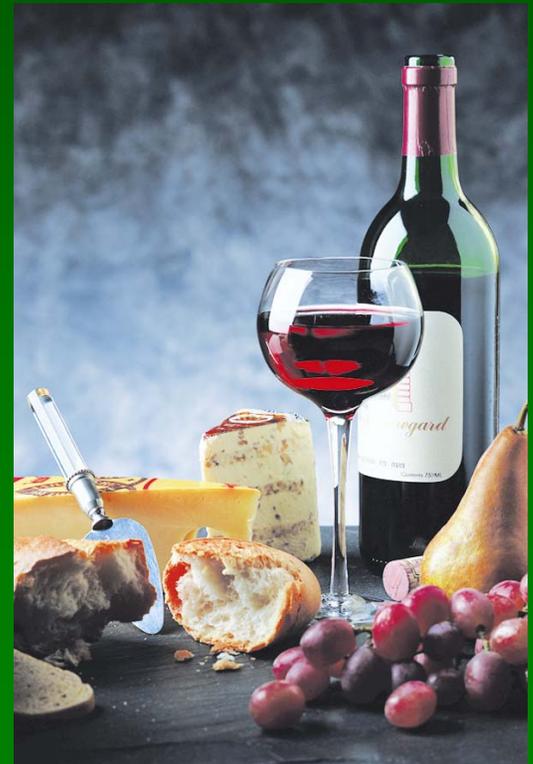


Climate Change: Observed and Predicted Impacts on the Wine Industry



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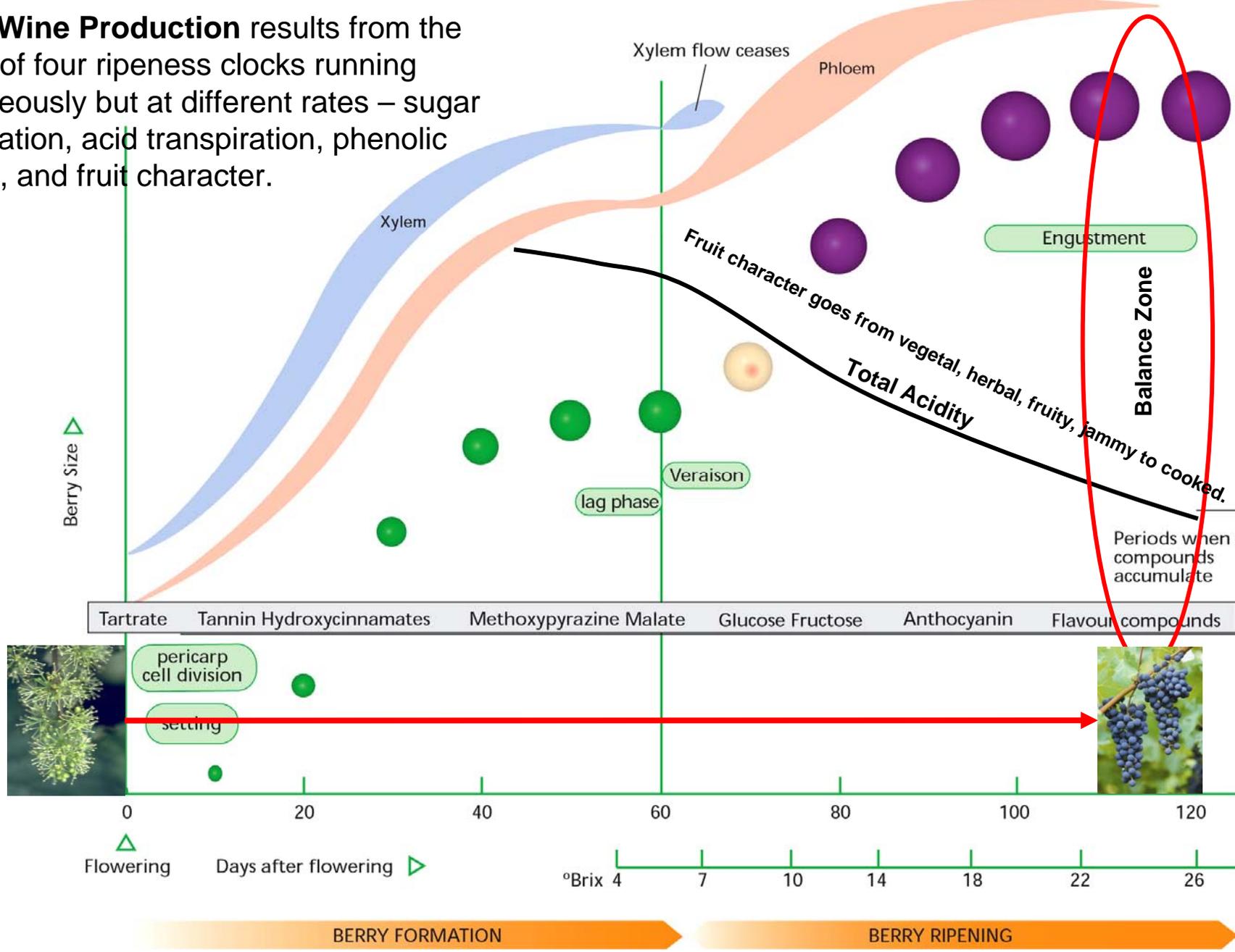
King County – Regional Climate Change Conference
Thursday, October 27th, Seattle, Washington

Talk Outline

- Grapes, Wine, and Climate
- Climate Change Impacts
- Focus on the West Coast and Washington State
- Global Overview
- Potential Implications
- Conclusions

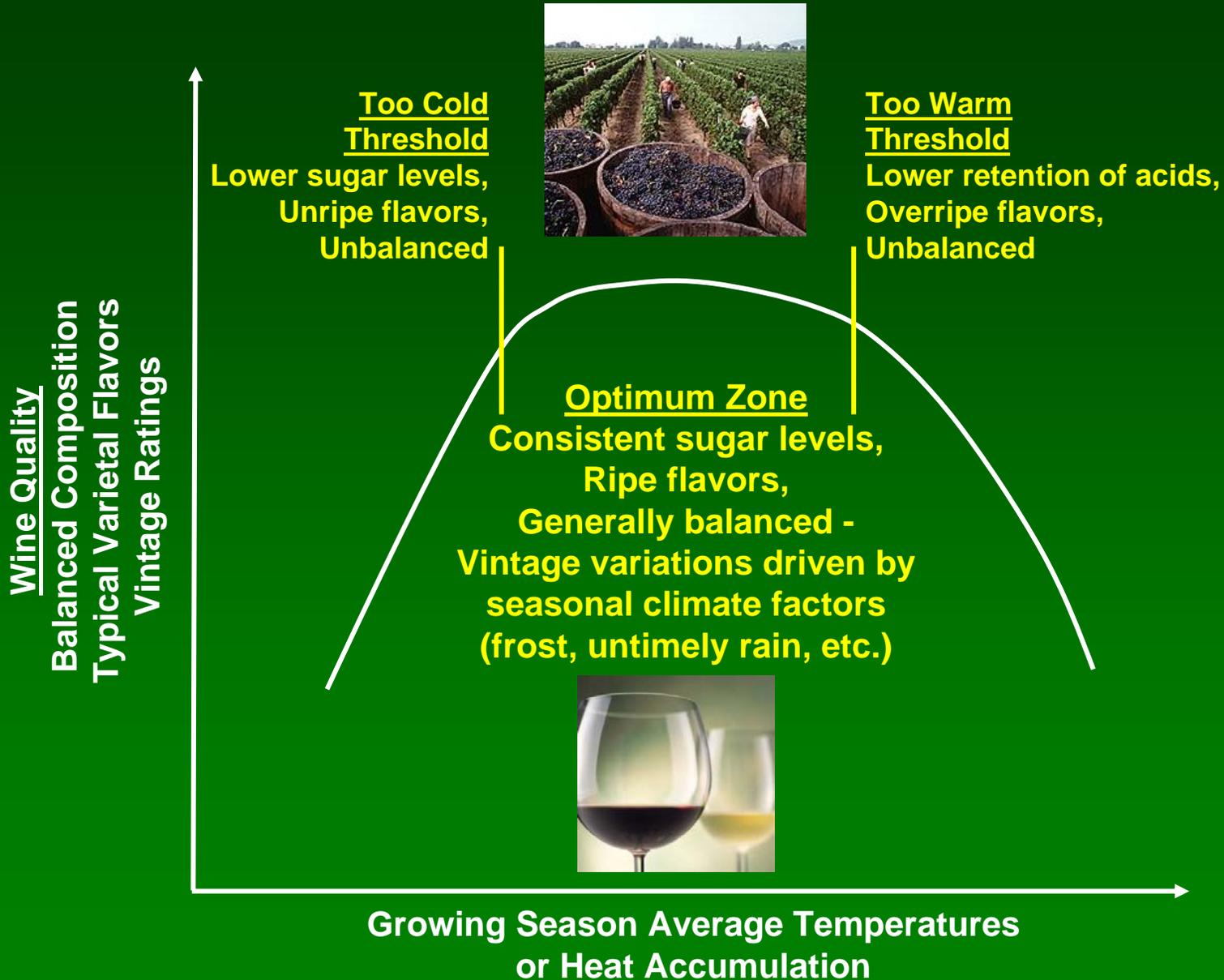


Quality Wine Production results from the balance of four ripeness clocks running simultaneously but at different rates – sugar accumulation, acid transpiration, phenolic ripeness, and fruit character.



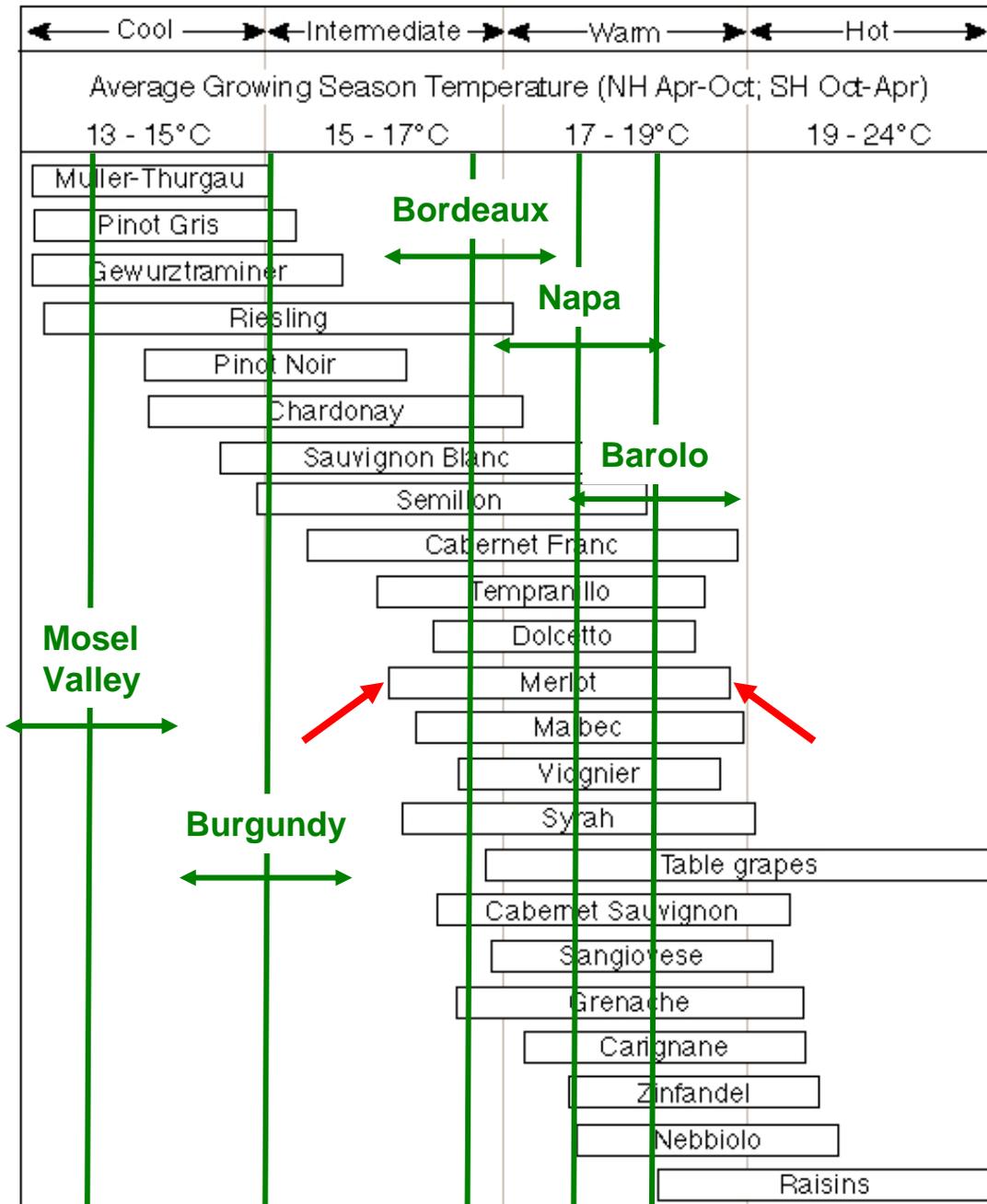
Australian Viticulture from text: "Ripening berries – a critical issue" by Dr. Bryan Coombe and Tony Clancy (Editor, *Australian Viticulture*), March/April 2001. Illustration by Jordan Koutroumanidis and provided by Don Neel *Practical Winery and Vineyard*

Varietal-Climature Thresholds



Grapevine Climate/Maturity Groupings

- Climate influences the style of wine an area can produce
- Maturity groupings give an indication of the span of potential ripening period for different varieties based on phenology requirements
- Each variety is generally grown in specific regions and narrow climatic zones for optimum quality and production



Length of rectangle indicates the estimated span of ripening for that varietal



1948-2002

16 Parameters

46 Climate Stations

Aggregated to 11 Regions

Puget Sound

Columbia Valley, WA

Columbia Valley, OR

Willamette Valley

Umpqua Valley

Rogue Valley

North Valley

Foothills

North Coast

Central Coast

Central Valley

Observed Climate Trends for the Western U.S. during 1948-2002

Variable	Puget Sound	Eastern Washington	Average Change across all regions
Growing Degree-Days (Apr-Oct, base 50°F)	226	265	326
Growing Season Average Temperatures	1.3°F	1.4°F	1.6°F
Growing Season Maximum Temperatures	+, NS	+, NS	Mixed, 1.6°F
Growing Season Minimum Temperatures	2.9°F	2.0°F	2.4°F
Ripening Period Average Temperatures (8/15-10/15)	1.5°F	1.7°F	1.8°F
Growing Season Number of Days >95°F	NS	NS	Mixed, Most NS
Number of Days below Freezing - Annually	-22 days	-14 days	-18 days
Number of Days below Freezing - Spring (Mar-May)	-9 days	-9 days	-7 days
Number of Days below Freezing - Fall (Sept-Nov)	-4 days	-, NS	-3 days
Date of Last Spring Frost (32°F)	-27 days	-17 days	24 days earlier
Date of Last Fall Frost (32°F)	+17 days	+12 days	10 days later
Frost-Free Period	44 days	29 days	34 days longer
Winter Precipitation (Nov-Mar)	-, NS	NS	Mixed, Most NS
Growing Season Precipitation (Apr-Oct)	NS	NS	Mixed, Most NS
Bloom Period Precipitation (May 15-June 15)	+1.20"	+, NS	+, Most S
Ripening Period Precipitation (Aug 15-Oct 15)	-2.02"	NS	-, Most NS

Recent Research - Wine Regions Analyzed



Growing Season Temperature Trends 1950-2000

- All regions showed warming during the growing season (2.3°F average warming)
- All regions showed warming during the dormant season (2.5°F average warming)
- Warming trends are more significant and of greater magnitude in the N. Hemisphere vs. S. Hemisphere
- The majority of the wine regions/categories of wine exhibit significant trends to better quality, with declines in vintage to vintage quality variability
- However, cool climate regions appear to benefit the most and quality thresholds are evident for many regions

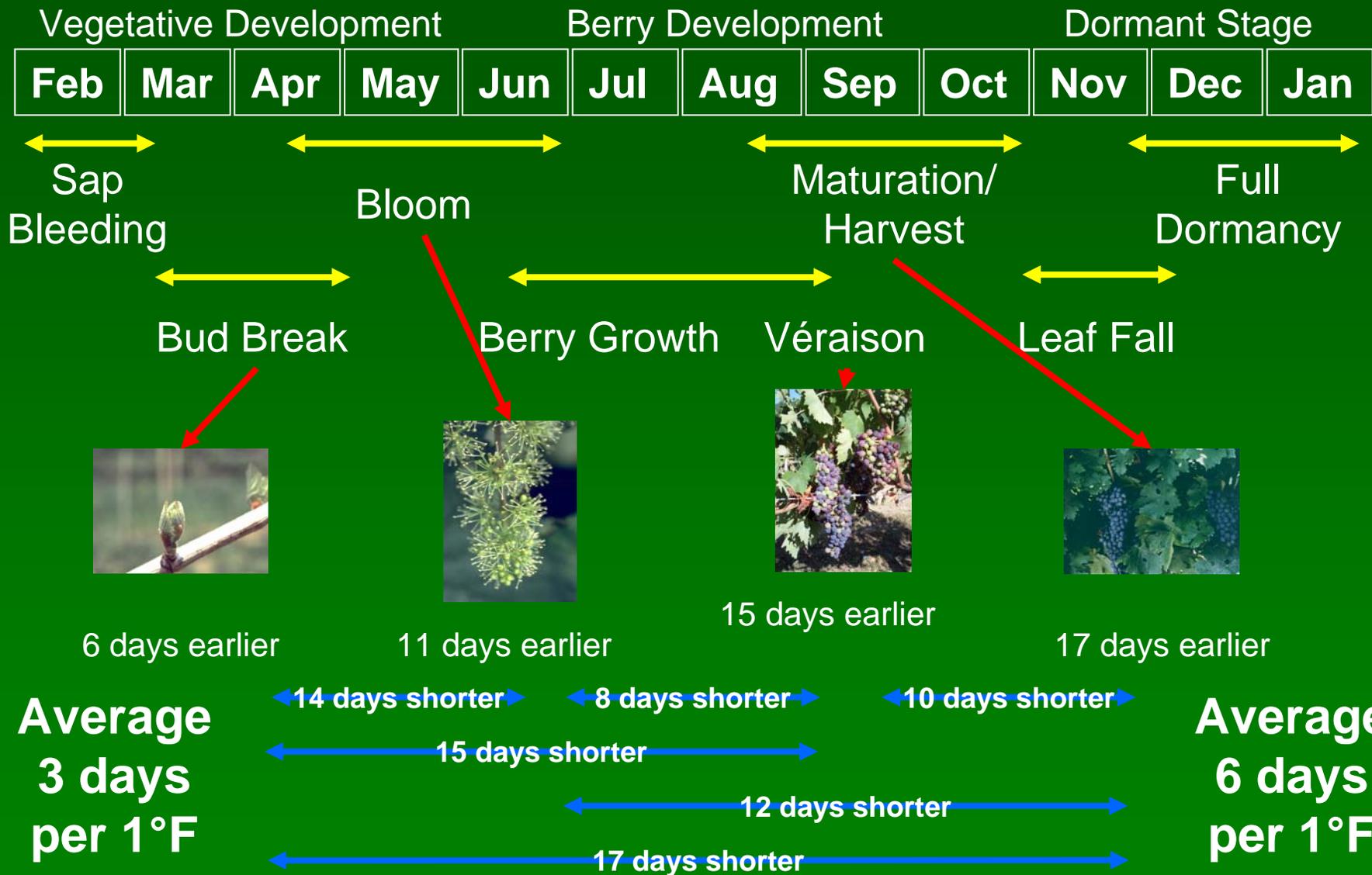
Growing Season Temperature Trends 2000-2049

HadCM3 Climate Model - Overview and Example Locations

What does the Future Hold?

- All regions show significant warming over the next 50 years
- Greater warming modeled for the growing season than for the dormant season
- Trends range 0.3-1.1°F per decade
- Average warming is 3.6°F/50 years
- South Africa lowest (1.6°F/ 50 years)
- Portugal highest (5.1°C/ 50 years)
- N.H. (3.8°F/50 years) > S.H. (3.1°F/50 years)
- Growing season temperature variability increases in 20 of 27 regions (14 of 27 in the dormant season)

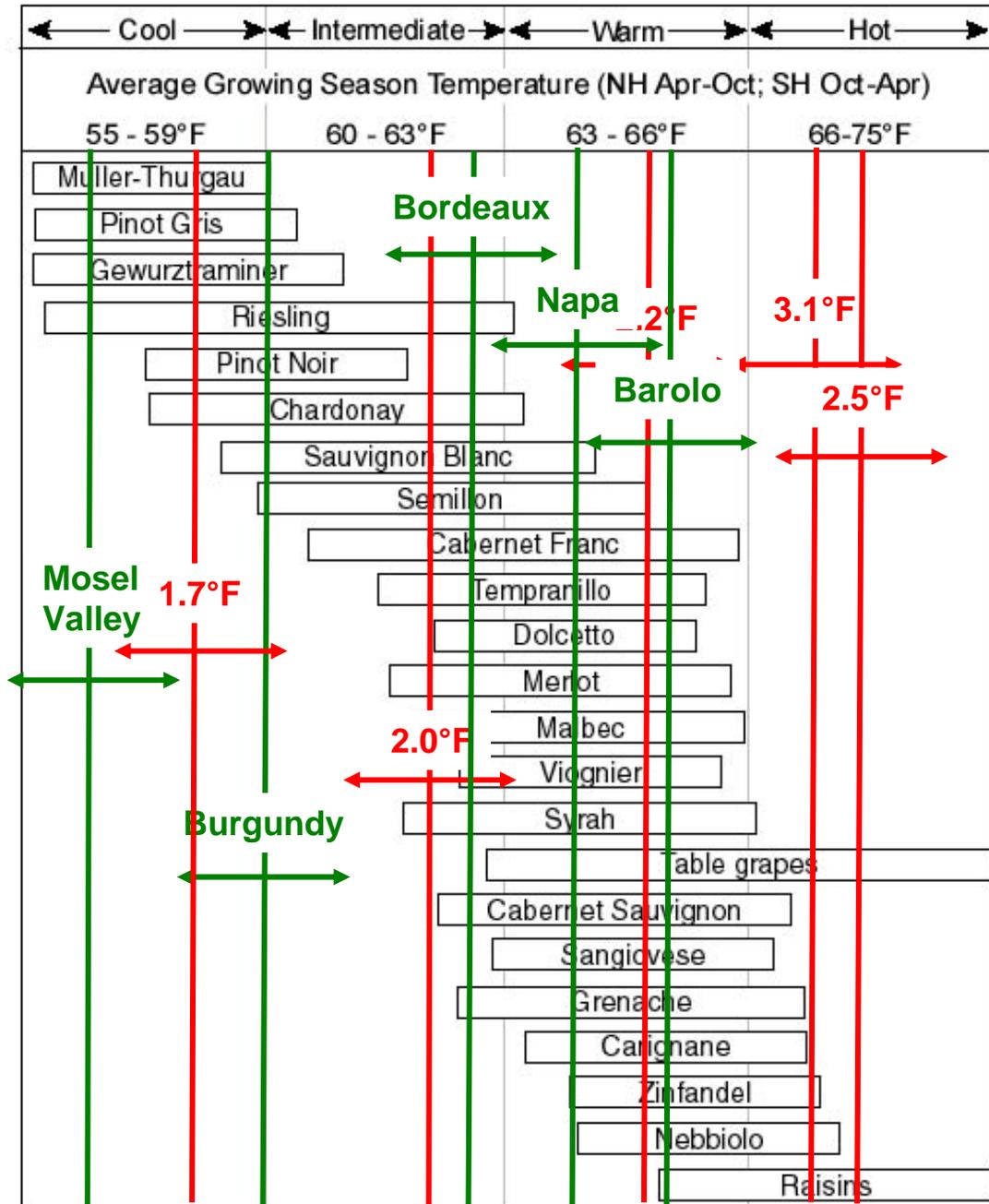
Observed Average Phenological Calendar Changes Europe, Australia, North America



For Global and Regional Wine Production

- Ramifications of the predicted warming are evident as shifts in climate may produce shifts in varietal maturity viability
- Cooler regions should benefit more than warm regions with the ability to shift to a wider range of varieties
- Some regions, near their optimum, may no longer be able to produce the same wines without changes in production technologies

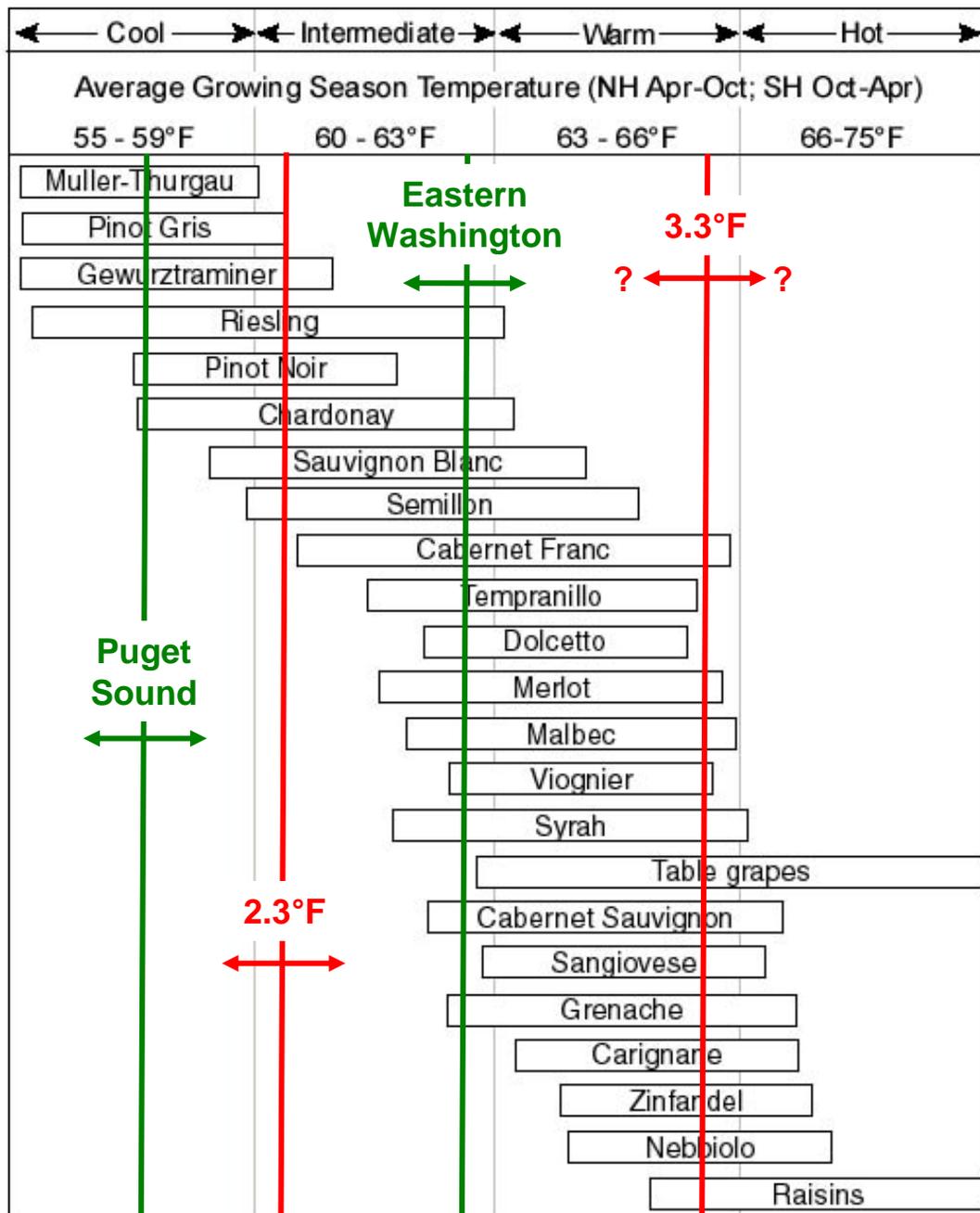
Grapevine Climate/Maturity Groupings



Length of rectangle indicates the estimated span of ripening for that varietal

Predicted Changes for: Puget Sound Eastern Washington

Grapevine Climate/Maturity Groupings



Length of rectangle indicates the estimated span of ripening for that varietal

Conclusions

- Wine production is a climatically sensitive endeavor, with narrow zones providing the most optimum production and quality characteristics, which therefore puts the industry at great risk from climate change.
- The observed warming of the past 50 years appears to have mostly benefited the quality of wine grown worldwide through longer and warmer growing seasons, generally less frost risk, and more consistent ripening climates.
- The predicted warming in the next 50-100 years presents numerous potential impacts and challenges to the wine industry including:
 - Additional changes in grapevine phenological timing
 - Disruption of balanced composition in grapes and wine
 - Alterations in varieties grown and regional wine styles
 - Spatial changes in viable grape-growing regions
 - Increased presence and/or intensity of pests and disease
 - Added water-related challenges (e.g., timing and availability)

Conclusions

- The impacts of climate change are not likely to be uniform across all varieties and regions, but are more likely to be related to a climatic threshold whereby any continued warming would push a region outside the ability to optimally ripen varieties that are already established.
- Cooler climate regions have a greater ability to adapt to climate change, however in warm to hot climate regions, quality wine production in the same manner as today will likely be challenging.
- To prepare for the future, the industry will most certainly need to integrate planning and adaptation strategies to adjust accordingly to the predicted changes in climate.