Vintage 2022
North Willamette Valley

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Summary:
Following a relatively warm 2021-22 winter, the spring will long be remembered for frost impacts and the prolonged cool and wet conditions into mid-June. The vines were slow to recover but experienced nearly ideal conditions during bloom that lead to a much larger than anticipated fruit set. The rest of the summer provided ample warmth, with a record-breaking stretch of eight days over 95°F in late July but very little heat stress compared to the 2021 vintage. However, concerns about normal fall rains and cooler temperatures left many wondering if adequate ripening would occur. But September and October delivered with heat accumulation higher than any other ripening period in the data record and precipitation held off until the last week in October, one of the drier ripening periods on record. Vintage 2022 growing degree-day totals at the reference vineyards averaged 2425 which was not as high as the 2021 vintage but higher than the average over the last five years. Across sites and varieties in the region that were used in this report, the phenological timing averaged April 10th for bud break, June 30th for bloom, August 29th for véraison, and October 10th for harvest. While budbreak was near average, all other events were significantly later due to the frost impacts and cool/wet spring.

Background:
This vintage summary is derived from weather stations located at nine locations across the North Willamette Valley. The locations include one in the Chehalem Mountains AVA, two in the Dundee Hills AVA, three in the Eola-Amity Hills AVA, one in the Yamhill-Carlton AVA, and two in the Willamette Valley AVA. The locations average 534 ft. in elevation, ranging from 205 ft. to 841 ft. Note that there is one fewer location in 2022 due to changes in the weather stations. Phenological observations come from the same nine locations plus eight others in the North Willamette Valley. Additional comparisons are made with the long-term McMinnville weather station located at the McMinnville Municipal Airport (157 ft.), and other stations in other growing regions in Oregon.

Climate:

Dormant Season
Like the previous winter, the PNW experienced a relatively warm winter during 2021-2022, with temperatures in the region 2.3°F above the 1901-2000 period[1]. In Oregon, the winter was the 8th warmest on record, averaging 2.9°F warmer than normal, with maximum temperatures significantly higher than minimum temperatures compared to averages (3.9°F vs. 2.0°F). Spatially the winter ranged from 2.0°F above within the coastal climate division to 3.7°F above in the high plateau climate division. Figure 1 shows the temperature and precipitation values for the McMinnville weather station from November 1, 2021, through the winter and growing season to October 31, 2022. The first three months of the winter were very

[1] Some comparisons are made with a 100-year average from 1901-2000 while others are made with climate normals, which are 30-year periods used by the global weather and climate services community for summarizing numerous weather variables. All references to 'normal' and 'average' for the McMinnville weather station in this report are with the 1991-2020 period.

mild with November substantially above average while December and January slightly above average. This was followed by a February that was slightly below average (-0.5°F) while March was slightly above average (0.8°F). The last week of December through the first week of January, the last week of January, the third week in February, and mid-March saw the coldest temperatures of the winter with an absolute minimum of 21.0°F observed on December 27th at the McMinnville airport station. The dormant period saw three record temperature extremes for the station with maximum records of 60°F on November 11th, 68°F on February 11th, and 65°F on February 12th. There were no minimum temperature records during the 2021-22 dormant period.

The nine reference vineyards in the North Willamette Valley averaged 43.2°F during the winter of 2021-2022 (Table 1), which was close to the previous winter's average (Table 2). Average minimum temperatures during the winter ranged from 37.0 to 38.7°F over the sites with an absolute minimum of 19.5°F observed on January 1st when all nine sites dropped into the low 20s. On average, the sites observed a total of 25 days below freezing during the winter, which was similar to the previous winters (Table 2).

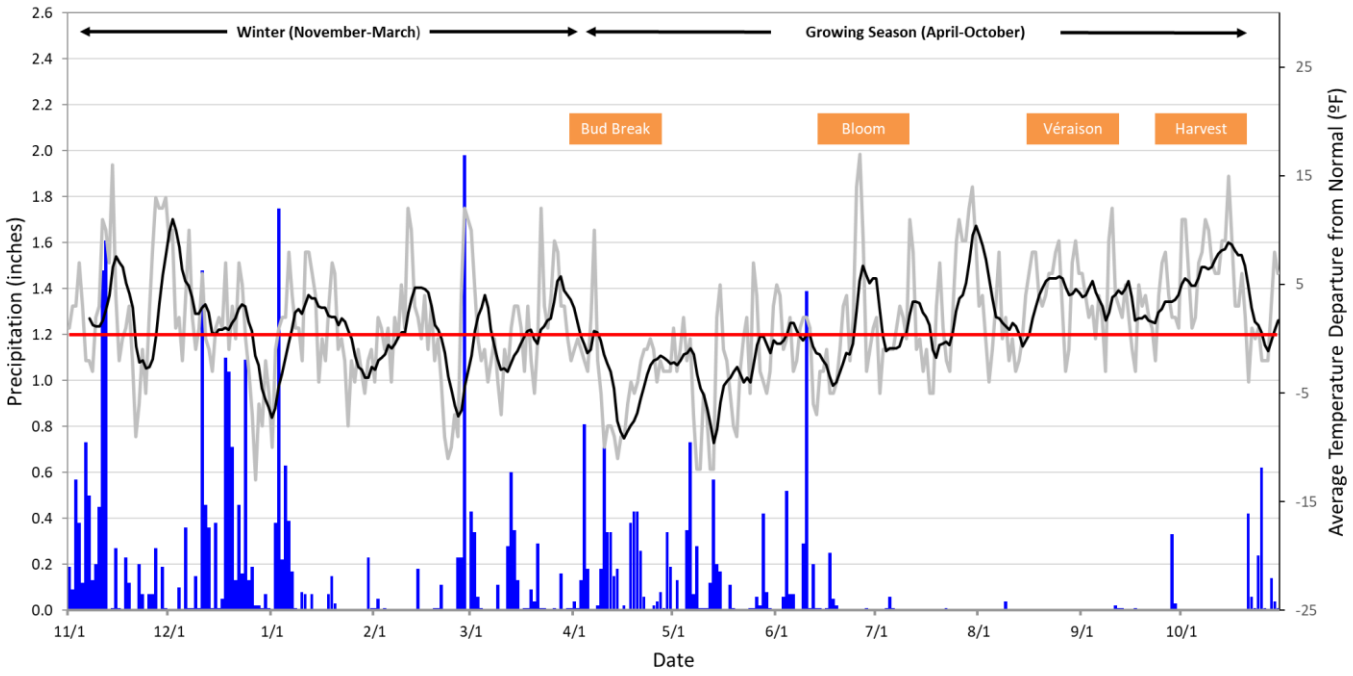

Figure 1 – Precipitation (blue bars) and temperature departure from normal for the McMinnville weather station from November 1, 2021, through October 31, 2022. The gray line represents the daily temperature departures from average, above and below the red line) and the black line represents the weekly moving average.

Precipitation during the winter of 2021-2022 was below normal over the majority of the PNW, with the driest areas continuing to be southern and eastern Oregon, eastern Washington, and central to southern Idaho (60-80% of normal). Only portions of western Washington, northwest Oregon, and the northern Cascades experienced normal winter precipitation (100-130% of normal). The McMinnville weather station experienced November through March precipitation of 28.46", which was 2.51" above the 1991-2020 climate normals (10% above) with November and December seeing above normal precipitation and January through March experiencing below average precipitation (Figure 1). The greatest one-day precipitation amount at the McMinnville weather station occurred on February 28th with 1.98" which was a record for that date for the McMinnville weather station.

Over the winter the nine reference vineyards averaged 28.17" of precipitation with the wettest periods occurring during early November, most of December, early January, and the end of February, which is the same pattern as can be seen in Figure 1 for the McMinnville weather station. Precipitation amounts ranged from 25.59" to 33.62" (Table 1) and the highest daily total experienced was 2.49" on February 28th. The number of days experiencing light rainfall (<0.25") averaged 60 across the sites (40% of the days), while heavier rainfall days (>0.25") averaged 34 across the sites (23% of the days). Days without precipitation during the 2021-2022 winter averaged 57 days or roughly 38% of the winter.

Table 1 – Weather and climate characteristics from nine vineyard locations in North Willamette Valley for the dormant season (November 1, 2021-March 31, 2022) and growing season (April 1-October 31, 2022). Growing degree-days are calculated with a base of 50°F with no upper cut-off. Note that some missing data during the dormant season from the stations was statistically replaced by data from the McMinnville station.

Dormant Season (Nov 1 – Mar 31)	***Average***	***Standard Deviation***	***Maximum***	***Minimum***	***Range***
Average Temperature (°F)	43.2	0.5	43.7	42.5	1.2
Average Maximum Temperature (°F)	49.4	0.7	50.4	48.4	2.0
Average Minimum Temperature (°F)	37.8	0.6	38.7	37.0	1.7
Absolute Minimum Temperature (°F)	21.5	1.1	22.6	19.5	3.1
# of Days < 32°F	25	6	33	18	15
Total Precipitation (inches)	28.17	2.47	33.62	25.59	8.03
Highest Daily Total (inches)	2.26	0.17	2.49	2.01	0.48
# of Days Without Precipitation (days)	57	6	67	50	17
# of Days with Precipitation < 0.25" (days)	60	6	70	49	21
# of Days with Precipitation > 0.25" (days)	34	3	37	29	8
Growing Season (Apr 1 – Oct 31)	***Average-Median***	***Standard Deviation***	***Maximum***	***Minimum***	***Range***
Growing Degree-Days	2425	134	2593	2206	387
Growing Season Average Temperature (°F)	60.4	0.7	61.2	59.3	1.9
Average Maximum Temperature (°F)	71.6	0.7	72.5	70.7	1.8
Absolute Maximum Temperature (°F)	99.2	1.4	101.5	97.1	4.4
# of Days > 95°F	7	3	11	2	9
Average Minimum Temperature (°F)	50.7	1.1	52.3	49.2	3.1
Absolute Minimum Temperature (°F)	29.9	1.4	32.0	27.4	4.6
# of Days < 32°F	3	0.8	4	2	2
Median Last Spring Frost (date or days)	4/15	0.7 days	4/17	4/15	2 days
Median First Fall Frost (date or days)	11/9	2.1 days	11/13	11/7	6 days
Median Frost-Free Period (days)	208	2 days	212	206	6
Total Precipitation (inches)	15.42	3.67	24.79	12.09	12.70
Highest Daily Total (inches)	1.46	0.80	3.50	0.75	2.75
# of Days Without Precipitation (days)	146	4	153	142	11
# of Days with Precipitation < 0.25" (days)	43	5	36	22	14
# of Days with Precipitation > 0.25" (days)	26	4	36	22	14

Growing Season

The 2022 growing season in the PNW from April through October was a whiplash from a cool and wet spring to one of the driest and warmest ripening periods on record. Across the PNW the 2022 vintage ended up 2.2°F above the long-term average from 1901-2000 and the 9th warmest on record. But to start, the April through June portion of the vintage in the PNW ended up 2.2°F below average, the 12th coolest on record and the coolest since 2011. For the ending of the vintage, the PNW saw its warmest August through October on record at 5.7°F above average. Statewide Oregon was slightly warmer than the PNW as a whole during the April through October period at 2.5°F above average (8th warmest on record). Oregon was not as cool as the PNW region during the April-June period, but still 1.8°F below average and the

coolest start to a vintage since 2011. For the end of the vintage, Oregon saw August through October temperatures that were the warmest on record at 6.1°F warmer than average.

The McMinnville weather station started the growing season with April and May substantially colder than average at 3.7°F and 3.3°F below average respectively (Figure 1). June was cool to start, then rebounded to seasonally warm conditions, ending up at 0.5°F above average. From July through October temperatures were above average every month, from 2.6°F in July to 5.3°F in October. The warmest days at the McMinnville station during the growing season occurred during the last week in June, the last 10 days in July, and the third and fourth week in August with the highest temperature of 102°F observed on July 30th. The station experienced 24 days above 90°F, 11 days above 95°F, and 3 days above 100°F, each significantly lower numbers compared to 2021. But the eight days from July 24-31 with temperatures above 95°F each day was one of the longest such periods on record for the McMinnville station (similar records were set throughout the region, including Portland).

Over the western US, growing degree-days were substantially different north and south. California was warmer overall than the PNW and ended up mostly 15-25% above normal for growing degree-day accumulations. Due to the cool and wet spring, heat accumulation in the PNW started off below average everywhere. GDD accumulations tracked at or slightly above the 2010 and 2011 vintages and above the 1981-2010 average until late June and early July when the PNW finally saw warmer temperatures. By the end of the vintage, Oregon heat accumulation (GDD) amounts ended up slightly below to moderately above the 1991-2020 climate normal with McMinnville (+18%), Roseburg (+7%), and Medford (+15%) each above average, while Milton-Freewater was 4% below the period average. All locations ended up above the 1981-2010 climate normals (+6 to +21%), while for the last 15 years the stations ended up from 3% below (Milton-Freewater) to 5-7% above. Each location was below the GDD experienced in 2021 (4-9%) but 11-34% GDD above the cool 2010 and 2011 vintages. For the McMinnville weather station, the 2022 GDD ended up at 2484, which was similar to GDD amounts seen in the 2004, 2013, 2016, and 2017 vintages (+/-3%) but below the 2014 and 2015 vintages, the warmest to date for McMinnville.

The nine reference vineyards averaged 2425 GDD during the 2022 growing season (Table 1), slightly lower than the 2021 vintage but higher than the average over the last four vintages (Table 2). The sites ranged from a low of 2206 GDD to a high of 2593 GDD for the vintage. Figure 2 shows that the average GDD accumulation at the nine sites (red line) was 59 GDD lower than the McMinnville airport location (black line), which is slightly less than the differences seen the previous four vintages. Each of the site curves show the two main periods; the cool spring and the very warm end of the season compared to the normals (Figure 2). Figure 3 shows the same degree-day data but, instead of cumulative as in Figure 2, it gives the daily accumulation values. Evident in the figure are the very low daily accumulation amounts in the spring to the much higher than normal accumulation amounts in September through the third week in October (Figure 3).

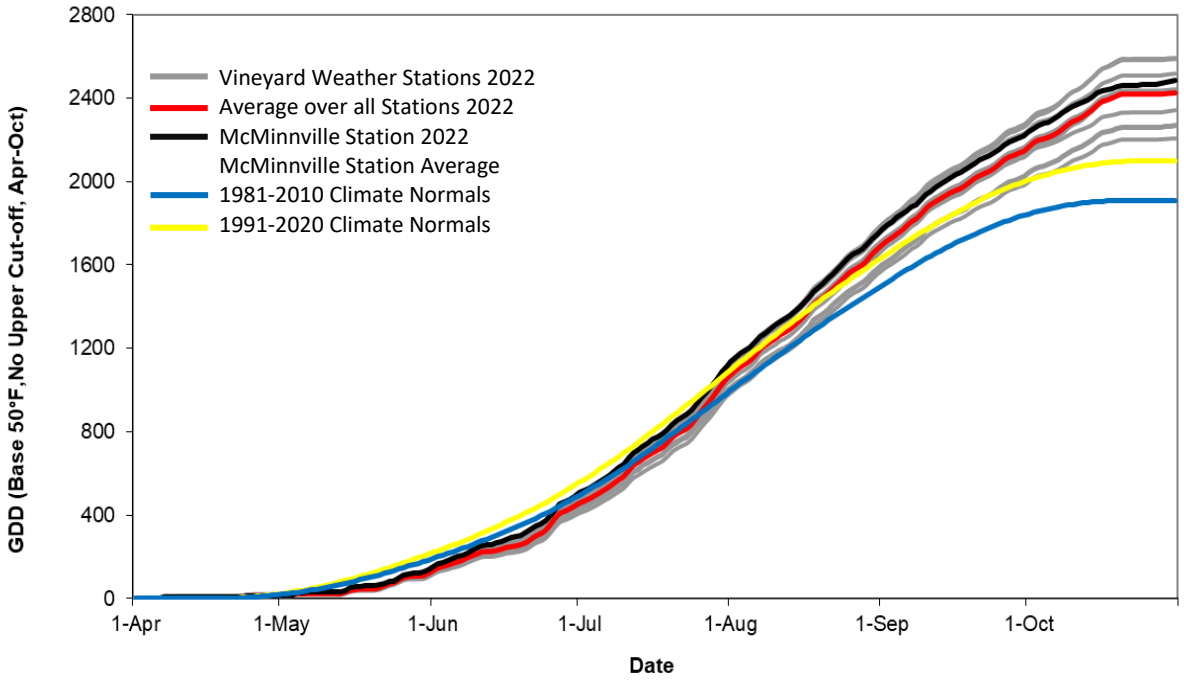

Figure 2 – Growing degree-day accumulation during April-October 2022 from each of the vineyard weather stations (grey lines), the average over all vineyard weather stations (red line), and the McMinnville Airport weather station (black line). The long-term average (blue line) is from the 1981-2010 climate normals and (yellow line) is from the 1991-2020 climate normal, both for the McMinnville weather station. Calculated from daily Tmax and Tmin observations for April 1st through October 31st using a base of 50°F with no upper cut-off.

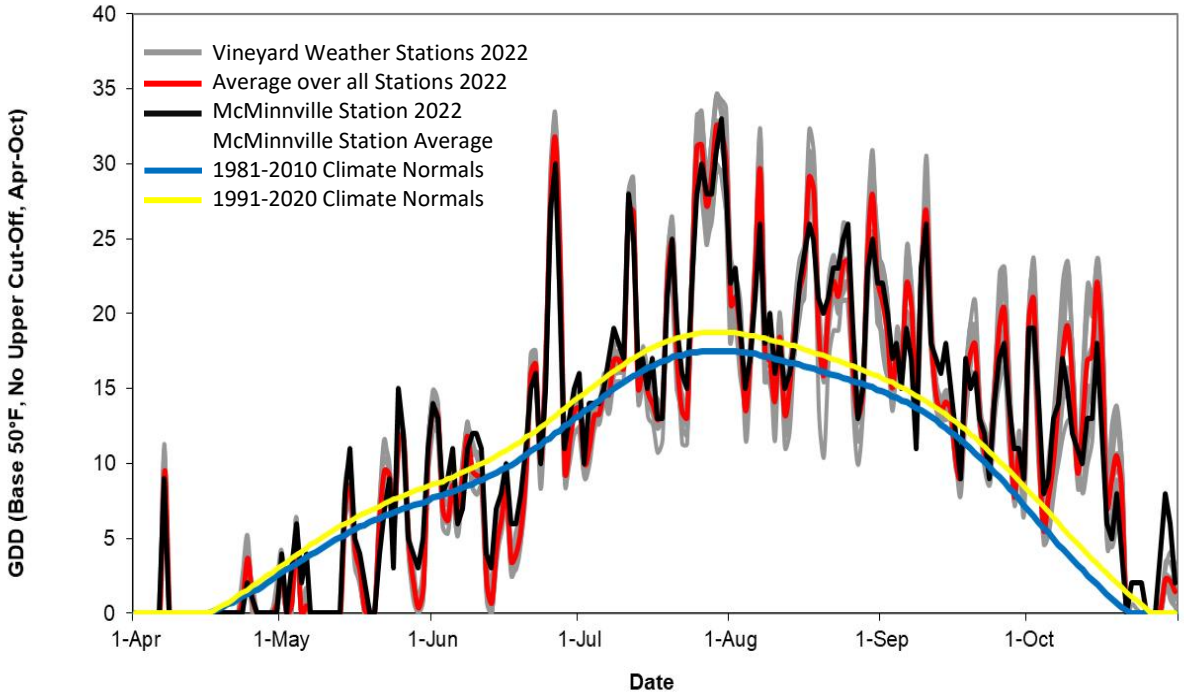

Figure 3 – Same data as in Figure 2 but shown as daily growing degree-day values during April-October 2022 from each of the vineyard weather stations (grey lines), the average over all vineyard weather stations (red line), and the McMinnville Airport weather station (black line). The long-term average (blue line) is from the 1981-2010 climate normal and (yellow line) is from the 1991-2020 climate normal, both for the McMinnville weather station. Calculated from daily Tmax and Tmin observations for April 1st through October 31st using a base of 50°F with no upper cut-off.

For the reference vineyards, the growing season average temperature during 2022 was 60.4°F (Table 1), which was cooler than 2021 but the same as the five-year average (Table 2). Maximum temperatures were cooler than average in 2022 while minimum temperatures were slightly warmer than average. Like the McMinnville station, the warmest periods during the growing season occurred in the last week in June, the last 10 days in July, and the third and fourth week in August (Figure 1) with an average absolute maximum site temperature of 99.2°F observed on July 30th. During the vintage, the reference vineyards experienced 7 days over 95°F on average (Table 1), less than 2021 but more than average.

The coldest periods during the growing season came during April 10-17 with site temperatures dropping to 27-34°F, during a cool period down to the mid to upper 30s during the second and third week in May, and during the cool down in late October. The absolute minimum temperature observed at these sites was 27.6°F on April 15th when all nine locations dropped below 32°F. The number of days below 32°F during the growing season ranged from two to four across the sites, with all coming during the April 10-17 period. The median last spring frost date across the sites in 2022 was April 15th, 2 to 3 weeks later than the past four vintages. The median first fall frost date across the sites was on November 9th (Table 1), close to the average over the past few vintages. The overall frost-free period in 2022 averaged 208 days across the sites, which was 16 days shorter than the average over the last five vintages (Table 2).

Table 2 – Same weather station information as in Table 1, except for each year since 2018. *Note that the winter of 2017-2018 data was not processed for these sites.

Dormant Season (Nov 1 – Mar 31)	***2017-18****	***2018-19***	***2019-20***	***2020-21***	***2021-22***	***Average***
Average Temperature (°F)		42.0	43.1	43.1	43.2	42.9
Average Maximum Temperature (°F)		48.4	49.6	49.7	49.4	49.3
Average Minimum Temperature (°F)		36.8	37.7	36.8	37.8	37.3
Absolute Minimum Temperature (°F)		23.4	25.9	23.8	21.5	23.7
# of Days < 32°F		32	23	24	25	26
Total Precipitation (inches)		19.03	18.60	24.94	28.17	22.69
Highest Daily Total (inches)		1.48	1.35	2.37	2.26	1.87
# of Days Without Precipitation (days)		58	62	49	57	57
# of Days with Precipitation < 0.25” (days)		67	66	75	60	67
# of Days with Precipitation > 0.25” (days)		25	25	28	34	28
Growing Season (Apr 1 – Oct 31)	***2018***	***2019***	***2020***	***2021***	***2022***	***Average***
Growing Degree-Days	2372	2101	2299	2503	2425	2340
Growing Season Average Temperature (°F)	60.7	59.3	60.3	61.4	60.4	60.4
Average Maximum Temperature (°F)	73.1	70.3	71.9	73.5	71.6	72.1
Absolute Maximum Temperature (°F)	97.8	96.8	99.3	110.5	101.5	101.2
# of Days > 95°F	6	2	4	8	7	5
Average Minimum Temperature (°F)	50.2	50.2	50.4	50.8	50.8	50.5
Absolute Minimum Temperature (°F)	32.5	30.0	30.3	31.2	27.4	30.3
# of Days < 32°F	0	1	2	1	3	1
Median Last Spring Frost (date or days)	3/23	3/11	3/26	3/30	4/15	3/27
Median First Fall Frost (date or days)	11/9	10/29	10/26	11/21	11/9	11/6
Median Frost-Free Period (days)	231	232	223	224	208	224
Total Precipitation (inches)	9.09	12.23	9.53	10.08	15.42	11.27
Highest Daily Total (inches)	1.17	0.96	0.92	1.29	1.46	1.16
# of Days Without Precipitation (days)	167	150	154	165	146	156
# of Days with Precipitation < 0.25” (days)	35	46	47	35	43	41
# of Days with Precipitation > 0.25” (days)	12	18	13	14	26	17

Growing season precipitation was near average to significantly below average over most of the western US in 2022, with continued drought conditions in California and much of the Great Basin. The PNW ended the

season with Oregon's northwestern valleys, the Cascades, and across the Columbia Valley to western and southern Idaho seeing near average to nearly 200% above average amounts. The Olympic Peninsula, the northern Cascades, south-central Oregon, and the Bitterroot Mountains were down by approximately 10-25% for the April through October months. The McMinnville station ended the growing season 2.24" above average (+19%) with the wettest periods coming during April, May, and June and the last week in October (Figure 1). The highest single day event for the McMinnville station during the growing season was 1.39" on June 10th.

For the nine reference vineyards, precipitation during April through October averaged 15.42", ranging from a low of 12.09" to a high of 24.79" (Table 1) with the highest amounts coming from the more elevated sites and eastside location. The 2022 vintage experienced above average rainfall amounts compared to the last five years (Table 2). The highest single amount received at any one site was 3.50", which occurred on June 10th during an atmospheric river event when locations in the north valley saw 1.3" to over 3.0" for the day. A total of 146 days during the growing season had no precipitation (68%), which was fewer than average. The number of days with precipitation amounts less than 0.25" was 43, slightly more than average, while the number of days with greater than 0.25" was 26 (Table 1), substantially more than average during the last five vintages (Table 2).

The McMinnville weather station experienced nine record weather events during the 2022 growing season. This is more than what has been experienced over the past five years at the site. These included a record low of 27°F on April 15th, a record daily precipitation amount of 1.39" on June 10th, two record warmest minimum temperatures on July 30th (64°F) and August 18th (62°F), and five record maximum temperatures during the first two weeks of October, ranging from 85 to 89°F.

Phenology:

Phenology was observed at 25 locations in the North Willamette Valley with bud break, bloom, and véraison recorded at 25-50% occurrence, and harvest as the date that picking started for each location (Pinot Noir and Chardonnay). Summarizing the phenological observations for the locations and averaged across all varieties for 2022 shows an average bud break of April 10th (Table 3), which was the same as the long-term average but slightly earlier than the last four vintages (2018-2021) (Table 4). For 2022, the sites had a longer range of 19 days across sites, reported as early as March 30th and as late as April 18th.

Table 3 – Phenological date (25-50% occurrence) and interval characteristics for the 2022 vintage averaged over all sites and varieties (Pinot Noir and Chardonnay).

Event/Interval	*Average*	*Standard Deviation*	*Latest or Longest*	*Earliest or Shortest*
Bud Break	April 10	5 days	April 18	March 30
Flowering	June 30	3 days	July 7	June 27
Véraison	August 29	4 days	September 5	August 22
Harvest	October 9	5 days	October 19	September 25
Bud Break to Flowering	79 days	6 days	92 days	67 days
Flowering to Véraison	60 days	5 days	70 days	52 days
Véraison to Harvest	42 days	6 days	50 days	24 days
Flowering to Harvest	101 days	6 days	111 days	88 days
Bud Break to Harvest	181 days	5 days	190 days	168 days

The average date of flowering was June 30th which was the latest observed over the previous four vintages and two weeks later than the longer-term average. The range across sites for flowering during 2022 saw the earliest occurring on June 27th and the latest on July 7th. Véraison and the start of the ripening phase during 2022 occurred over a 14-day period across the third week in August into the first week in September. The earliest véraison in 2022 was observed on August 22nd while the latest was observed on September 5th, averaging August 29th across the sites, which was the latest over the past four vintages and the longer-term average (Table 4). For the 2022 vintage, harvest at these sites occurred over a 24-day period from September 5th to October 19th with an average date of October 9th (Table 3). Across these sites and varieties, harvest dates were the latest during the past four vintages.

Intervals between phenological events show that bud break to flowering during 2022 had an average interval across these sites of 79 days; that flowering to véraison was 60 days on average; and that véraison to harvest was 42 days on average (Table 3). These intervals had 5 to 6-day standard deviations across sites and varieties, but a wide range between the shortest and longest intervals due to site elevation/temperature and frost impact differences. For the 2022 vintage, the length of flowering to harvest averaged 101 days ranging from 88 days (early sparkling pick) to 111 days. The length of the bud break to harvest period averaged 181 days with 22 days between vineyard sites with the shortest and longest intervals. Compared to the 2018-2021 vintages, 2022 saw significantly longer intervals for bud break to flowering and bud break to harvest but surprisingly similar interval lengths for flowering to véraison or harvest or véraison to harvest.

Table 4 – Same phenological information as in Table 1, except for each year since 2018. **§** The earlier vintage average comes from Results Partners and a summary of North Willamette Valley sites for a 17-year average prior to 2018. The average* comes from the 2018-2022 vintage data.

Event/Interval	*Earlier Vintages §*	*2018*	*2019*	*2020*	*2021*	*2022*	*Average**
Bud Break	April 10	April 17	April 16	April 11	April 14	April 10	April 13
Flowering	June 15	June 12	June 8	June 11	June 4	June 30	June 12
Véraison	August 20	August 15	August 14	August 17	August 10	August 29	August 16
Harvest	NA	Sept. 29	Sept. 27	Sept. 27	Sept. 14	October 8	Sept. 26
Bud Break to Flowering	65 days	56 days	53 days	61 days	51 days	79 days	60 days
Flowering to Véraison	66 days	65 days	67 days	68 days	67 days	60 days	65 days
Véraison to Harvest	NA	45 days	45 days	41 days	35 days	42 days	42 days
Flowering to Harvest	NA	110 days	111 days	108 days	102 days	101 days	106 days
Bud Break to Harvest	NA	167 days	164 days	170 days	153 days	181 days	167 days

NA = Not Available

Records, Impacts, and Influences:

Records

Given the large swings between the cool and wet spring and the warm and dry ripening period, the question would be “how extreme were these periods in 2022 compared to the historical record?”. To do this I have summarized climate division data for the Willamette Valley below. In the continental US there are 344 climate divisions. For each climate division, monthly station temperature and precipitation values are computed from the daily observations. The divisional values are weighted by area to compute statewide values and the statewide values are weighted by area to compute regional values. Oregon has nine climate divisions (https://www.ncei.noaa.gov/access/monitoring/dyk/us-climate-divisions), of which

climate division #2 spatially covers the vast majority of the Willamette Valley AVA. The data cover the **1895-2022** period, providing the longest-term view of climate characteristics for the area.

Spring

- April through June growing degree-days were the 38th lowest during the 1895-2022 period.
- April through June precipitation totals were the 2nd wettest during the 1895-2022 period with only 1993 being wetter. Other recent years in the top 15 wettest include 2010, 2011, and 2012.

Ripening

- September and October precipitation totals were the 15th driest during the 1895-2022 period.
- September growing degree-days were the 5th highest during the 1895-2022 period. Similar accumulation in September was seen in 2011, 2014, and 2020.
- October growing degree-days were the highest year during the 1895-2022 period. Similar accumulation in October was seen in 2014 and 2015.
- The September and October combined growing degree-days were highest year during the 1895-2022 period. Similar accumulation in September and October was seen in 2014.

Frost Occurrence and Types

From an agricultural point of view, the occurrence of a specific temperature cannot be considered as frost, as there are plants that suffer the consequences of low temperatures without it reaching 32°F. Plants may also be more susceptible to low temperatures during different stages of growth. Therefore, knowing the plant system, its growth status, and anticipated low temperatures helps one better estimate the potential impacts and/or use appropriate measures of protection (e.g., wind machines, overhead sprinklers, heating devices, etc.).

However, not all frosts are the same. Frosts can be divided into three different types: advection, radiation, and evaporation.

- An advection frost is due to the arrival of a mass of cold air whose temperature is below 32°F. These air masses are typically quite large and have cold air both vertically and horizontally dispersed throughout the area and are often associated with higher wind speeds and higher wind chill temperatures.
- In contrast, radiation frosts are caused by the vertical stratification of the air where the lower layers are colder, and the higher layers are warmer (a thermal inversion). This is due to the loss of heat from the Earth's surface by irradiation during the night. This type of frost occurs in calm or low wind conditions where little mixing of the air occurs and on clear nights that allow greater heat loss from the Earth's surface.
- Evaporation frosts are caused by the loss of water by evaporation from the surface of the plant. This occurs when the relative humidity decreases, and the dew on the plant surface evaporates. This transfer of energy to evaporate the water, requires heat which leads to cooling of the plant.

While all three types of frost are common, even in Oregon, the frosts occurring during April 10-17, 2022, were the result of an advective frost with cold air largely engulfing the entire region. The air source initially moved out of the Siberian Arctic, then moved over the Gulf of Alaska before dipping down into the western US. As such, wind machines were not very useful in most locations.

Frost Records

The dates of the last freezing temperatures of the spring and the first freezing temperatures of the fall are of great importance to most all agribusinesses, including viticulture. Climate information on frost timing

relies on past temperature observations to calculate the historical probability of freezing temperatures occurring after (spring) or before (fall) certain dates. Users can use these probabilities to make decisions based on their tolerance for risk for what would be 'expected' given the historical data.

Putting the April 15th frost across Oregon into perspective requires examining data from the National Centers for Environmental Information, a division of NOAA. The NCEI has produced freeze data that is derived from the 1991–2020 U.S. Climate Normals, 30-year averages of climatological variables. Updated maps and data can be found at the NCEI website (https://www.ncei.noaa.gov/news/last-spring-freeze).

To read the freeze map or tables, find your location or one close to your site, then read the probability associated with a given temperature (32°F is most common). For example, for 32°F, a date of April 15th, and a probability of 50% it would mean that there is a 50% chance of the temperature falling to 32°F or colder after April 15th. Or in this example, April 15th would be the 'average date' of the last spring freeze at 32°F. Some users might use a lower probability threshold, such as 10-30%, to be surer of the risk at the location.

For the Willamette Valley, the following average spring freeze dates (50% probability) are found in the 1991-2020 climate normals on the NCEI website:

Mollala – March 16
Stayton – March 29
Salem – April 3
Eugene – April 11
McMinnville – April 15
Forest Grove – April 16
Dallas – April 16
Corvallis – April 17

One can see from these dates that an April 15th frost is not out of the question for many locations in the Willamette Valley. What was unusual was that this was an advective event with cold air vertically integrated over the area. Spring frosts in Oregon are more commonly of the radiation type, where warmer air aloft keeps areas elevated off the valley floor less impacted. Of course, sites nearer to urban areas, closer to the coast, at higher elevations, and up valley extensions will have slightly different freeze probabilities which highlights the need for having site specific weather stations.

Impacts and Influences

Weather-related impacts (from above) combined with grower comments provide a general summary for the 2022 vintage and include:

- Frost damage varied spatially, even within the same vineyard, block, and vine. Reports from growers found primary bud damage averaging close to 50% but ranging from no damage to 80% or higher depending on site and the variety.
- Differences in damage were most pronounced between lower and higher elevation sites, largely due to the higher elevation sites not having seen buds breaking yet.
- Primary bud damage along with the cool and wet conditions meant that budbreak did not advance for several weeks even with secondary buds.
- Higher humidity led to very high mildew pressure and with the wet soils, challenges in getting equipment out to do spraying.

- Heavy rain into early June with an atmospheric river June 10th bringing heavy rainfall totals to many.
- When bloom finally arrived, it did so during a moderate heat spike but under mostly clear skies, resulting in great fruit set and ultimately very large clusters. As a result, fruiting thinning was very important, even in a year where most did not anticipate needing to do any.
- Powdery mildew continued to be high throughout the vintage and botrytis appeared quite early.
- Harvest occurred in glorious conditions. A run of days with temperatures above 80°F in early October was heaven sent but everyone was seemingly still on edge expecting rainfall to start anytime and dampen the recovery. But it held out till October 21st, absolutely amazing.

Current Conditions:

The 2022-23 winter to date has seen near average to warmer than average temperatures from the mountains of Washington, Oregon, and California west to the coast. The inland PNW, Great Basin, and Rockies have seen moderate to significant colder than average temperatures so far. Precipitation amounts have been mixed across the west with western Washington, most all of Oregon, and northern California seeing near average to 80% of normal for the winter. The exceptions are portions of the Rockies and especially central California which has seen significant rain and snow from a train of atmospheric rivers that has whiplashed the region from drought to flooding.

Dry conditions have been prominent over the past few years in the west and have continued into winter 2022-23 (Figure 4). At the end of the year drought conditions were continuing at near record areal coverage in the west with the overall drought footprint remaining over 90%. Fortunately, the most extreme categories of drought (extreme and exceptional) have dropped some and are now under 15%. Washington has over 85% of the state in some level of drought, but still has no areas in the state in the most extreme drought categories. Oregon remains at over 90% of the state in some level of drought with the eastern and southern portions of the state remaining in extreme categories (>25%). California continues to have 100% of the state in some level of drought with the most extreme drought conditions decreasing slightly to just over 35% during the last 30 days and will likely continue some declines with the current circulation pattern in place. Drought levels have also worsened over much of the Great Basin of Nevada and Utah.

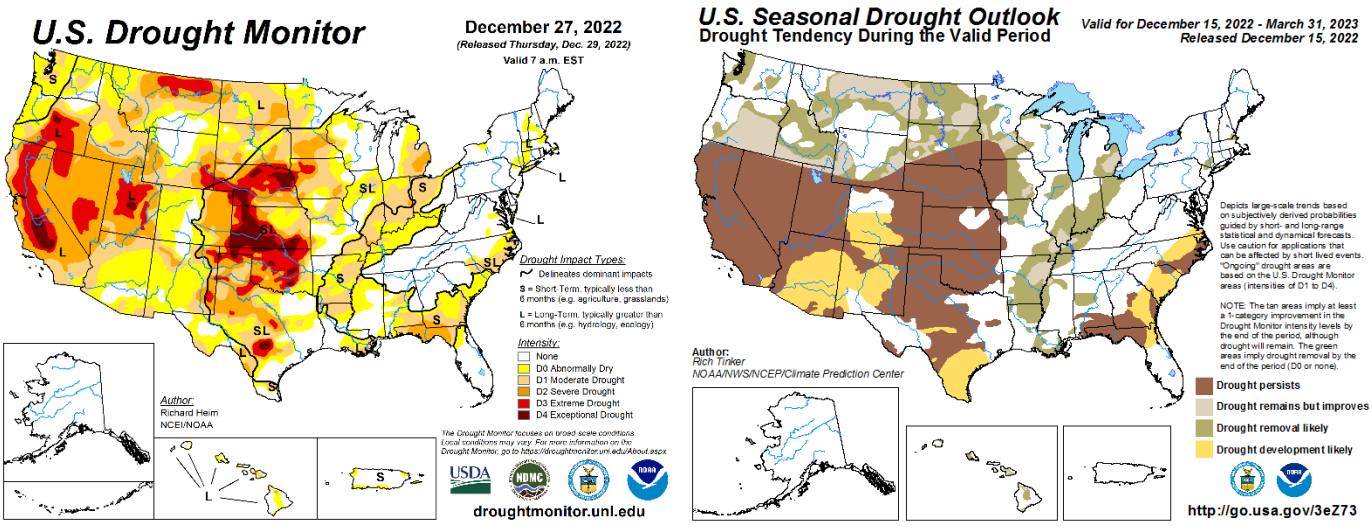

Figure 4 – Current US Drought Monitor and seasonal drought outlook.

The seasonal drought outlook for the second half of winter continues to exhibit some potentially good news but continues to show both short and long-term drought issues for significant areas of the west (Figure 4). The wet winter forecast for the PNW and across the northern Rockies and Plains has the outlook lowering the severity or removing drought altogether in the region. However, even with the major inputs from the current precipitation occurring in California, the state along with the Great Basin and the southwest are likely to remain in some level of drought through the winter and into spring.

Two drivers of western US climate include sea surface temperatures (SSTs) and broad atmospheric pressure patterns over the Tropical Pacific and North Pacific Ocean basins. For the Tropical Pacific, we have been in a rare triple-dip La Niña, which has only happened three times in our data record. As such there is little history to go from in terms of these events and correlations with temperatures and precipitation. Currently the SSTs in the central-eastern equatorial Pacific remain below average and other key oceanic and atmospheric variables in the region are also consistent with La Niña conditions (Figure 5). As such the Climate Prediction Center (CPC) is continuing the La Niña Advisory. Modeling efforts also continue to predict SSTs remaining below average during winter, and then returning to ENSO-neutral levels during spring or early summer. The official outlook from numerous agencies confirms this forecast with the outlook calling for La Niña to continue with moderate probability during January through March and decreasing thereafter. While the current onslaught of precipitation in California is not indicative of typical La Niña conditions, the current patterns are more the result of amplified circulation created from the extreme Arctic blocking event that ushered in the extreme cold of mid to late December. As such, La Niña is still contributing to the model forecasts pointing to the PNW likely seeing a cooler/wetter second half of winter, while California has higher odds to be drier during the next few months and near average for temperatures. El Niño appears to be gaining more model and forecast favor in the late summer and fall of 2023.

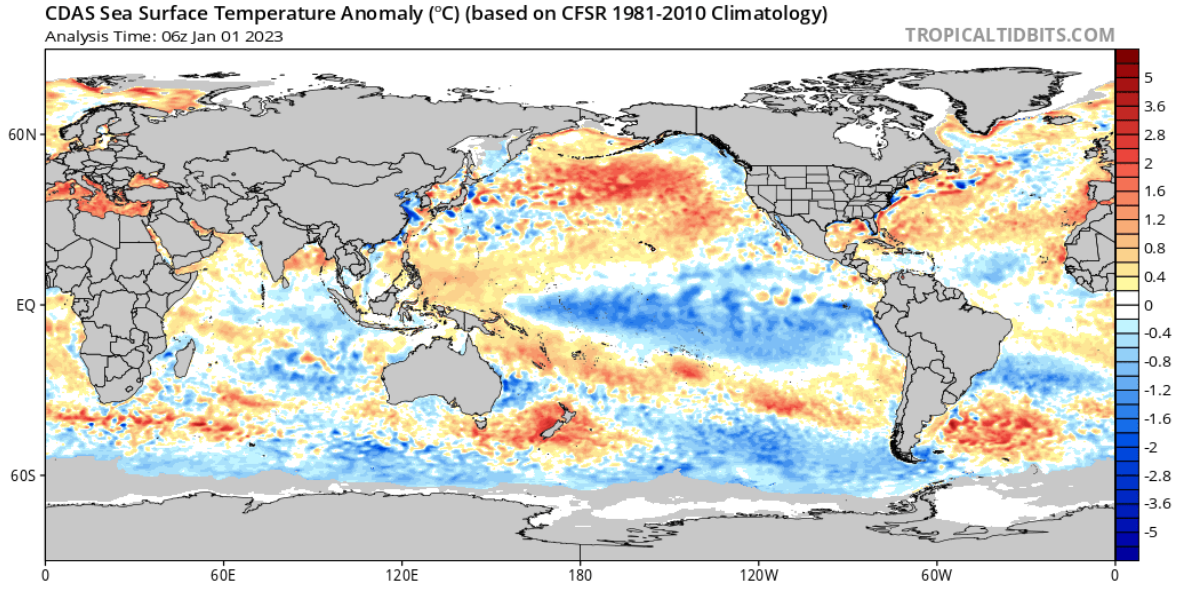

Figure 5 – Global sea surface temperatures (°C) for the period ending January 1, 2023 (image from Tropicaltibits.com).

The overall pattern in North Pacific SSTs continues to exhibit broad warmer than normal conditions over much of the central to western ocean basin (Figure 5). Likewise, the near-shore areas of the Gulf of Alaska and southward along the coast to Baja California have remained spatially consistent over the last month with cooler-than-average SSTs due to circulation over the region helping to mix cooler waters to the surface. Cooler SSTs also continue southwest from California and across the ENSO zone showing a classic La

Niña pattern in tropical SSTs. The overall pattern continues a strong negative phase in the Pacific Decadal Oscillation, where it has been for many months now. This type of pattern in cooler North Pacific SSTs supports the seasonal forecast showing the tendency for a cooler/wetter PNW, transitioning to cool and near average precipitation in northern California and to slightly cool and dry overall during the winter in most of the rest of California.

Further updates will be provided in monthly Weather and Climate Summary and Forecasts on my webpages (www.abacela.com/reports and www.climateofwine.com) and regional presentations over the coming months.

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