Cultivars for a Changing Climate

Management Practices for Vines

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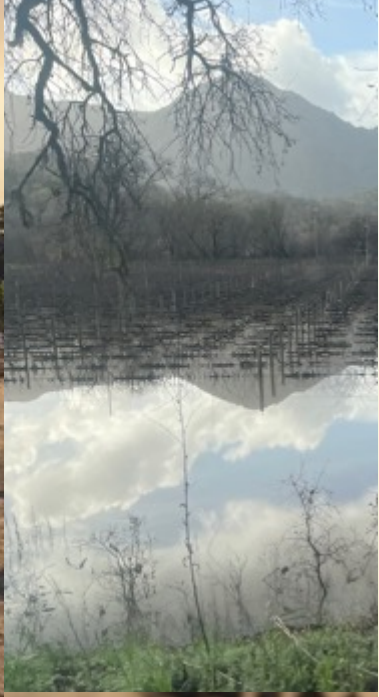
Climate Impacts

Must consider both **direct** and **indirect** impacts of changing climates

1. Change in growing season length
2. Earlier or later budbreak and ripening
3. Resource scarcity (i.e., water/fertilizer)
4. Increased soil salinity
5. More extreme weather events








66.6
°F/°C

Extreme Heat

Extreme temperatures

↓

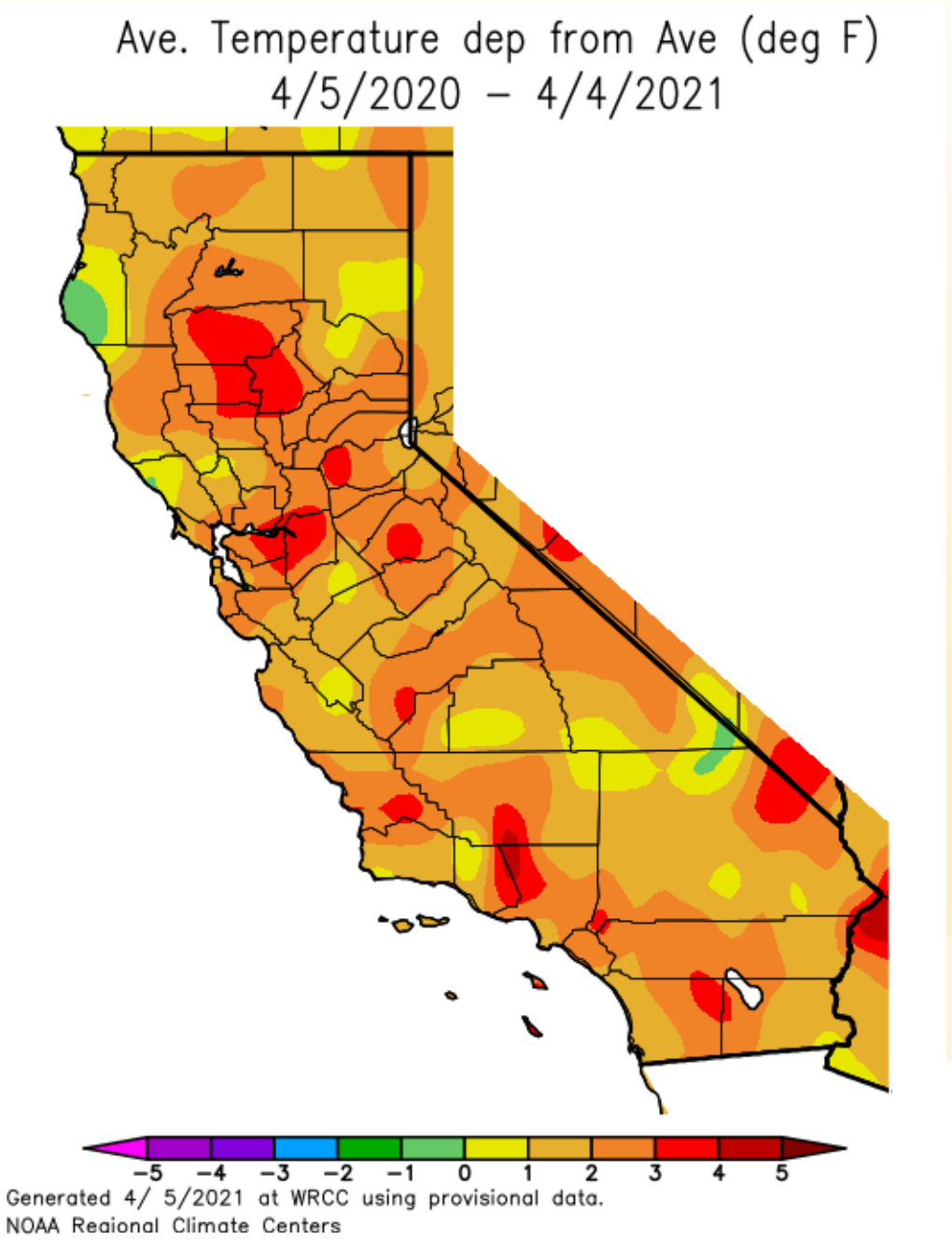
High evapotranspiration

↓

Greater water demand

↓

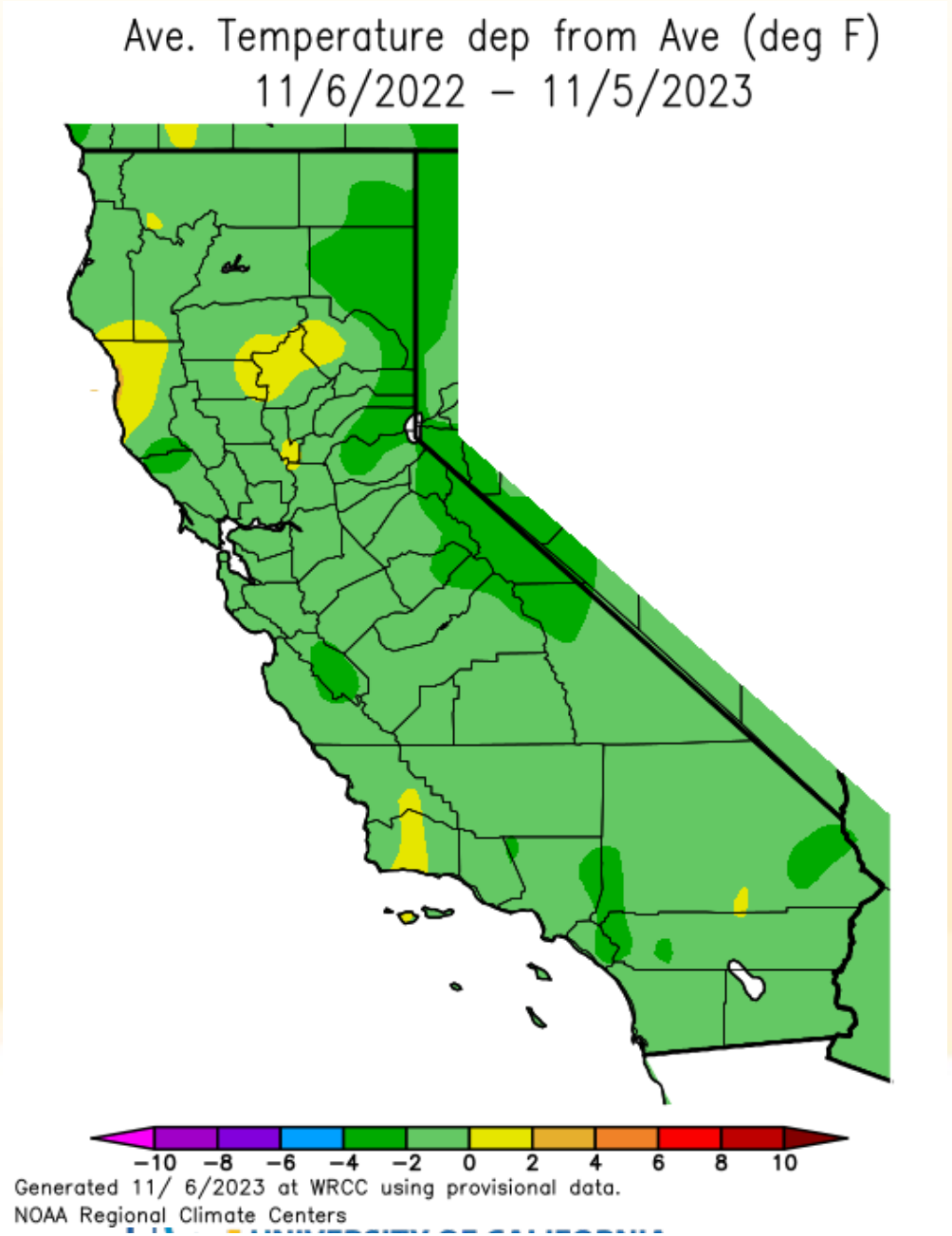
Damaged fruit



Credit: California Climate Data Archive (2021)

Extreme Heat?

Average temperatures in the 2023 growing season were notably lower across the state compared to average



Credit: California Climate Data Archive (2021)

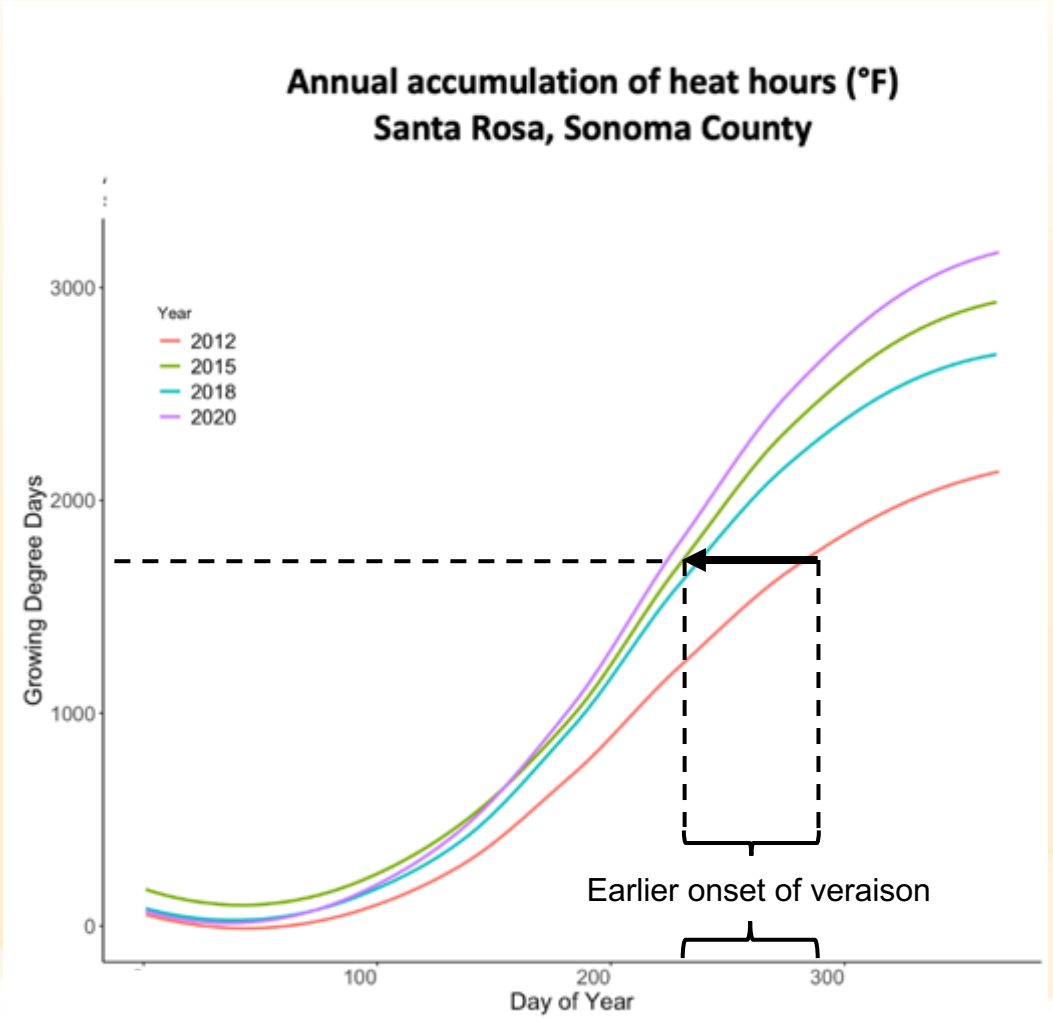
Station	Year	Final GDDs	Winkler Zone
Ukiah	2023	3301.5	III
Ukiah	2022	3475.5	III
Ukiah	2021	3679.1	IV
Ukiah	2020	3604.9	IV
Ukiah	2019	3470.4	III
Ukiah	2018	3602.5	IV
Ukiah	2017	3640.7	IV
Ukiah	2016	3344.6	III
Ukiah	2015	3656.8	IV
Ukiah	2014	3635.5	IV
Ukiah	2013	3326.1	III
Ukiah	2012	3285.4	III
Ukiah	2011	2965.9	II
Ukiah	2010	3136.9	III
Ukiah	2009	3572.9	IV
Ukiah	2008	3516.6	IV
Ukiah	2007	3392.1	III
Ukiah	2006	3666.2	IV
Ukiah	2005	3335.1	III
Ukiah	2004	3575.9	IV
Ukiah	2003	3509.8	IV

Increasing Temperatures

In Central Europe the impact of warming climates has been documented in Bernáth et al. 2021

Between 1985 and 2018

- Budbreak: 5-7 days earlier
- Flowering: 7-10 days earlier
- Berry maturity: 18 days earlier
- Harvest: 8-10 days earlier

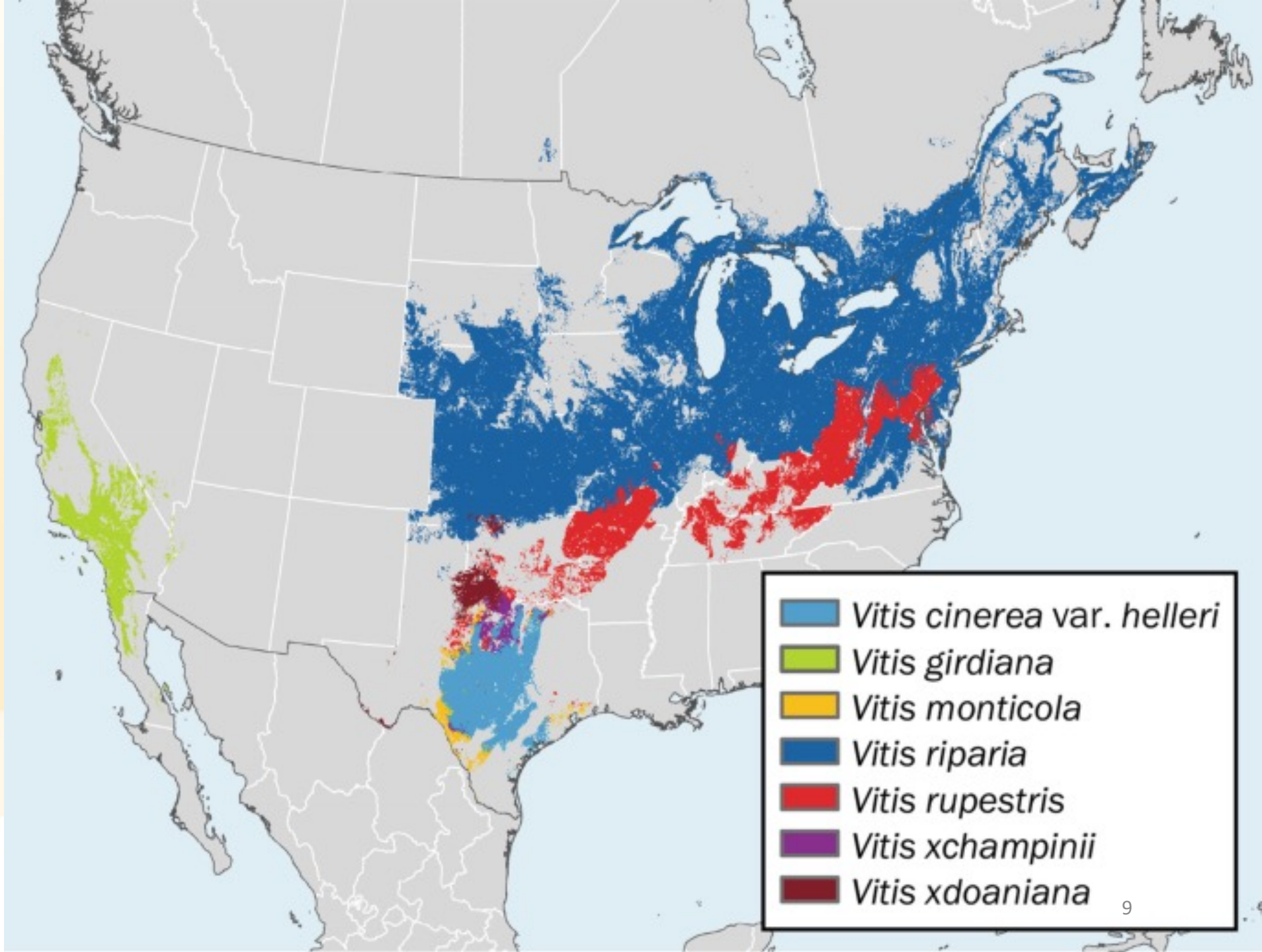


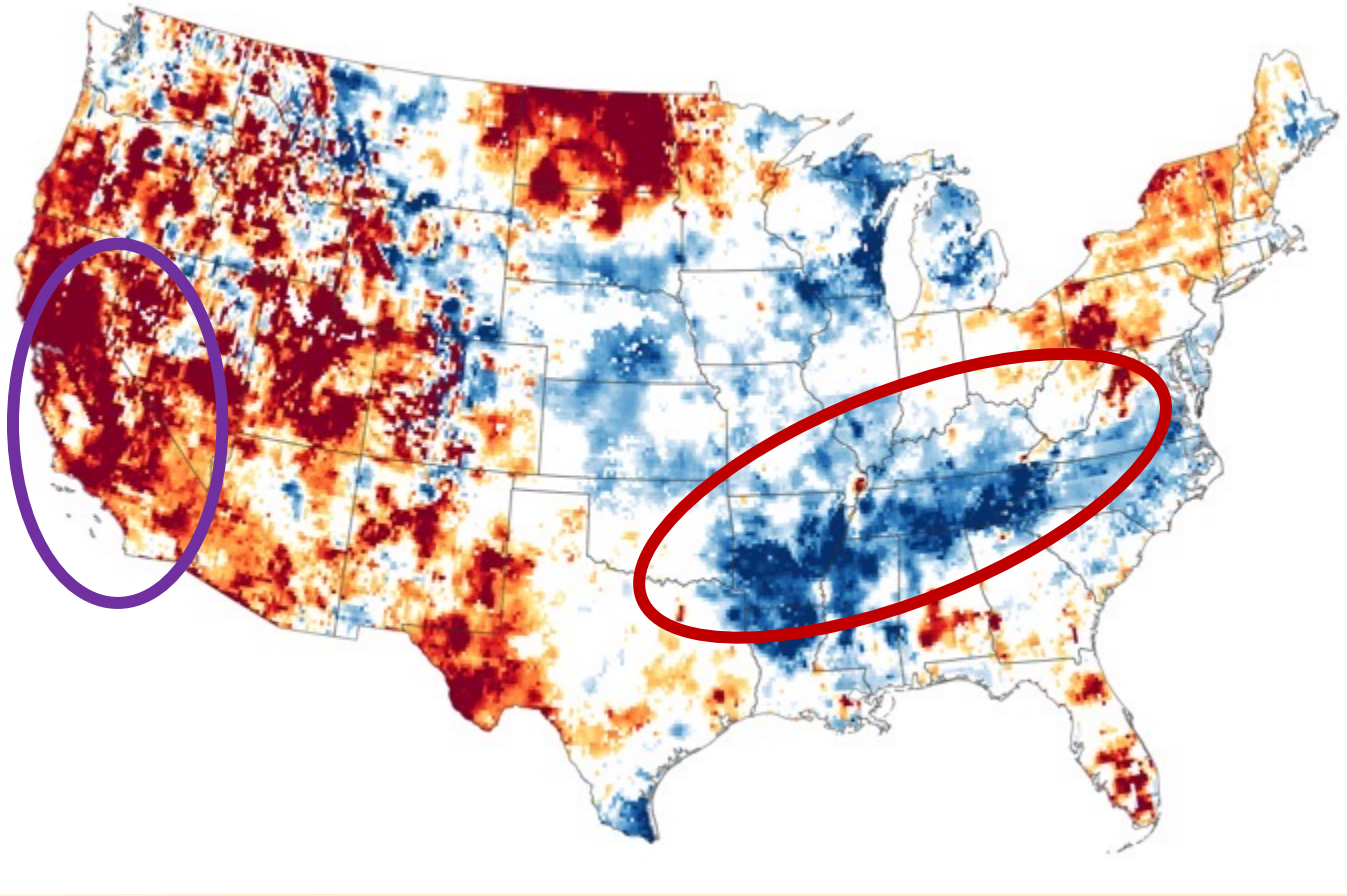
Cumulative heat accumulation in Santa Rosa, California in 2012, 2015, 2018, and 2020. (Data from https://cimis.water.ca.gov)

New Climate. New Cultivars.

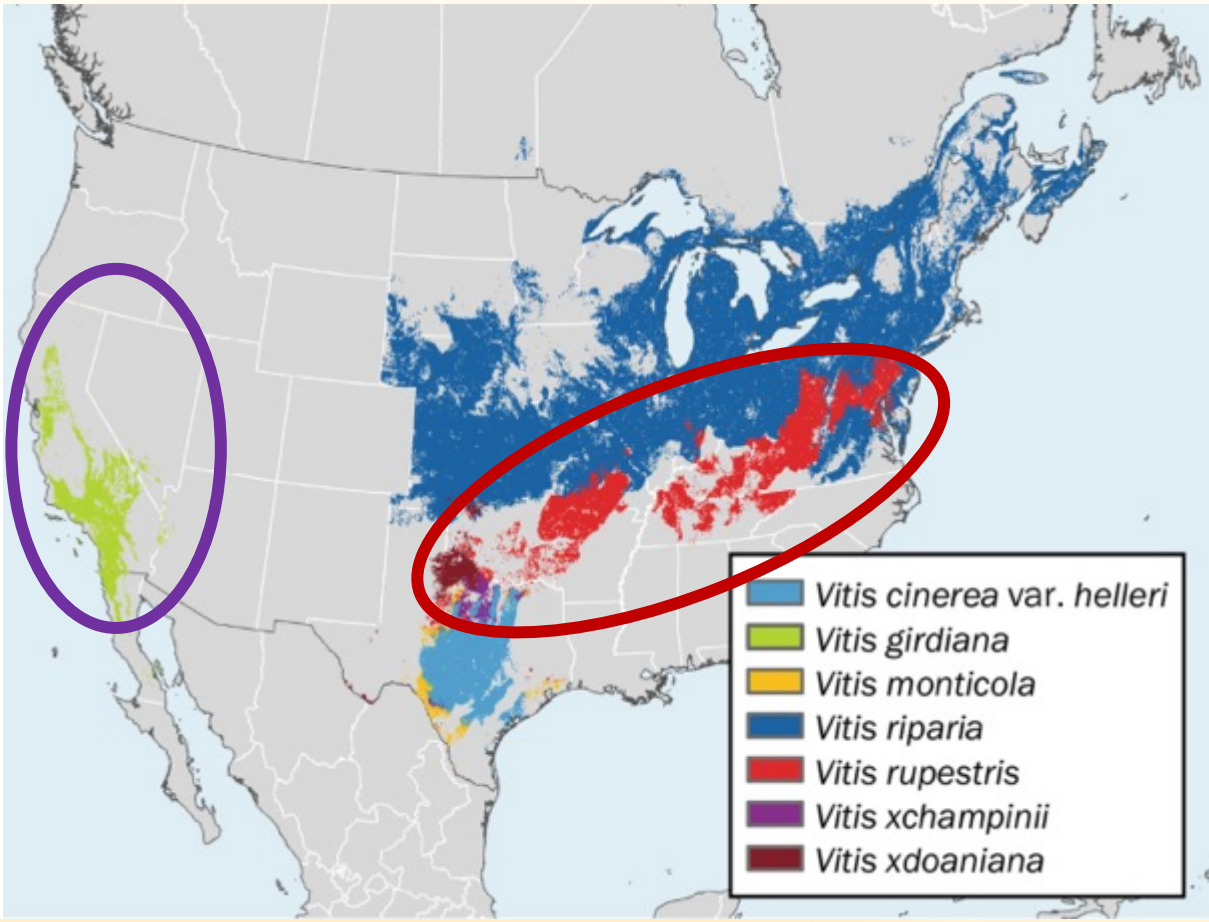
Trait sourcing

Wild vines





Drought conditions – 2021 (NASA)



Heinitz et al. 2019

Tolerant Cultivars

Rootstocks have long been used as a method of tolerance to both biotic and abiotic stressors

- GRN rootstocks for nematode tolerance

Scions are also being developed to help impart tolerance to specific pests and/or diseases

- Pierce's Disease resistant scions

PD tolerant scions – the 'Walkers'

Over 20 years of development led to the release of five grape scions with inherent resistant to *X. fastidiosa*

Developed by the Walker Lab at UC Davis

Meant to mimic the most popular cultivars in California

PD tolerant scions - Red Grapes

1. Camminare noir
   - 50% Petite Syrah; 25% Cab Sauv
   - Characteristics of both parents
   - Early budbreak and maturity
   - 94% *Vitis vinifera*
2. Passeante noir
   - 50% Zin; 25% Petite Syrah; 12.5% CS
   - Characters of Zinfandel and Cab Sauv
   - Late bloom and mid-season maturity
   - 97% *Vitis vinifera*

PD tolerant scions - Red Grapes

3. Errante noir
    - 50% Sylvaner
    - 12.5% each of:
        i. Cab Sauv; Carignane; Chardonnay
    - Mid-season bloom and maturity
    - High tannin content
    - Potential as red blending grape with Cabernet Sauvignon
    - 97% *Vitis vinifera*

PD tolerant scions - White Grapes

1. Ambulo Blanc
   - 62.5% Cab Sauv; 12.5% Carignane & Chard
   - Highly productive
   - Wines are similar to Sauvignon blanc
   - 97% *Vitis vinifera*
2. Caminante Blanc
   - 62.5% Cab Sauv; 12.5% Carignane & Chard
   - Small berries and small clusters
   - Late bloom and mid-season maturity
   - 97% *Vitis vinifera*

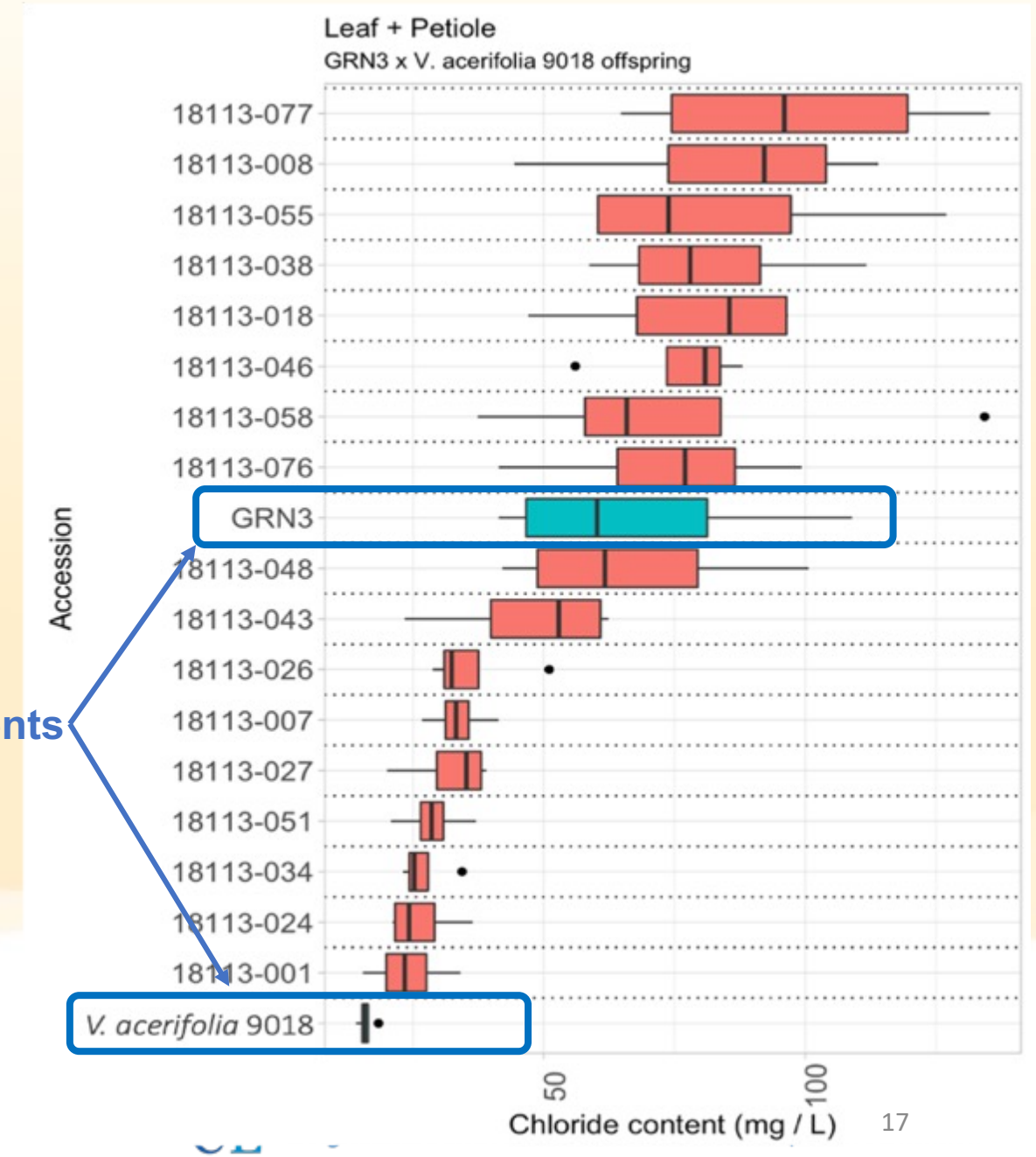
GRN Rootstocks

- Released in 2008
- Multiple parent vines
- GRN – 1 to 5
- Tolerant to feeding from:
  - Dagger nematode
  - Ring nematode
  - Root-Knot nematode
  - Citrus nematode
  - Lesion nematode

New Agronomic Traits

Breeding new cultivars

- Long term solution
  - Can take decades
- Utilize wild grapevines
  - Huge gene pool
  - Potential for high salinity tolerance
  - Largely unexplored
- Incorporate existing traits
  - Preserve other traits of existing rootstocks
  - Rootability, drought tolerance, vigor



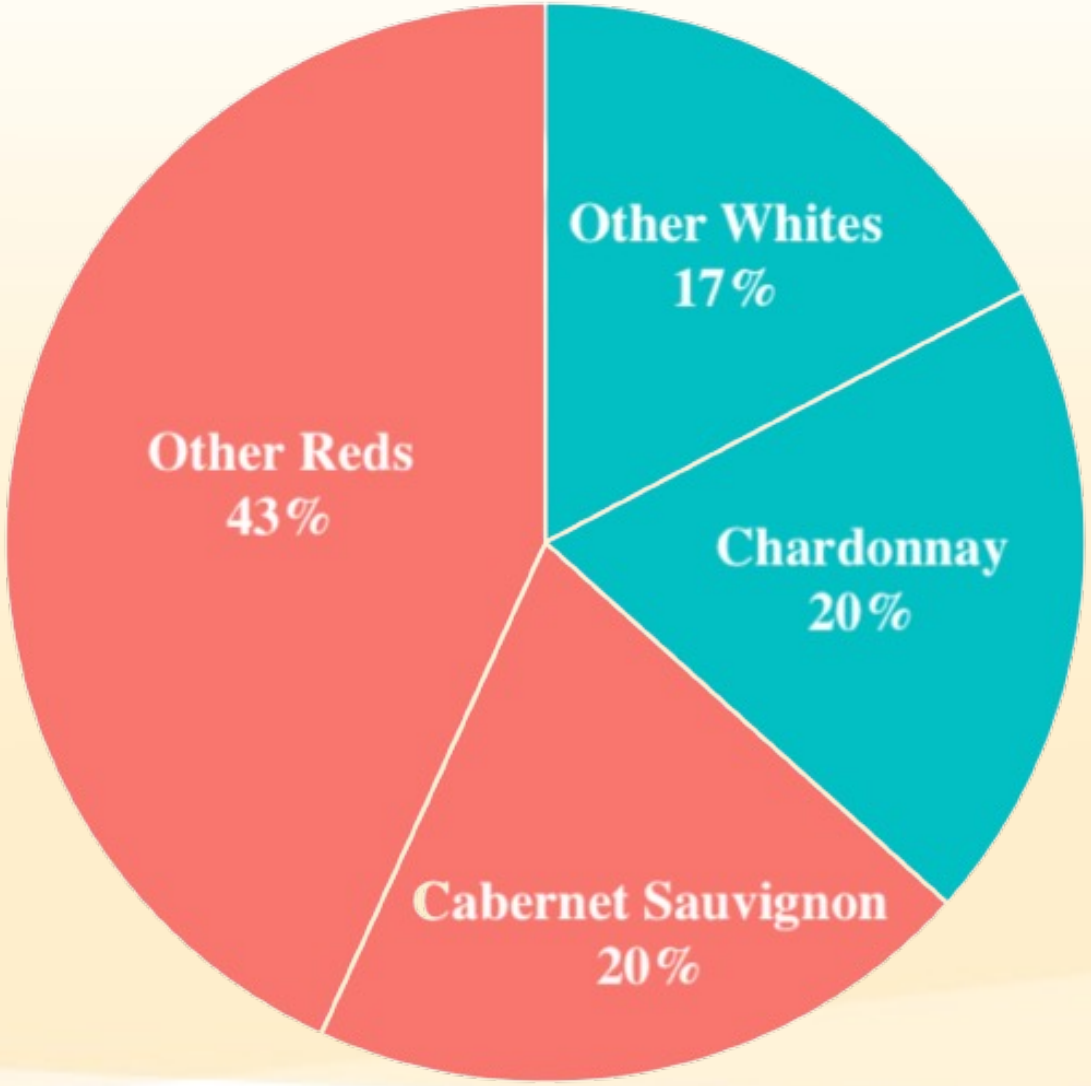
Changing Preferences.

Scion Variety Bottleneck

- Market limitations on profitable cultivars
- Bottleneck down to two scions
- Wide range of climate adaptation in scions

Examples of desirable characteristics:

i. Late budbreak (avoid frost)
ii. Moderate vigor (less water demand)
iii. Early fruit maturity (maybe)
    e.g., Sémillon; Tempranillo



CA Grape Acreage Report (2020)

Cultivars by Climate

Winkler Index

Region	°F	°C	Climate
Region Ia	1500 – 2000	850 – 1111	Cold
Region Ib	2001 – 2500	1111 – 1389	Cool
Region II	2591 – 3000	1389 – 1667	Warm
Region III	3001 – 3500	1668 – 1944	Warm – Hot
Region IV	3501 – 4000	1945 – 2222	Hot
Region V	4001 – 4900	2223 – 2700	Extreme

Variety	Region	Climate	Vigor	Yields
Chardonnay	I, II	Cold	Moderate	Moderate
Sauvignon blanc	I, II, III	Cool	High	High
Riesling	I, II, III	Cool	Moderate	Moderate
Gewürztraminer	I, II	Cool	Moderate	Low
Sémillon	II, III	Warm Coasts	Moderate	High (clonal 8-10)
Melon	I, II	Cold	Moderate	Moderate
Pinot blanc/gris	I, II	Cool	Low	Low-Moderate
Viognier	III, IV	Warm-Hot	Moderate	Low
Colombard	II, III, IV	Warm	High	High
Chenin blanc	II, III	Cool-Warm	High	High
Emerald Riesling	II, III	Cool-Warm	High	High
Burger/Monbadon	III, IV, V	Warm-Hot	High	High
Palomino/Listan	IV, V	Hot	High	High
Muscat blanc	II, III, IV	Warm	Low-Moderate	Low-Moderate
Malvasia bianca	II, III, IV	Warm	Moderate	Moderate
Cabernet sauvignon	I, II, III	Cool	High	Moderate
Merlot	I, II, III	Cool	High	Moderate
Cabernet franc	I, II, IIi	Cool	High	Moderate
Malbec/Cot	II, III	Cool-Warm	High	Moderate
Petite Verdot	I, II, III	Cool	Moderate	Low
Zinfandel	II, III, IV, V	Cool-Hot	Moderate	High
Mourvedre	II, III, IV	Warm	High	Moderate
Pinot noir	I, II	Cool	Low	Low
Syrah/Shiraz	II, III, IV, V	Cool-Hot	High	Moderate
Sangiovese	III, IV, V	Warm-Hot	Moderate	High
Petite Sirah/Durif	II, III	Cool-Warm	Moderate	Moderate
Valdiguie/Napa Gamay	III	Warm	Low	High
Carignane	III, IV	Warm-Hot	High	High
Grenache	III, IV	Warm-Hot	High	High
Tempranillo	II, III, IV	Warm	High	High
Barbera	III, IV	Warm-Hot	Moderate	Moderate
Ruby Cabernet	III, IV	Warm-Hot	Moderate	Moderate
Carnelian	IV, V	Hot	High	High
Mission	IV, V	Hot	High	High
Rubired	IV, V	Hot	High	High
Alicante Bouschet	IV, V	Hot	High	High

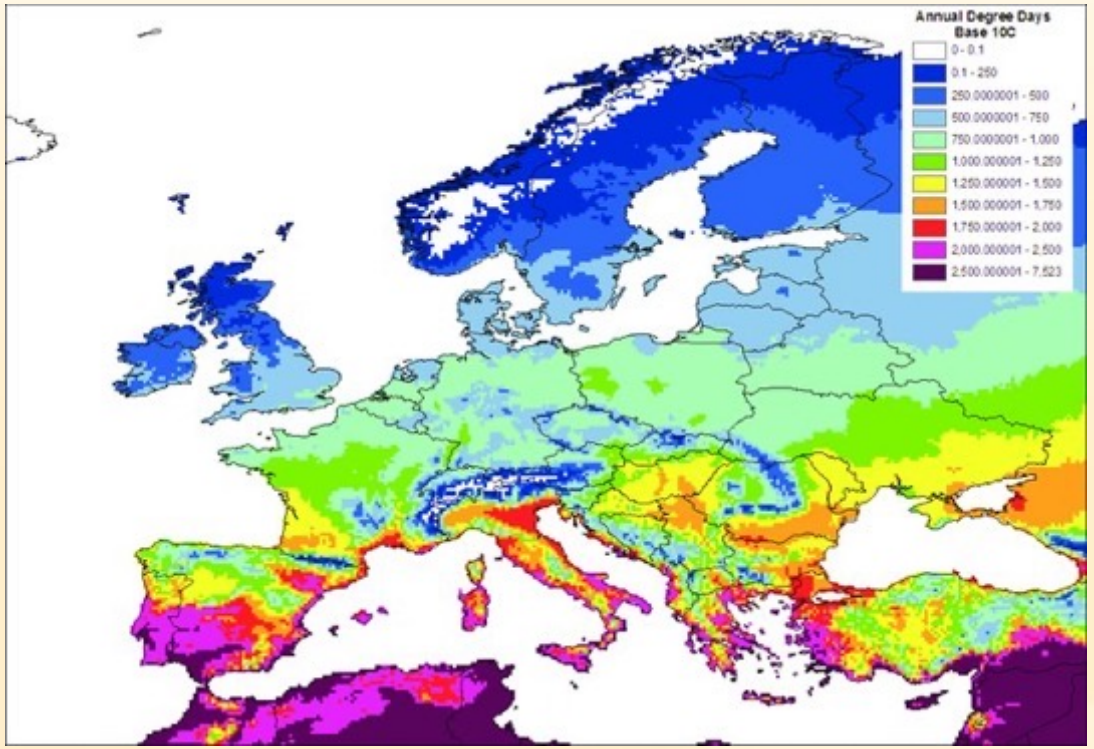
Climatic Origins

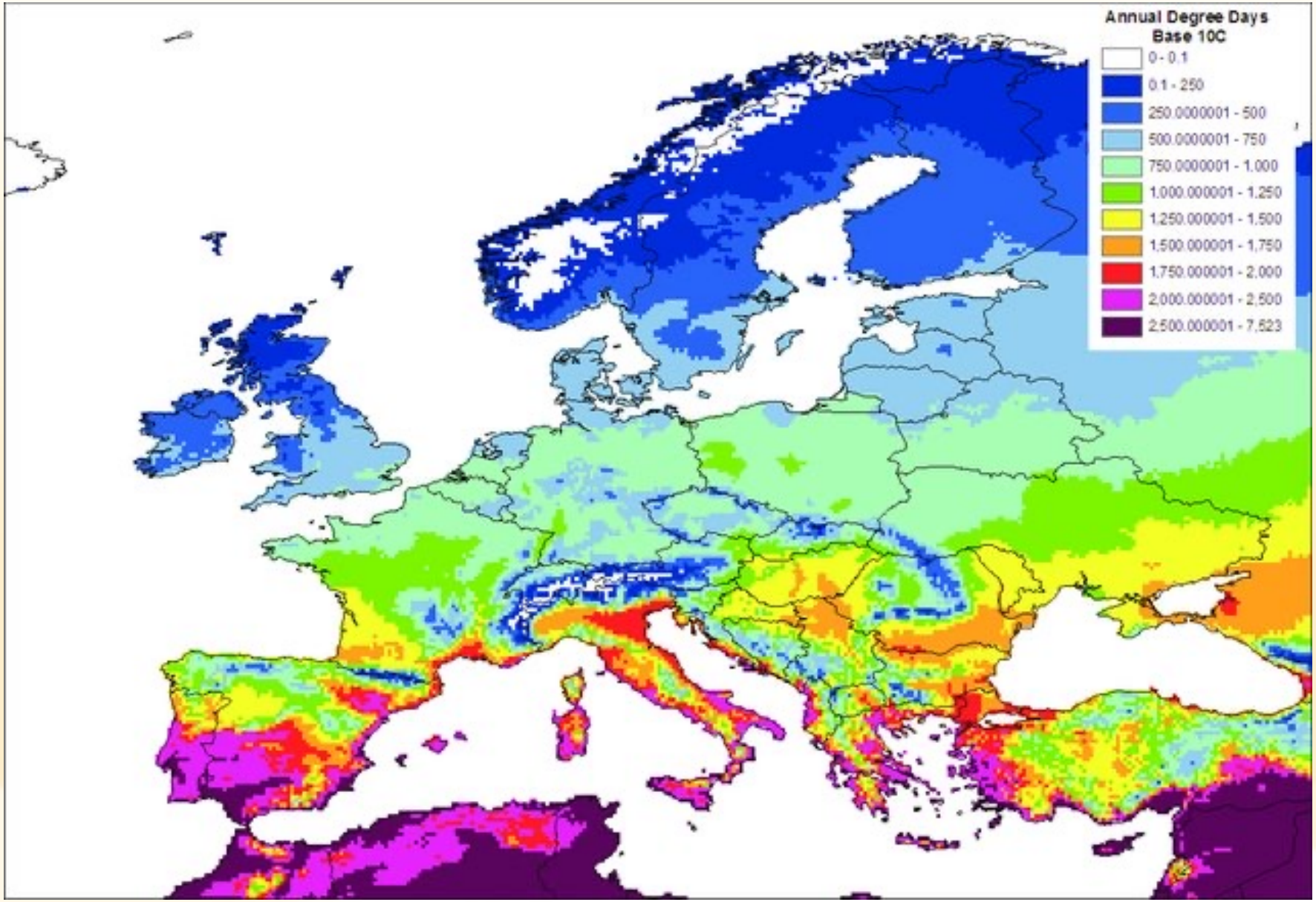
Where did the scions originate from?

This impacts their tolerance for heat (and other stressors)

- Rootstocks ≠ Phylloxera
- Vinifera roots = Phylloxera

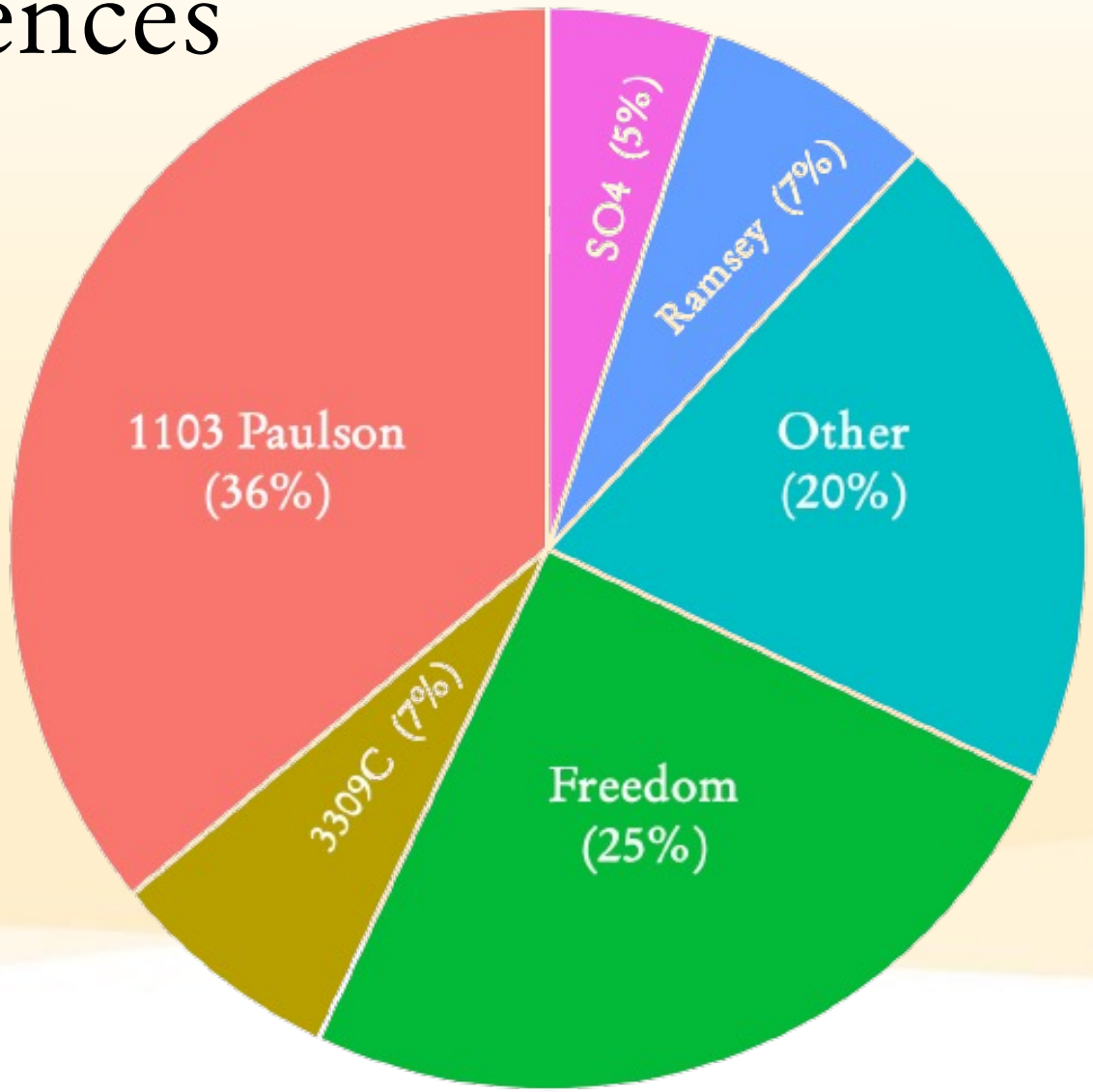
Think about how your climate matches up with the original climate of the scion




Annual Degree Days
Base 10C
0 - 0.1
0.1 - 250
250.0000001 - 500
500.0000001 - 750
750.0000001 - 1,000
1,000.000001 - 1,250
1,250.000001 - 1,500
1,500.000001 - 1,750
1,750.000001 - 2,000
2,000.000001 - 2,500
2,500.000001 - 7,523

Limited Rootstock Preferences

- The trend observed in scions appears to hold true for rootstock varieties as well
- Data is more sparce for rootstocks
- In 2022, we identified the most planted rootstocks across California



Past Research - Rootstocks

Rootstock	Vitis parentage	Phylloxera resistance	Nematode Resistance		Tolerance				Influence on scion		Soil adaptation	Ease of propagation	Other characteristics
			Root knot	Dagger (*Xiphinema index*)	Drought	Wet soil	Salinity	Lime	Vigor	Mineral nutrition[1]			
Riparia Gloire	riparia	High	Low	Med.	Low	Low	Med.	Low	Low–med.	N, P: low K, Mg: low–med.	Deep, well-drained, fertile, moist soils	High	Early maturation; scions tend to overbear
St. George (*Rupestris du lot*)	rupestris	High	Low	Low	Low–med. in shallow soils; high in deep soils	Low–med.	Med.–high	Med.	High	N: high P: low on low-P soils, high on high-P soils K: high	Deep soils	High	Fruit set problems with some scions; latent virus tolerant
SO4 (Selection Oppenheim)	berlandieri × riparia	High	Med.–high	Low–med.	Low–med.	Med.–high	Low–med.	Med.	Low–med.	N: low–med. P: med. K: med.–high Mg: med.	Moist, clay soils	Med.	Noted as a cool-region rootstock
5BB (Kober)	berlandieri × riparia	High	Med.–high	Med.	Med.	Low	Med.	Med.–high	Med.	N: med.–high P, K, Zn: med. Ca, Mg: med.–high	Moist, clay soils	High	Susceptible to phytophthora root rot; adapted to high-vigor varieties
5C (Teleki)	berlandieri × riparia	High	Med.–high	Low–med.	Low	Low–med.	Med.	Med.	Low–med.	N: low P, K: med. Mg: med.–high Zn: low–med.	Moist, clay soils	High	—
420A (Millardet et de Grasset)	berlandieri × riparia	High	Med.	Low	Med.	Low–med.	Low	Med.–high	Low	N, P, K: low Mg: med. Zn: low–med.	Fine-textured, fertile soils	Med.	Scions tend to overbear when young
99R (Richter)	berlandieri × rupestris	High	Med.–high	Low–med.	Med.–high	Low	Med.	Med.	Med.–high	P: med. K: high Mg: med.	Tolerant of acid soil	Med.	Young scions may develop slowly
110R (Richter)	berlandieri × rupestris	High	Low–med.	Low	High	Low–med.	Med.	Med.	Med.	N: med. P: high K: low–med. Mg, Zn: med.	Hillside soils; acid soils	Low–med.	Develops slowly in wet soils

140 Ru

140 Ru – deep rooted

101-14 mgt

101-14 mgt – shallow rooted

Ability to Induce Vigor in Scions

Vigor

Dog Ridge, Ramsey* (Salt Creek)
Freedom, Harmony
140Ru, O39-16*, 1103P, 110R, St. George
5BB, Börner(?), 101-14Mgt
Schwarzmann, 5C*, SO4, 3309C
44-53Malegue, 1616C, 420AMgt*, 161-49C, Riparia Gloire

Vigor

Nematode Resistant Rootstocks

Vigor

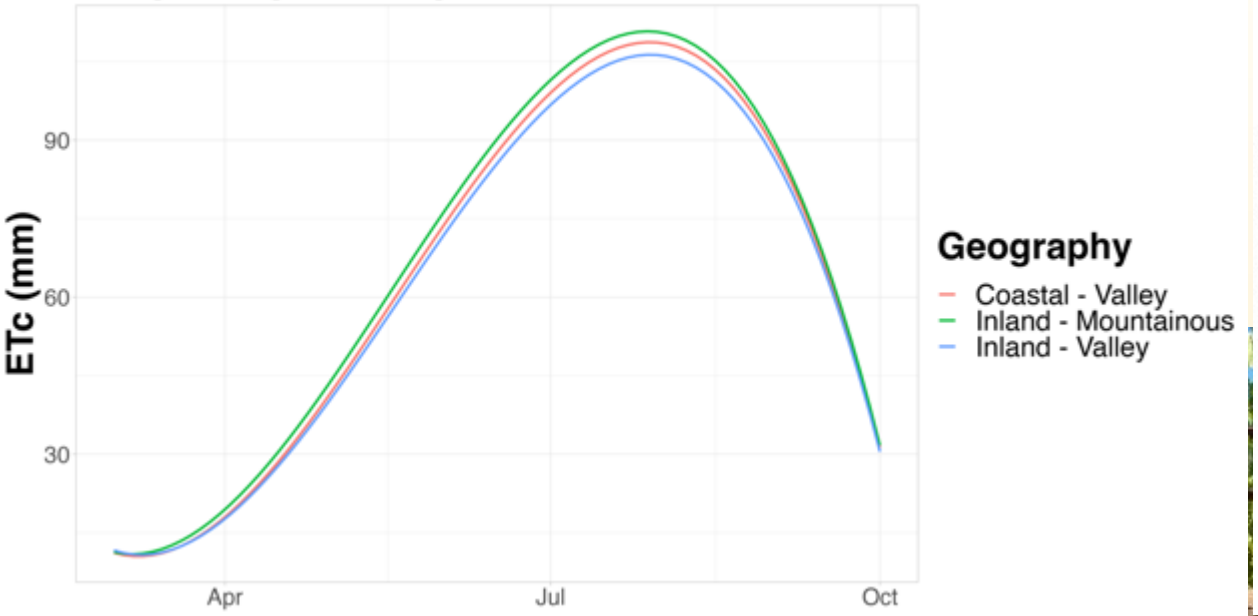
Dog Ridge, Ramsey (Salt Creek)
Freedom, Harmony
O39-16*, *1103P*
5BBB, 101-14Mgt, Börner?
Schwarzmann, 5C, SO4
1616C

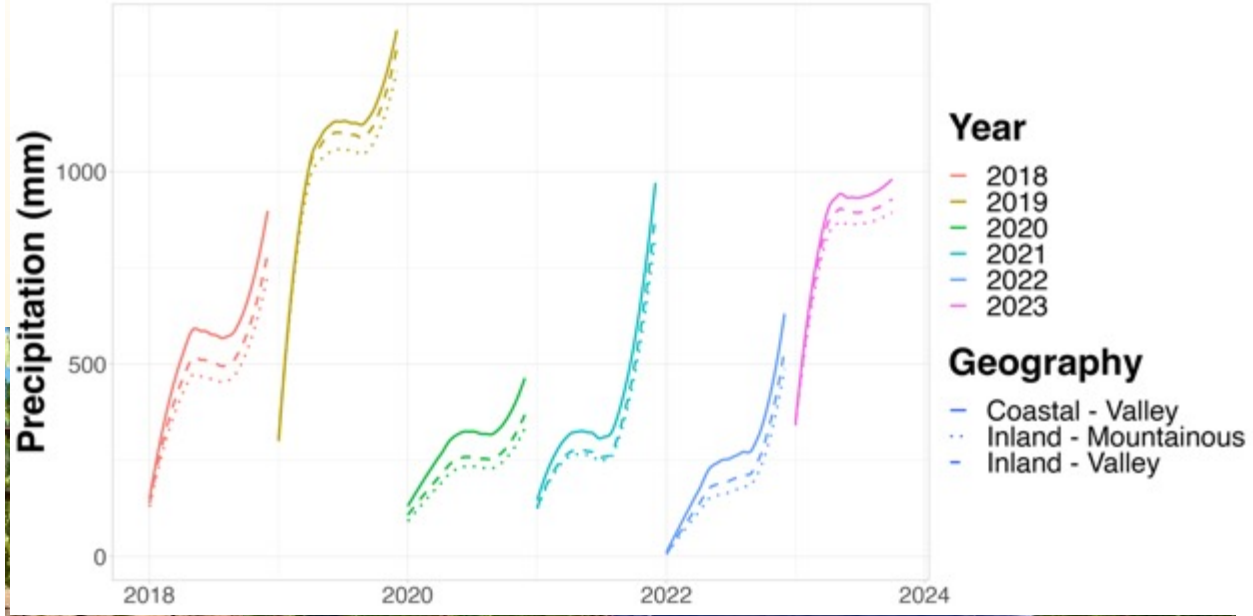
italics = moderate resistance
* = not root-knot resistant

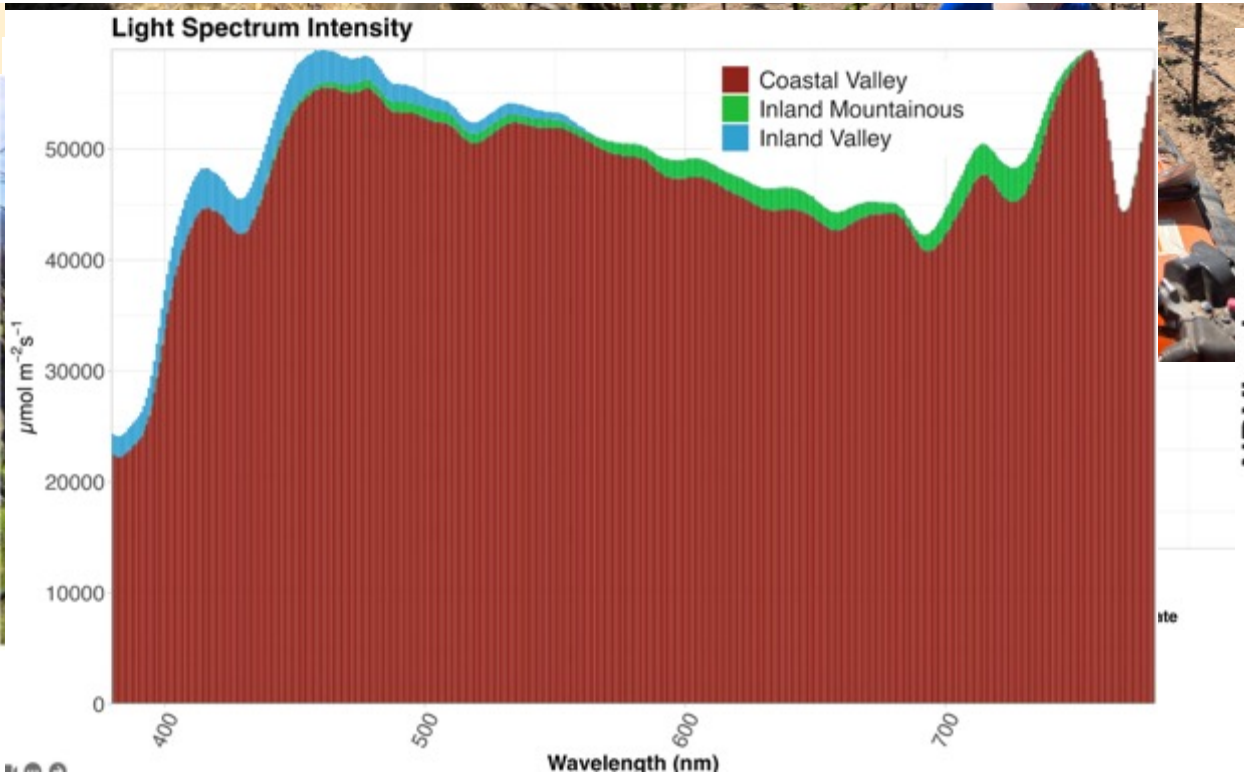
Vigor

Credit: Andy Walker

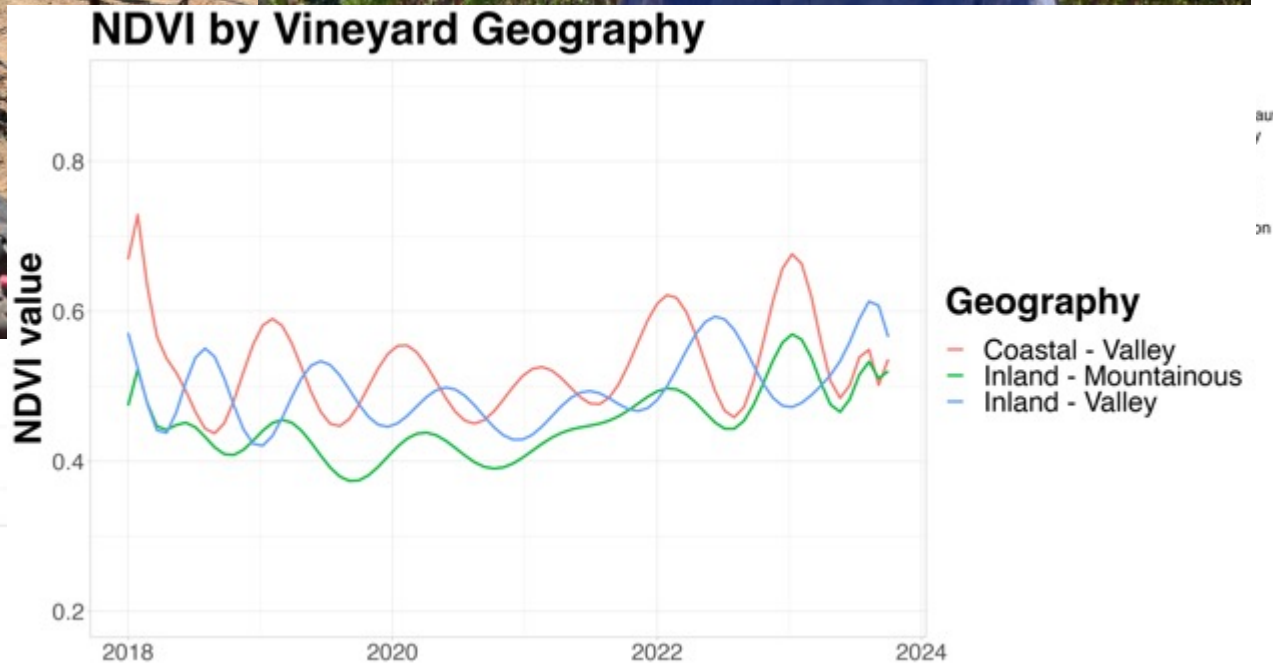
Crop Evapotranspiration







NDVI by Vineyard Geography



Other Challenges

There are many more challenges when considering adapting vineyard systems to climate change that must be addressed:

Adaptable Infrastructure

Labor Supplies

Site Suitability

Smoke-taint in Fruit

Wildfires

'New' Pests

Changes in Beneficials

Alternative Chemical Controls

Consumer Knowledge & Perception

"It's what the people want" may come down to how knowledgeable wine consumers are.

Trying out new kinds of wine can be daunting, especially for those just getting into wine.

More opportunities for educating consumers on the huge diversity of wine grapes out there may make it easier for grape growers to plant different and unique cultivars.

Summary

1. Climate change is difficult to predict

2. Limiting our winegrape acreage to a handful of cultivars also limits our potential to adapt

3. Development of new cultivars and finding existing cultivars that fit future climate conditions are essential to the longevity of viticulture in California

4. Changing the consumer perspectives on new winegrapes will make this process easier

Thank You

Sources

You can find the sources for this presentation at:
https://ucanr.edu/sites/ChenLab/files/378149.pdf

Or go to:

1. https://ucanr.edu/sites/chenlab
2. Resources
3. "Presentation Bibliographies and Cited Sources" (end of page)

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