

Analysis of statistical relationships between bioclimatic indices and wine grape harvest qualities



World Class. Face to Face.

Corydon Funk¹, Melba Salazar-Gutierrez¹, Bernardo Chaves¹, Rick Hamman², Bill Riley³, Gary Grove¹

¹ AgWeatherNet Program, Washington, State University, Prosser, WA 99350, USA; ² Hogue Ranches, Prosser, WA 99350, USA; ³ Ste. Michelle Winery Estates, Woodinville, WA 98072

Background

- Quality is mostly determined by the climate variability of a particular area
- Three of the most important measurable qualities are brix degrees, pH levels, and titratable acidity
- While bioclimatic indices are used for climate zoning, they are rarely used to correlate their values to the wine qualities themselves

Purpose

- Identify the climatic trends between different bioclimatic indices and grape qualities through data correlation
- Observe the use of a multidimensional preference analysis for data tendencies.
- Discover potential improvements to bioclimatic indices in their relation to wine grape qualities

Methods

- Harvest data for four locations and four cultivars were collected from at least 2009-2016.
- Locations included parts of the Horse Heaven Hills, the Yakima Valley, and the Columbia Valley American Viticultural Areas (Tab. 1)
- Cultivars included Cabernet Sauvignon, Merlot, Chardonnay, and White Riesling; all are of the genus-species *Vitis vinifera*
- Weather data was collected using the AgWeatherNet's data library (www.weather.wsu.edu)
- Four different bioclimatic indices were used:
 - The Branas Bernon Levadoux Index:

$$\sum_{\text{April 1}}^{\text{August 31}} (T_{\text{monthly_mean}} \times P_{\text{sum}})$$
 - The Cool Night Index:

$$\sum_{\text{September 1}}^{\text{September 30}} (T_{\text{avg_min}})$$
 - $$\sum_{\text{October 1}}^{\text{October 31}} (T_{\text{avg_min}})$$
 - $$\sum_{\text{September 1}}^{\text{October 31}} (T_{\text{avg_min}})$$
 - $$\sum_{\text{July 1}}^{\text{July 31}} (T_{\text{avg_min}})$$
 - The Huglin Index:

$$\sum_{\text{April 1}}^{\text{September 30}} \left(\left(\frac{(T_{\text{mean}} - 10) + (T_{\text{max}} - 10)}{2} \right) \times d \right)$$
 - The Winkler Index:

$$\sum_{\text{April 1}}^{\text{October 31}} \frac{(T_{\text{max}} + T_{\text{min}})}{2} - 10$$

Table 1: The locations of the different grape fields, and the distance they are from the AgWeatherNet Weather Stations. (weather.wsu.edu)

| GPS (Location) | Station Name | GPS (Station) | Distance (mi/km) |
|---------------------------------|--------------|---------------------------------|------------------|
| 45°52'33.697" 119°45'7.262" | Canoe Ridge | 45°52'33.697" 119°45'7.262" | 0mi / 0km |
| 46°35'16.402" 119°48'37.028" | Desert Aire | 46°42'10.471" 119°55'39.263" | 14.5mi / 23.3km |
| 45°56'29.333" 119°36'25.802" | Paterson | 45°56'19.449" 119°29'16.15" | 6mi / 9.7km |
| 46°21'53.024" 119°57'4.622" | Sunnyside | 46°23'7.957" 119°59'48.85" | 3.5mi / 5.6km |

- The Branas Bernon and Levadoux Index would attempt to predict mildew susceptibility
- Each temperature index had different classifications for climate, so it would be possible that one would better represent a location than another
- In addition, a multidimensional preference analysis was utilized to visualize other tendencies in relation to the qualities. (Fig. 1)
- indices such as the Cool Night Index, the Huglin Index, and the Winkler Index show positive correlations to all grape qualities. (Tab. 2)

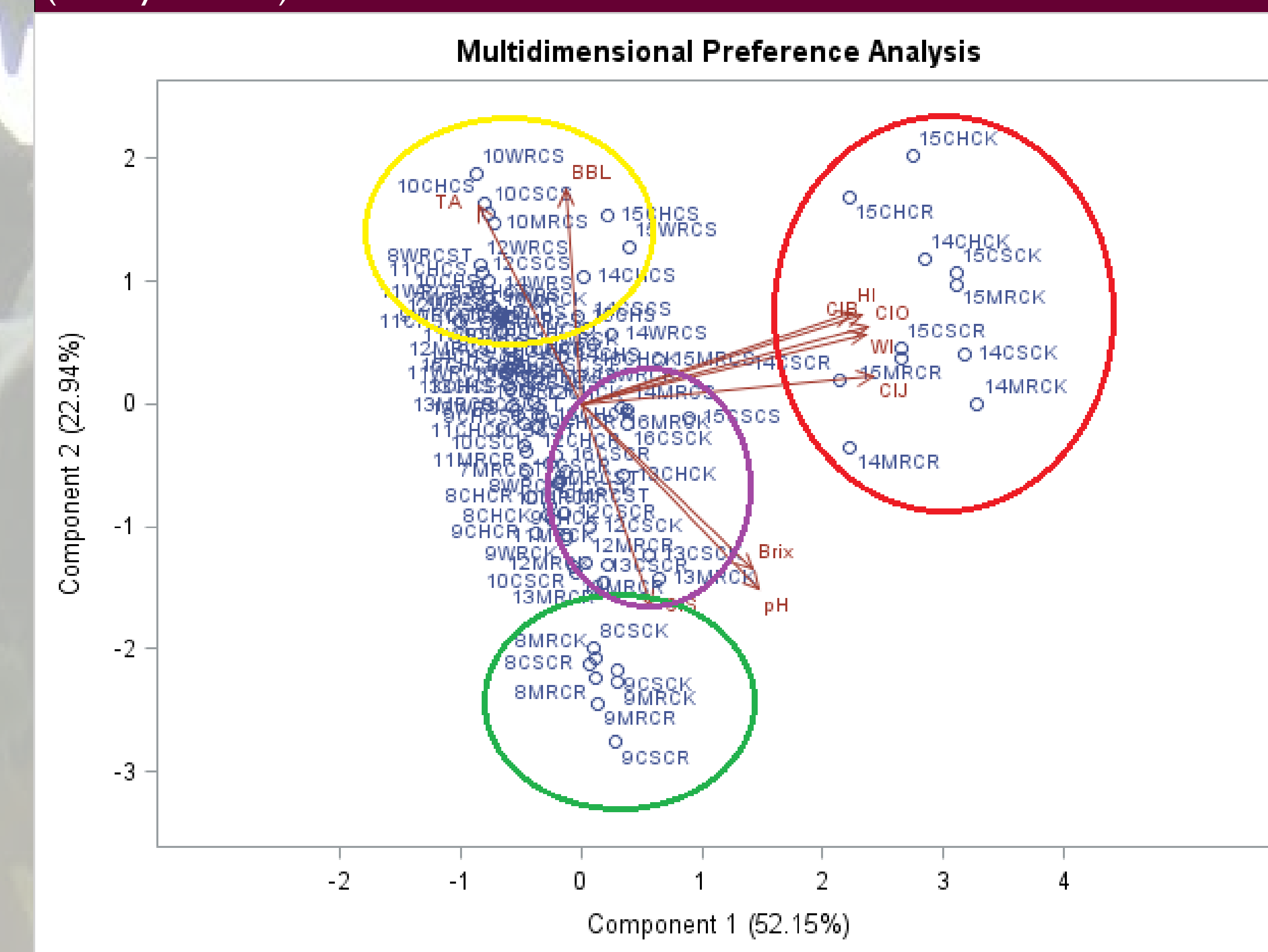
Preliminary Results

Table 2: The correlations overall, between every location's temperature and their qualities. A symbol of (*) indicates a significance value of .005 or less, a significant correlation.

| Index | Brix Degrees | pH Levels | Titratable Acidity |
|-------------------------------|--------------|-----------|--------------------|
| BBL Index | -.320* | -.131 | .114 |
| Huglin Index | .274* | .184 | -.259* |
| Winkler Index | .341* | .300* | -.333* |
| Cool Night Index September | .129 | .349* | -.101 |
| Cool Night Index October | .148 | .178 | -.187* |
| Cool Night Index Both | .347* | .347* | -.313* |
| Cool Night Index July | .436* | .453* | -.208* |

- When looking at correlation values, the temperature The Cool Night Index used 4 different time periods: the months of July, September, and October, as well as both September and October in conjunction
- The Branas, Bernon, and Levadoux Index showed only one significant negative correlation to Brix degrees
- The Winkler and Cool Night Index (July and Both) represented climatic relationships well
- The multidimensional preference analysis (MPA) plotted the wine-grape qualities in a diagonal line
- The MPA also plotted the bioclimatic indices, almost horizontal and perpendicular to the grape qualities

Figure 1: The multidimensional preference analysis biplot; Each different color represents a section with similar tendencies (within year or location). Some sections, can be used in conjunction and represent other tendencies as well (usually cultivar).



- The multidimensional preference analysis showed that the red varieties seemed to be closer to the Brix and pH lines, represented by the purple outline.
- The biplot also showed the white varieties following the titratable acidity closer, evidenced by the yellow outline.
- Sometimes, outliers such as those found in the green outline could be represented. With September holding a larger importance for these locations and/or years.
- Hot year such as outlined in red are more readily noticed.
- The MPA didn't show location expressly affecting the grapes, other than the climatic relationship.

Conclusion

- The data represented a positive correlation between temperature and qualities.
- While the Branas, Bernon, Levadoux Index didn't show many inherent correlations, the relationship to sugar should not be discounted
- The month of July is a crucial month in grape development
- The multidimensional preference analysis biplot did show some evidence of the relation of cultivar and year to the three qualities.
- In the future, a collection of data for a larger period of time would be preferred.
- A larger amount of data would most likely allow for a distinction between cultivar or location to be possible and relevant, not simply *Vitis vinifera*.

Acknowledgments

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