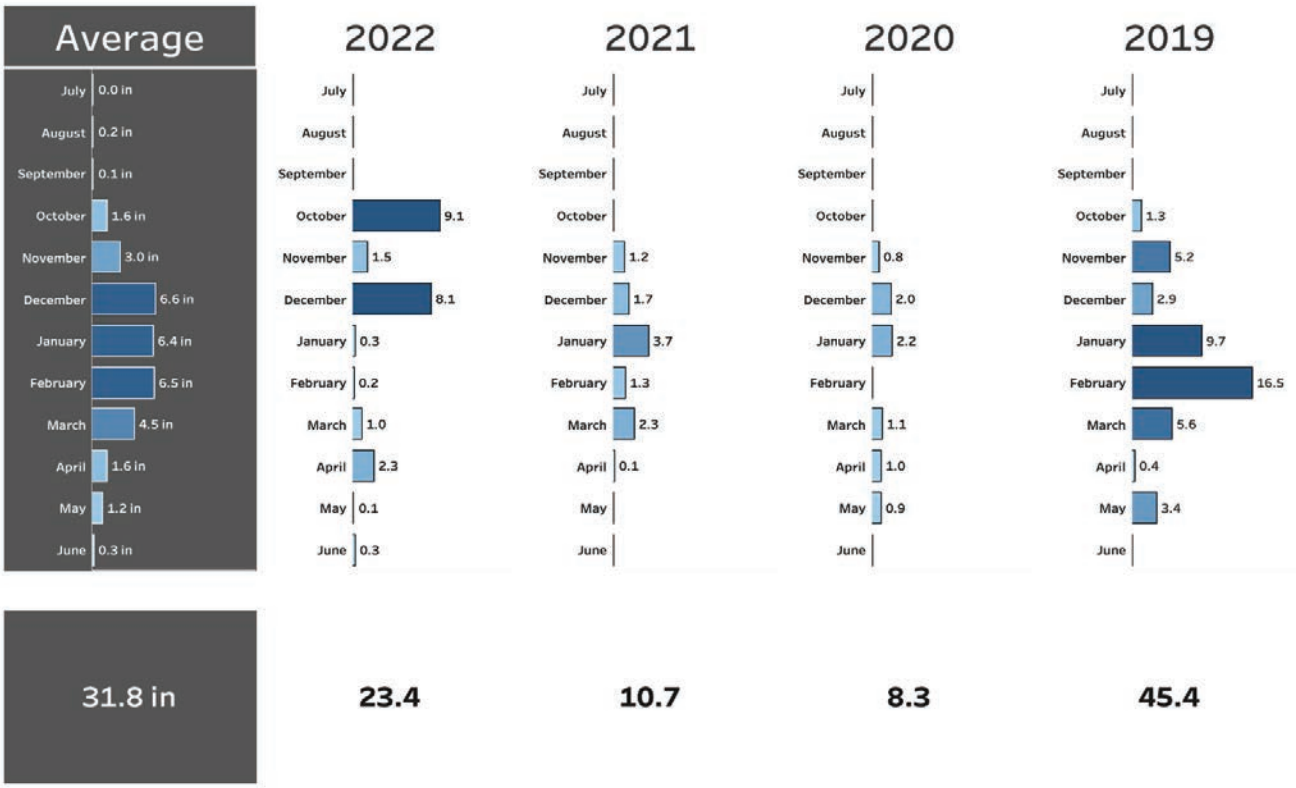
This is the time of the season when regular monitoring for vine stress to decide on irrigations would typically begin. Tools to monitor stress may include: visual assessment of canopy, leaf temperature, LWP readings, weather conditions, sap flow, ET and surface renewal measurements, as well as soil moisture readings.

These tools fall into categories in terms of how they measure stress:

- Direct vine measurement, individual vine stress: LWP, sap flow, leaf temperature, visual assessments
- Water available to vines: soil moisture probes
- Water loss through evapotranspiration, what the vines are using: ET, surface renewal
- Environmental conditions: weather stations and forecasts
- Vigor comparisons by aerial imagery: NDVI

**3. Veraison through harvest:** At veraison, berry skins soften and ripening begins. Maintaining canopies is important during this time to provide enough energy to fully ripen fruit. Moderate water stress is desirable to maintain fruit quality and berry size while also maintaining canopies to the end of the growing season.

Especially in dry years, monitoring early season rainfall, measurements of soil moisture and early vine stress are important to keep an eye on going into the growing season to ensure healthy early growth. Here's a comparison of how we started the past 4 seasons in terms of monthly rainfall compared to the average from Oakville CIMIS station (1989 – 2022).

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info@napagrowers.org • www.napagrowers.org