



The Microbial Biogeography of Wine Production



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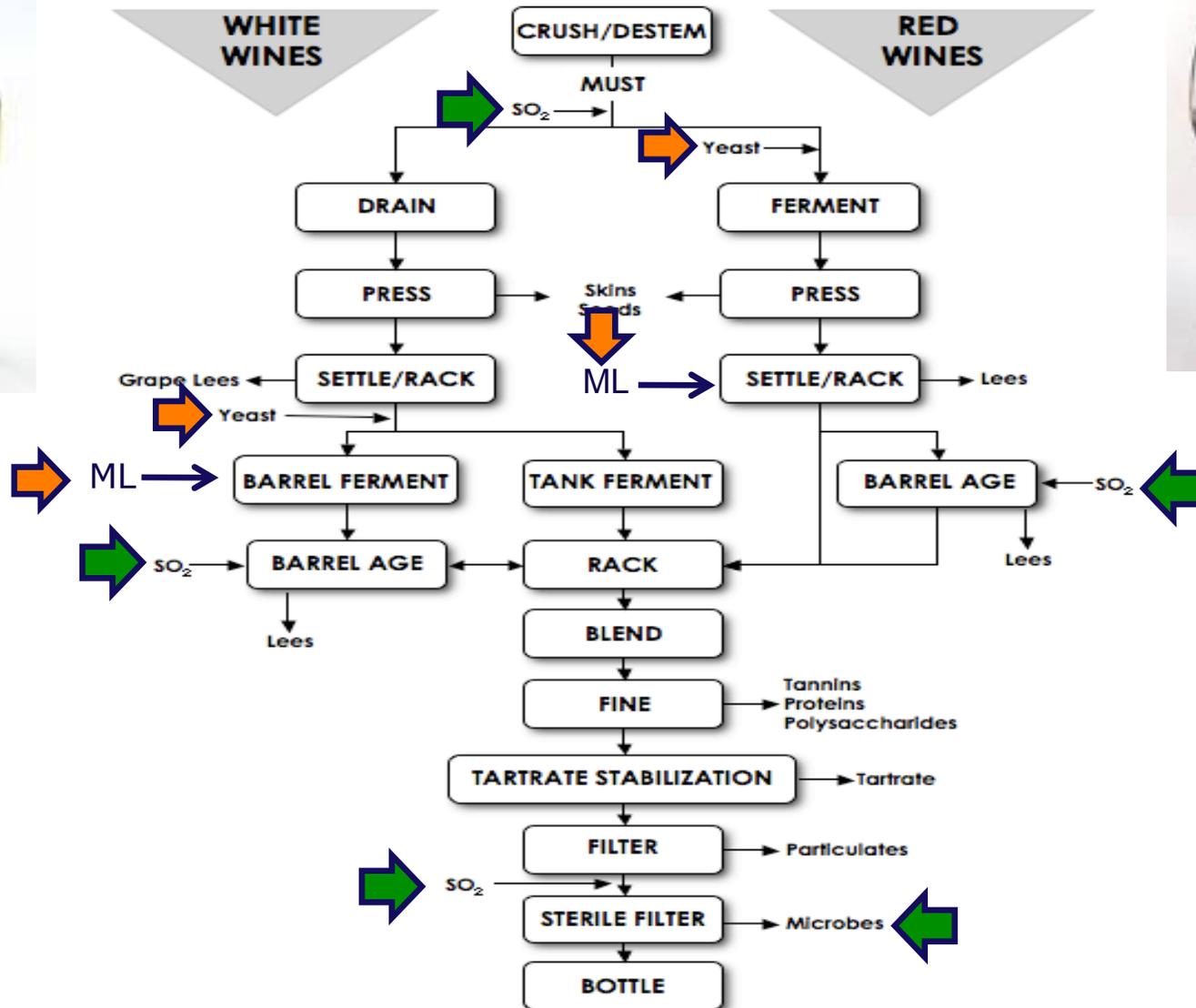
**Microbes are inherent to food production.
Both the good...**



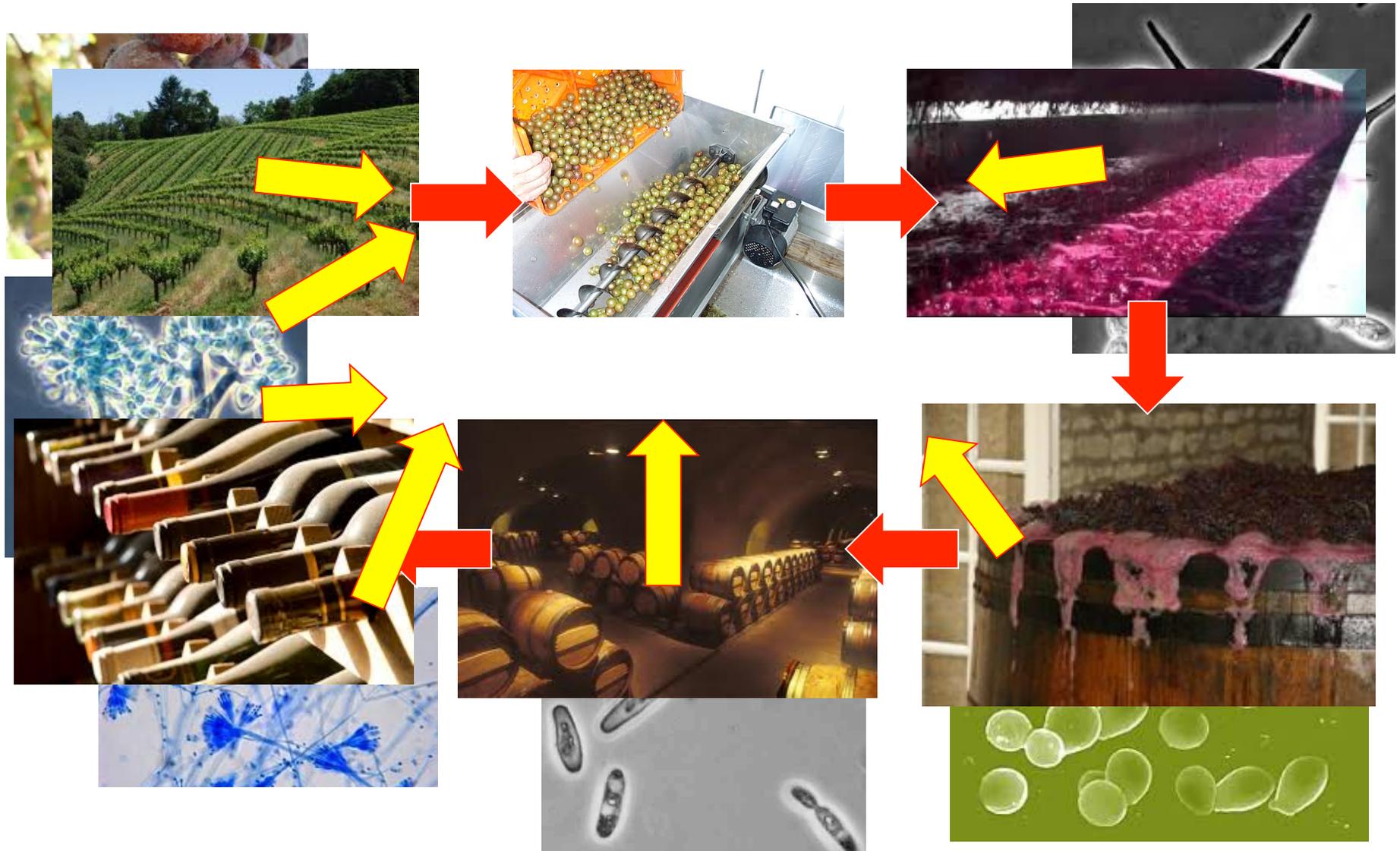
... And the bad



Wine Fermentation Process



We know the major microbial players



UCDAVIS Department of Viticulture and Enology

Problem → traditional microbiology is too tedious, low throughput and doesn't "see" all the microbes present

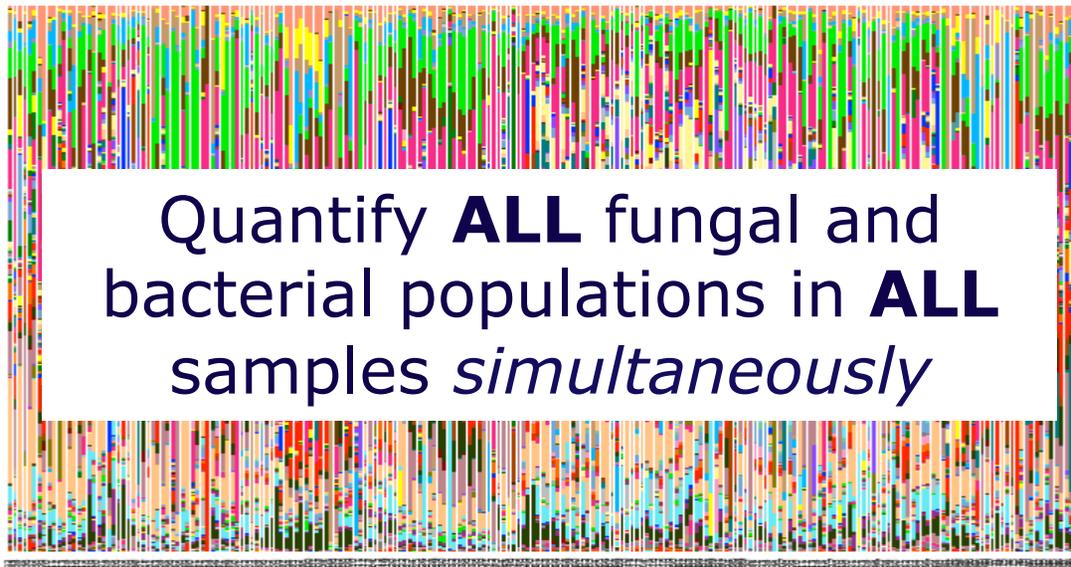




Microbial surveillance: Next Generation Sequencing

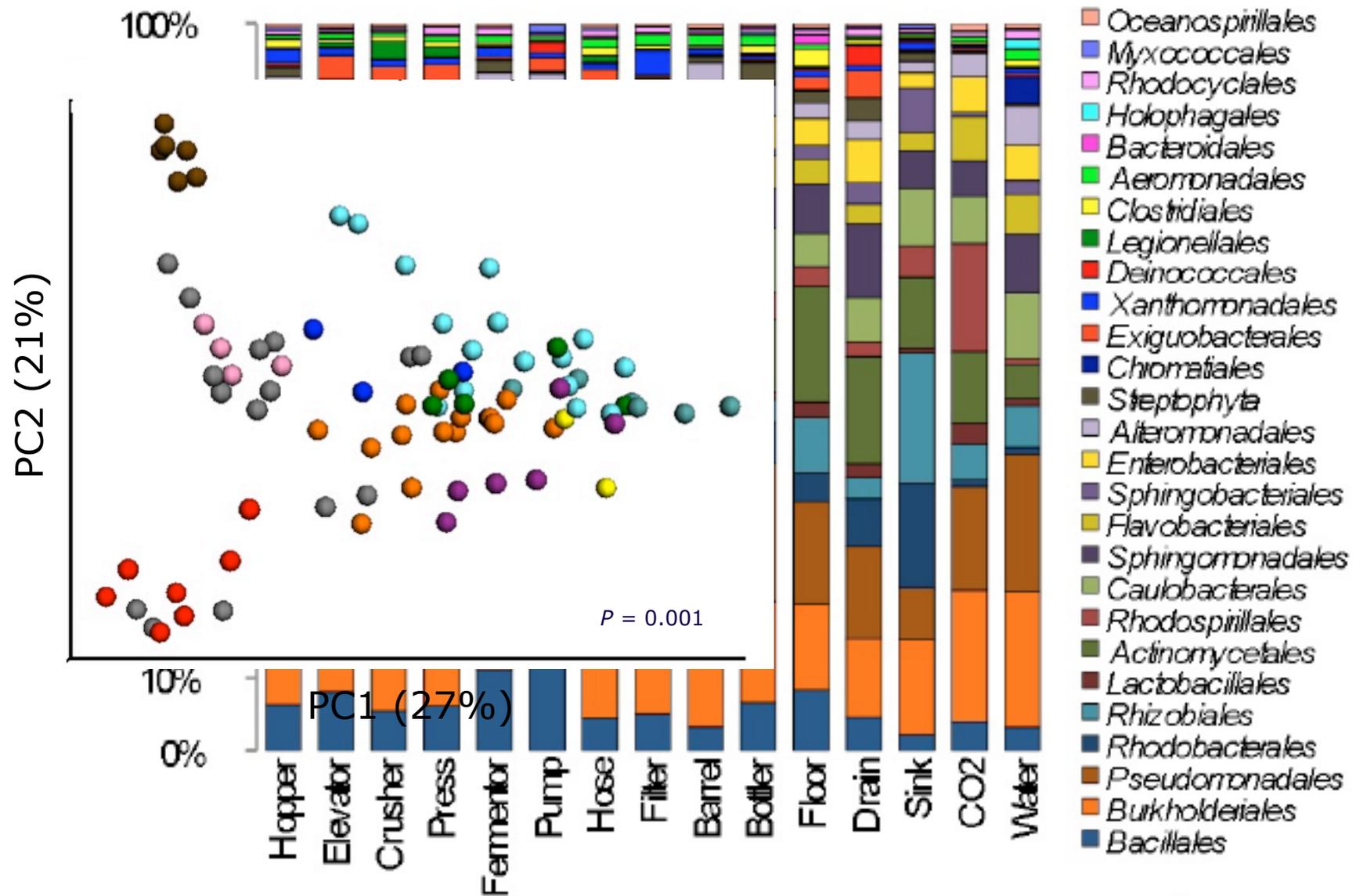


Extract DNA



Sequence:
Illumina Platform

Microbial surveillance: Next Generation Sequencing



Where do the wine microbes come from?

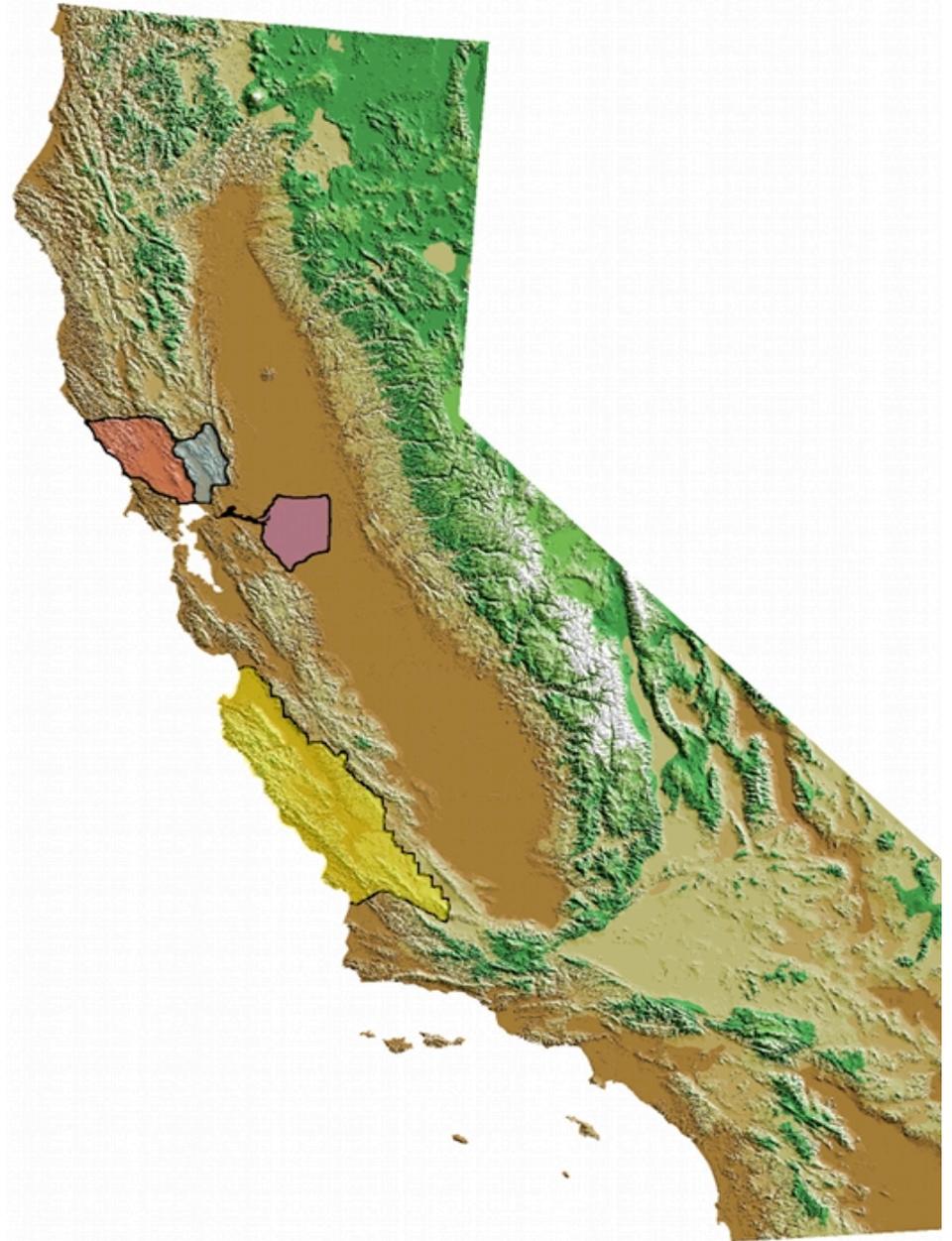


Can you define a region by the grape microbiota at harvest?

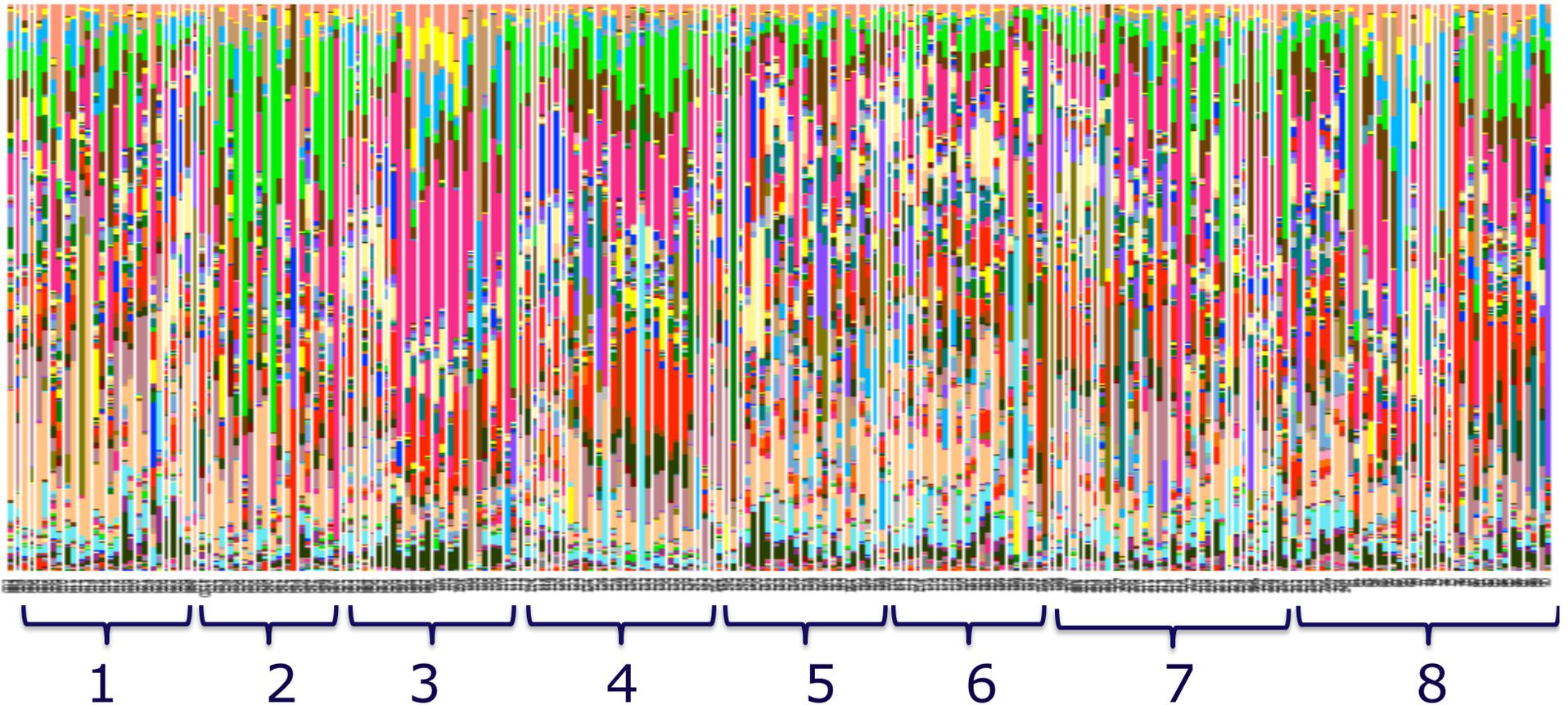


Early Fermentation Microbiota

- 240 musts (2010)
- 4 regions: Napa, Sonoma, Northern San Joaquin Valley (NSJV) Central Coast
- 8 Wineries
- Ran both fungal (yeast) and bacterial NGS analysis



Bacterial profiles across CA wineries



Winery Differences Across 300 Samplings

Varietal Variation?

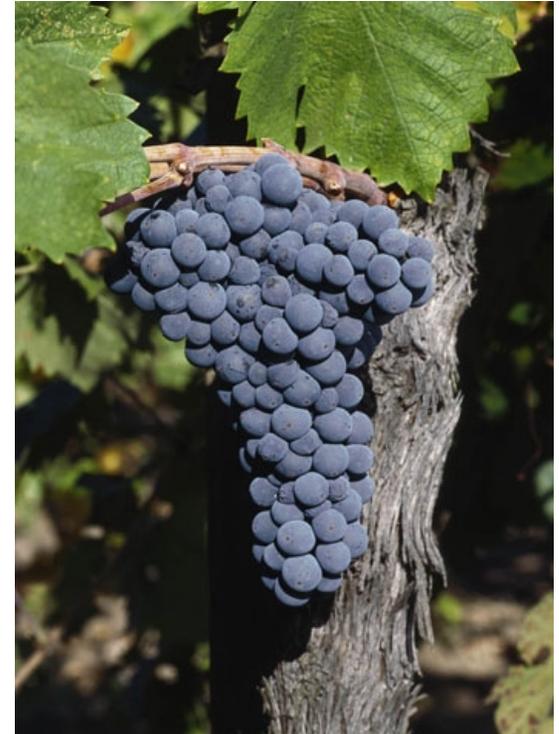
Cabernet



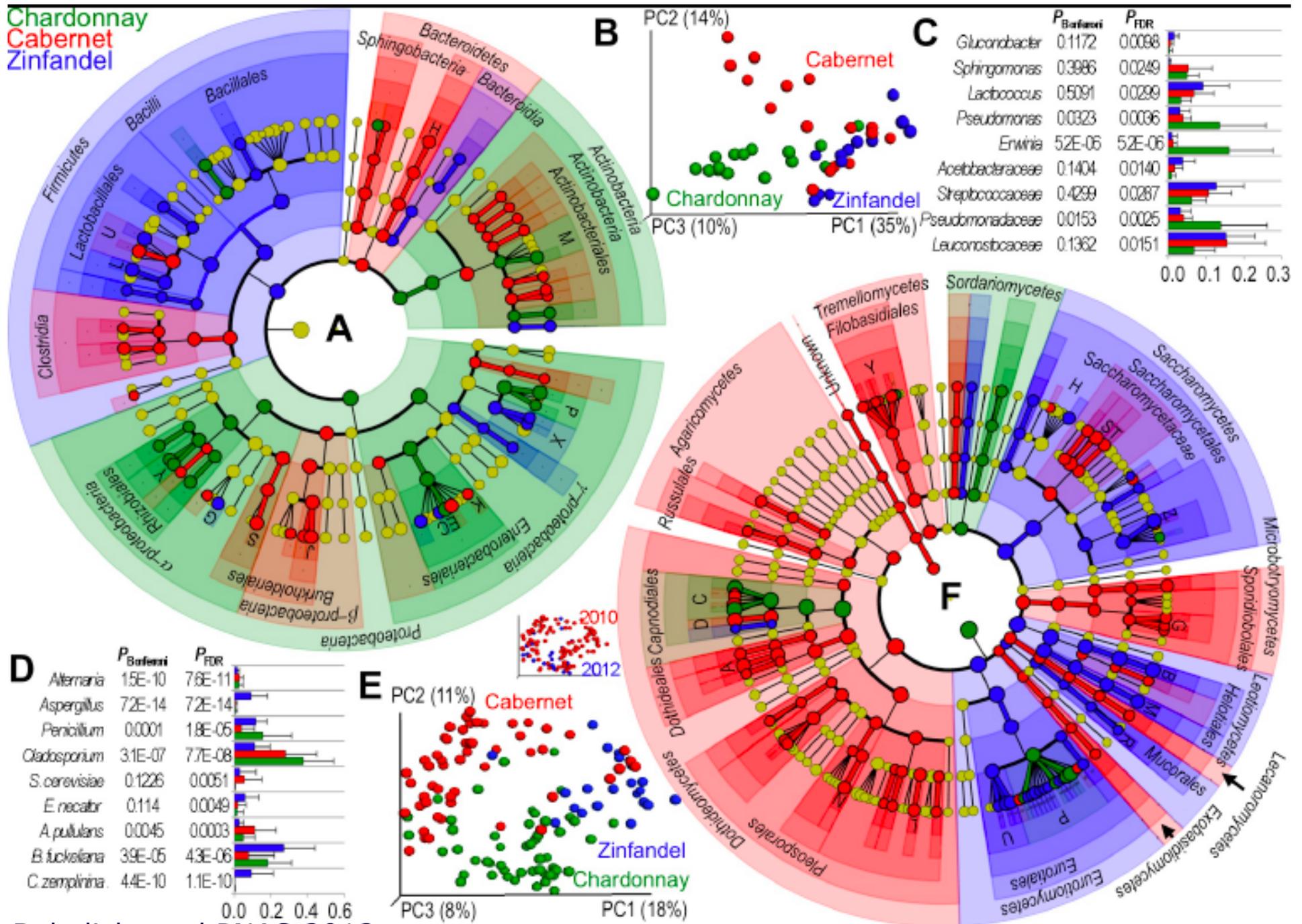
Chardonnay



Zinfandel



Chardonnay
Cabernet
Zinfandel

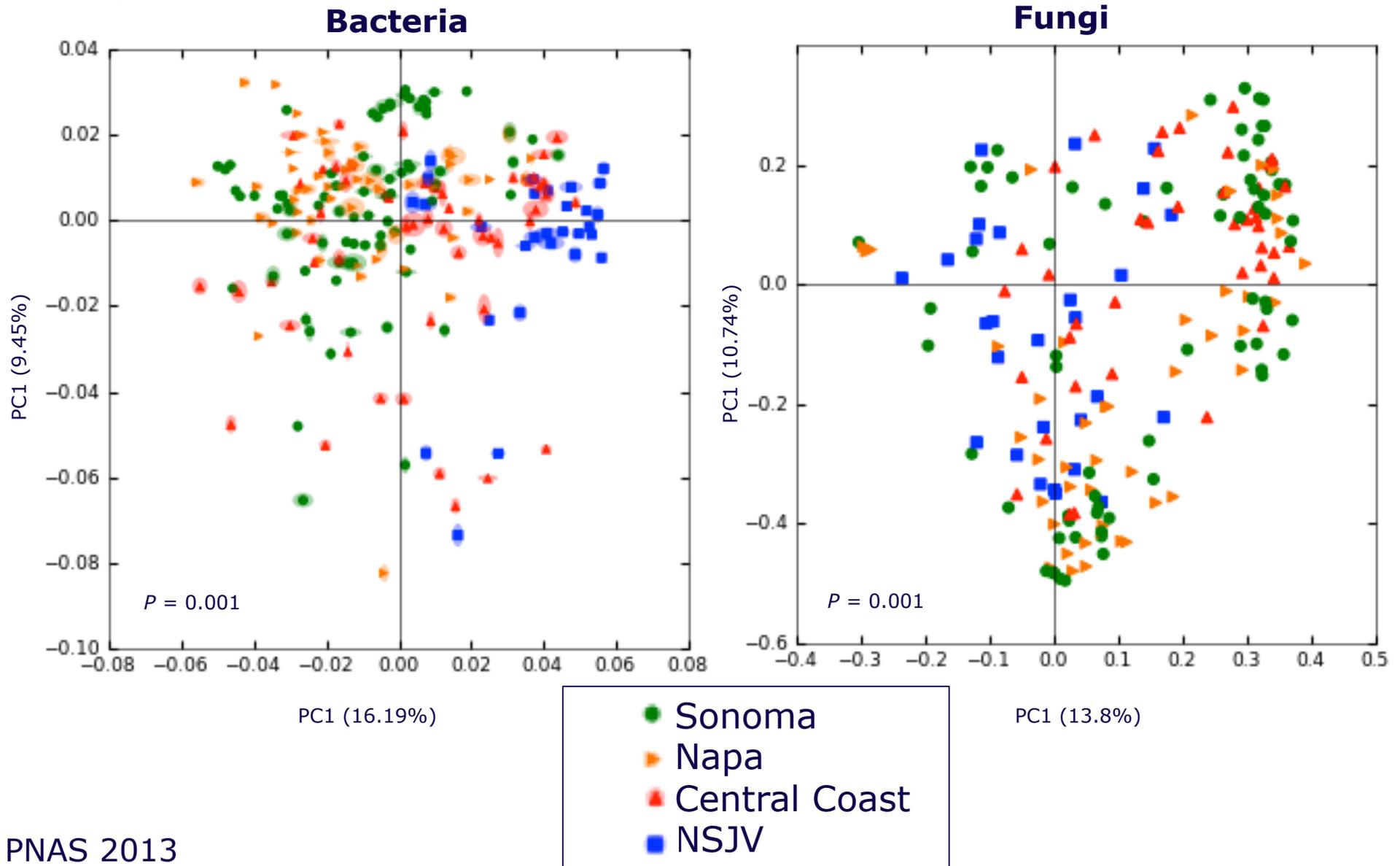


Bokulich et al PNAS 2013

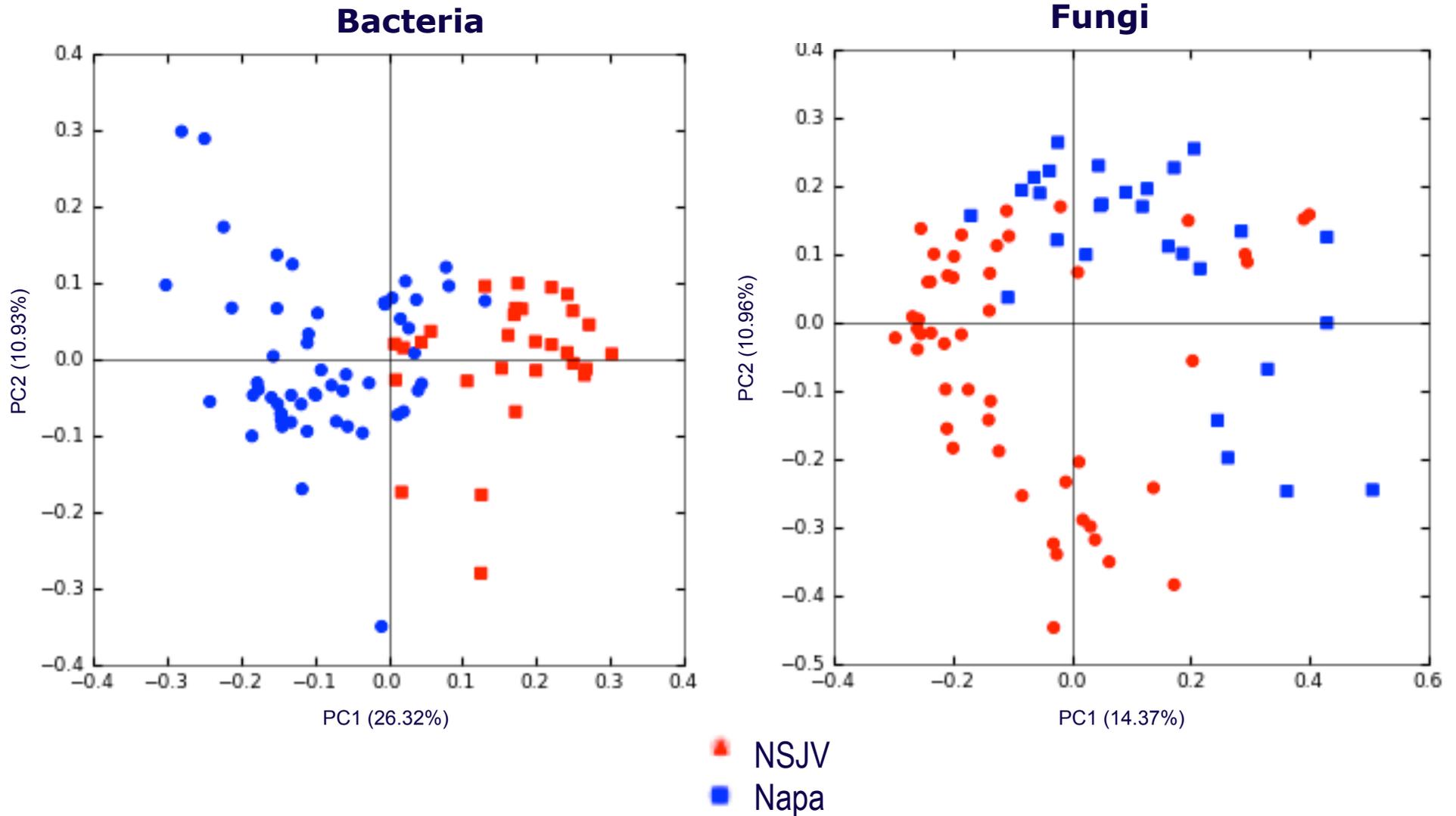


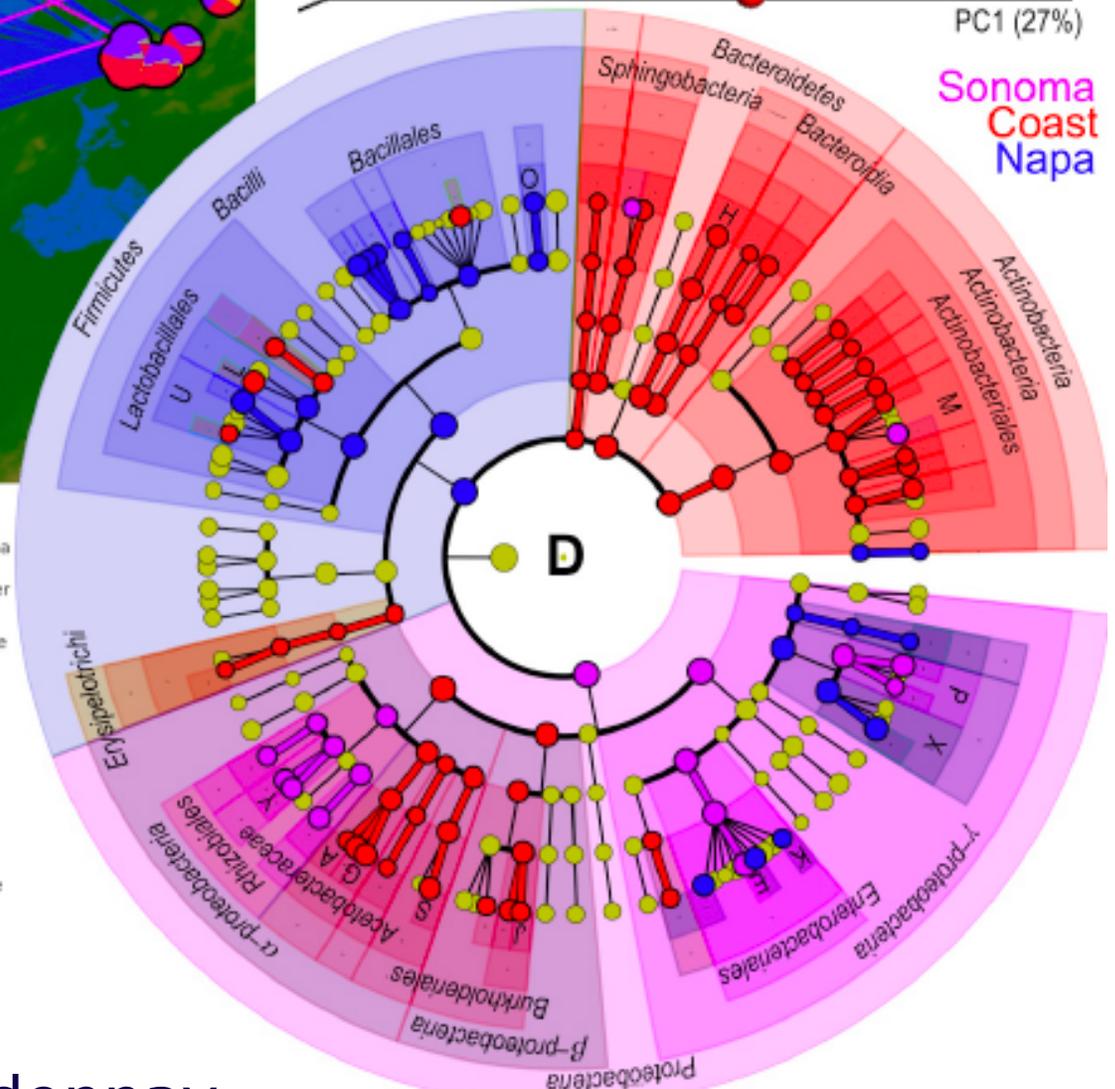
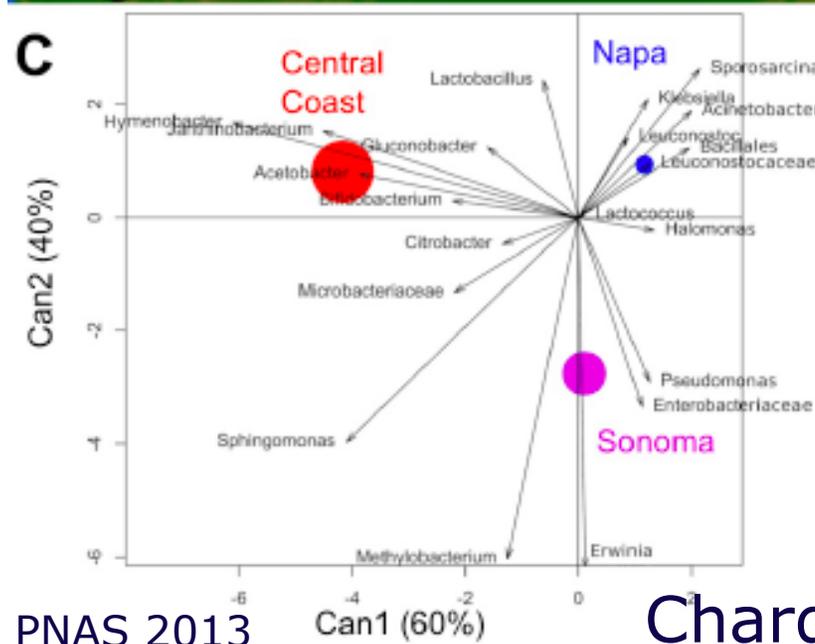
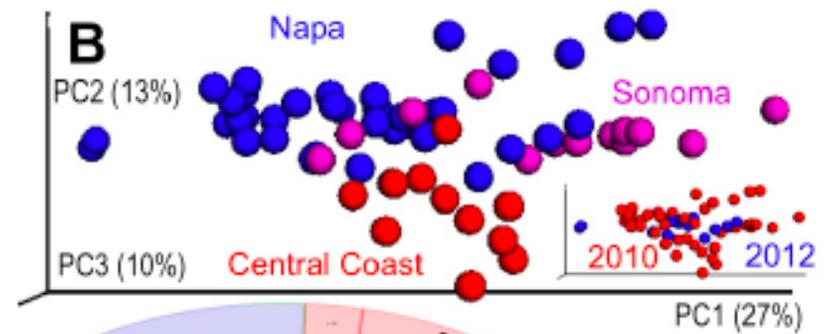
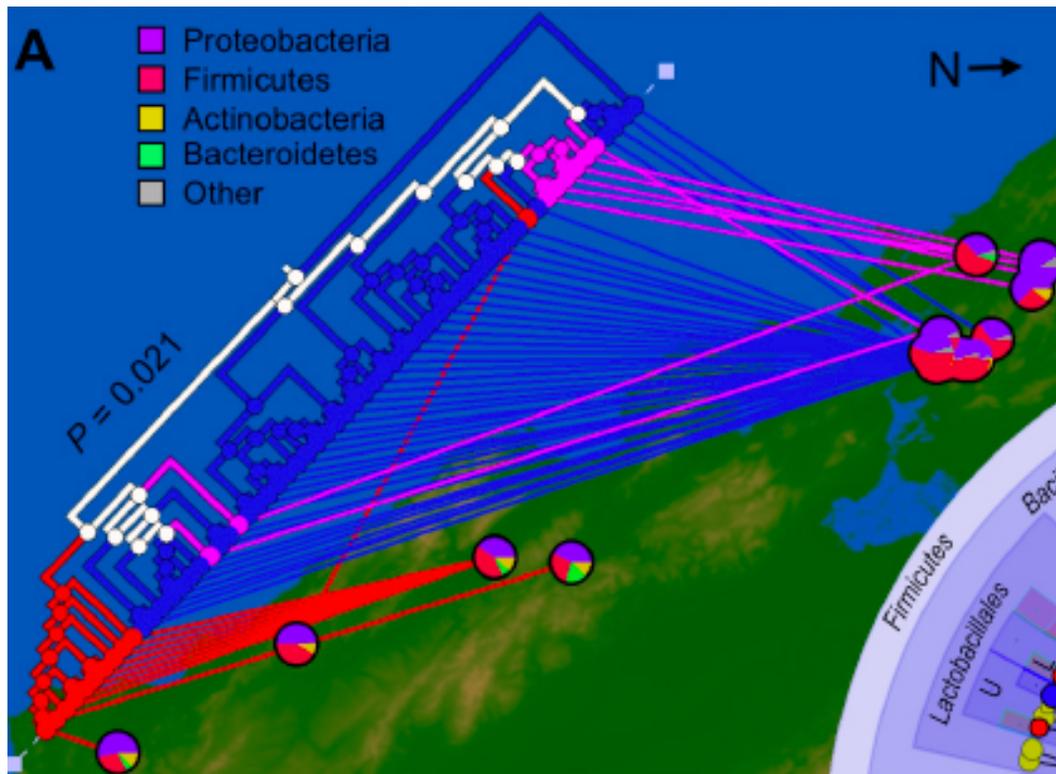
Can large regions
be differentiated?

Regional Variation – total



Regional Variation — Napa vs. NSJV





PNAS 2013 Chardonnay

Linear Discriminate Analysis Effect Size

**Can we identify sources of
contamination?**

Can we determine how microbes move through a winery?

- Can we track microbial transitions during grape harvest?
- What processes drive microbial community patterns?
- What reservoirs exist for spoilage microbes?



Can we determine how microbes move through a winery?

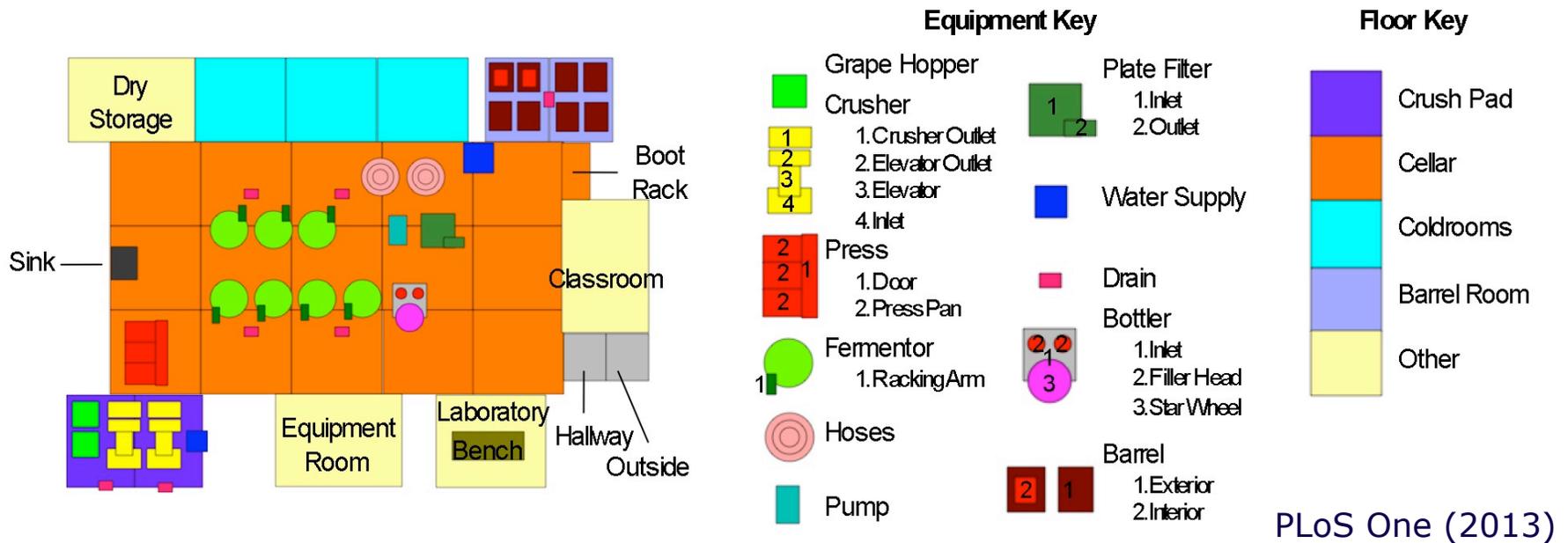


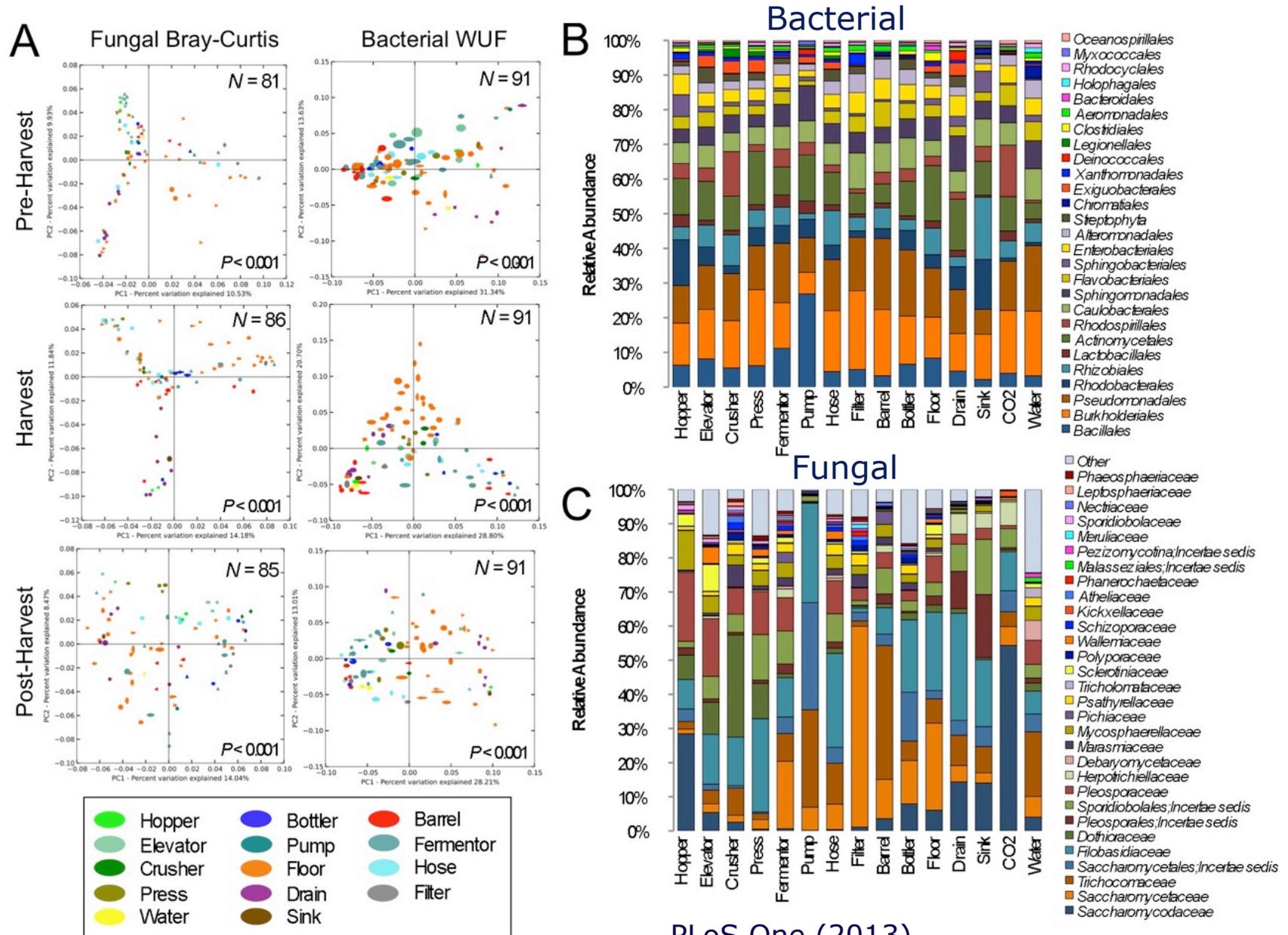
Surface swabbing



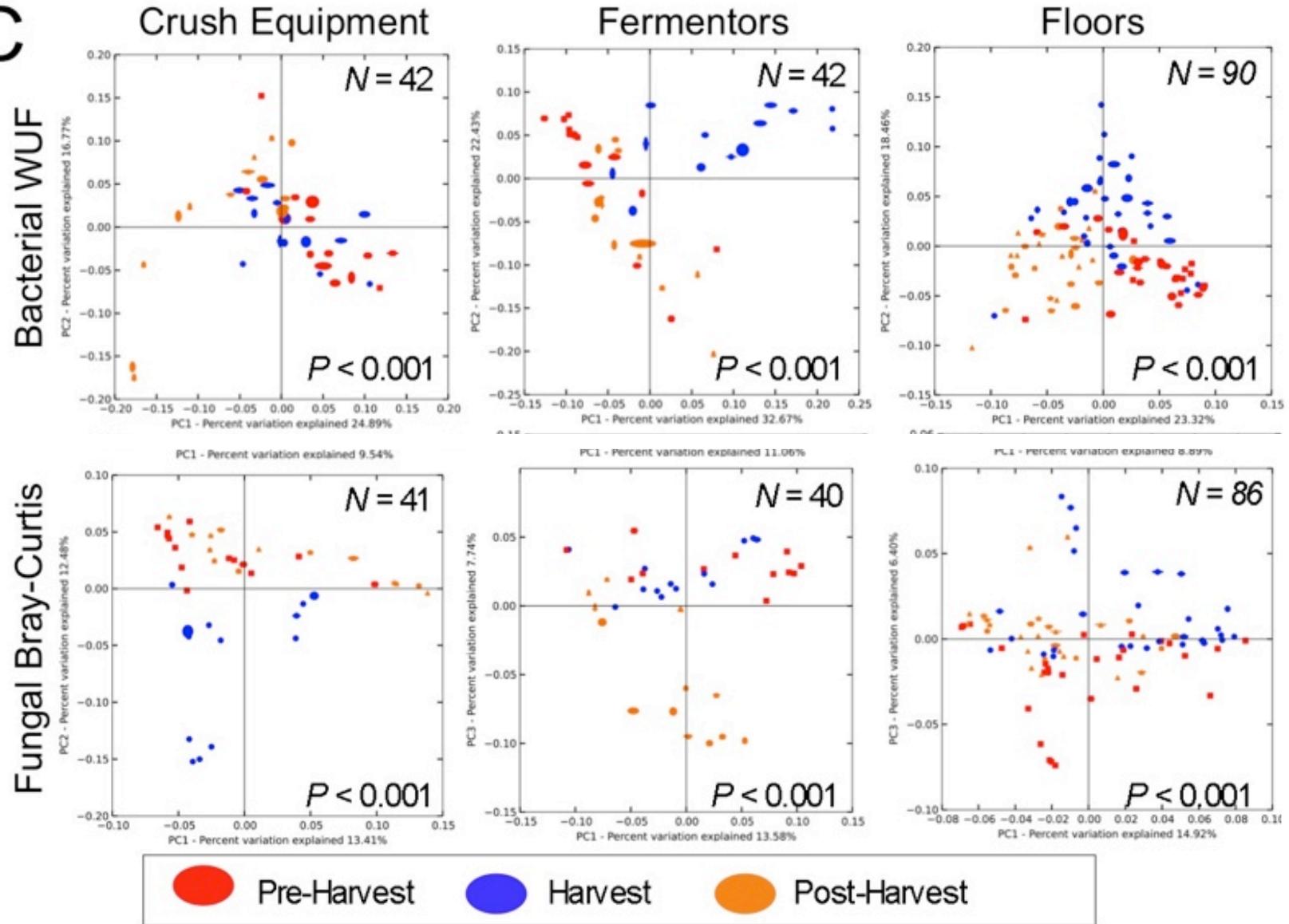
Moe Ohta

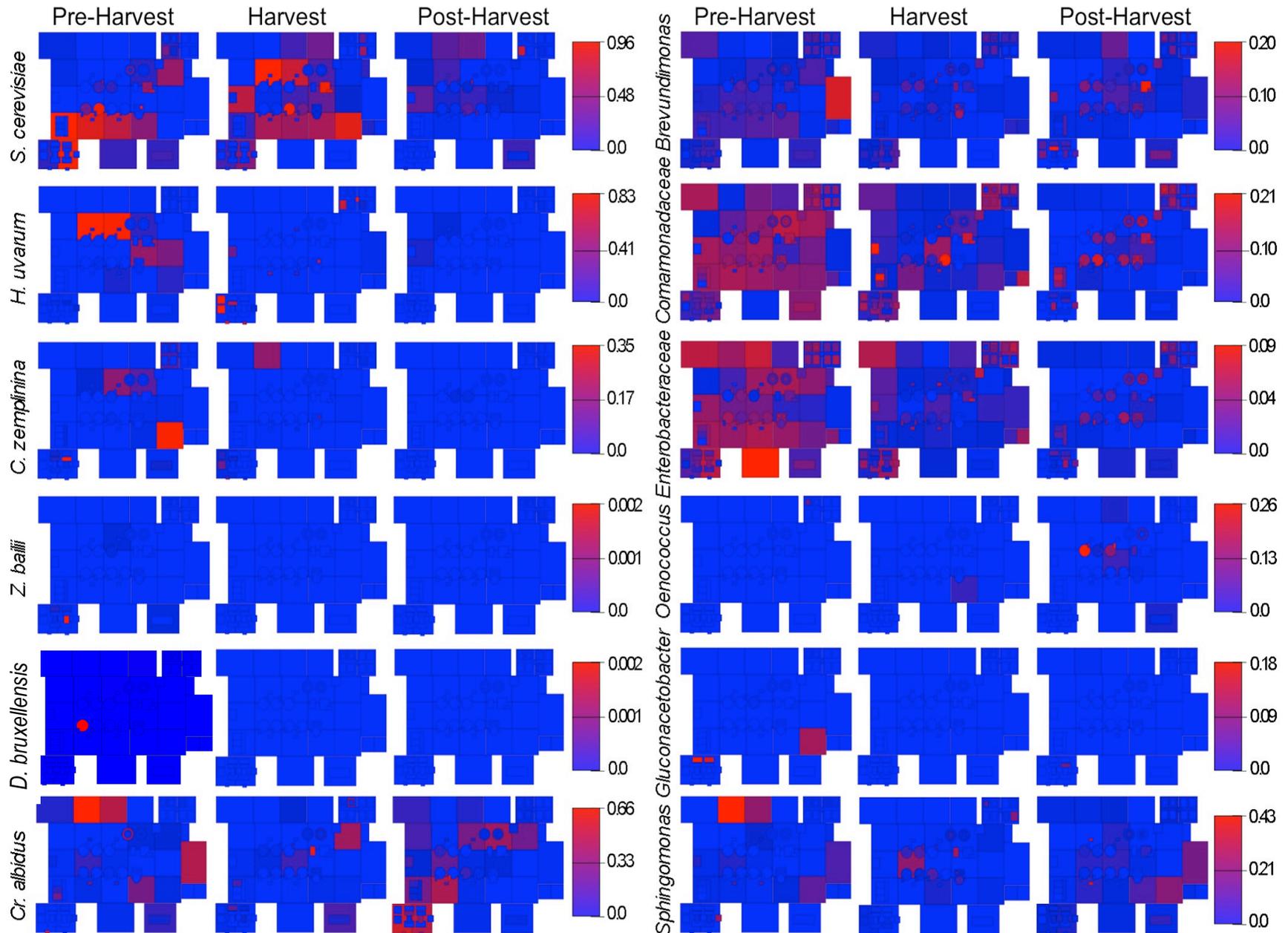
Seasonal Surveillance: UC Davis Winery





C





What about other food/ beverage fermentations?

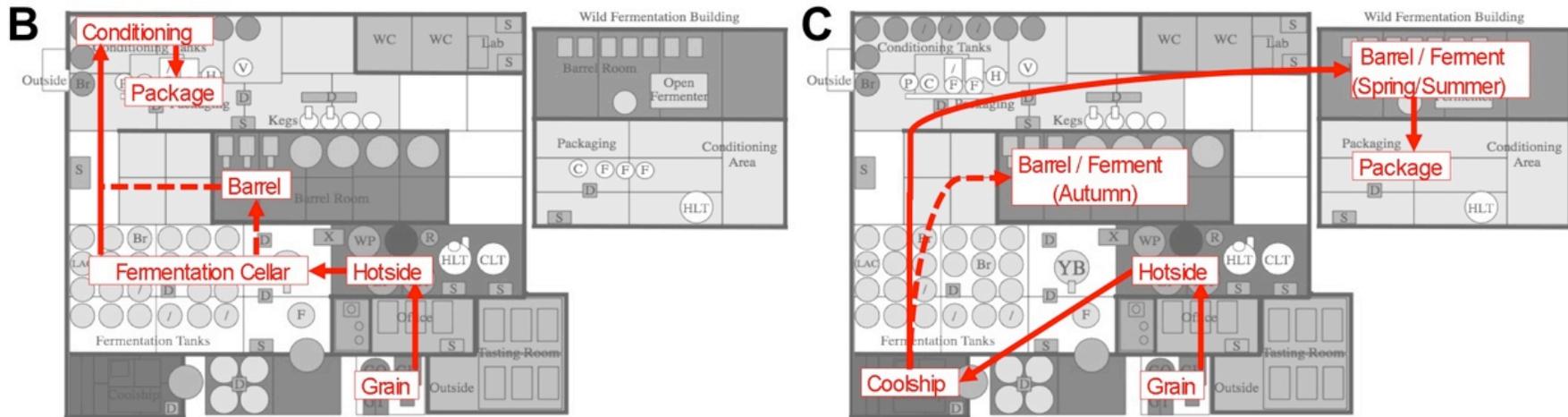
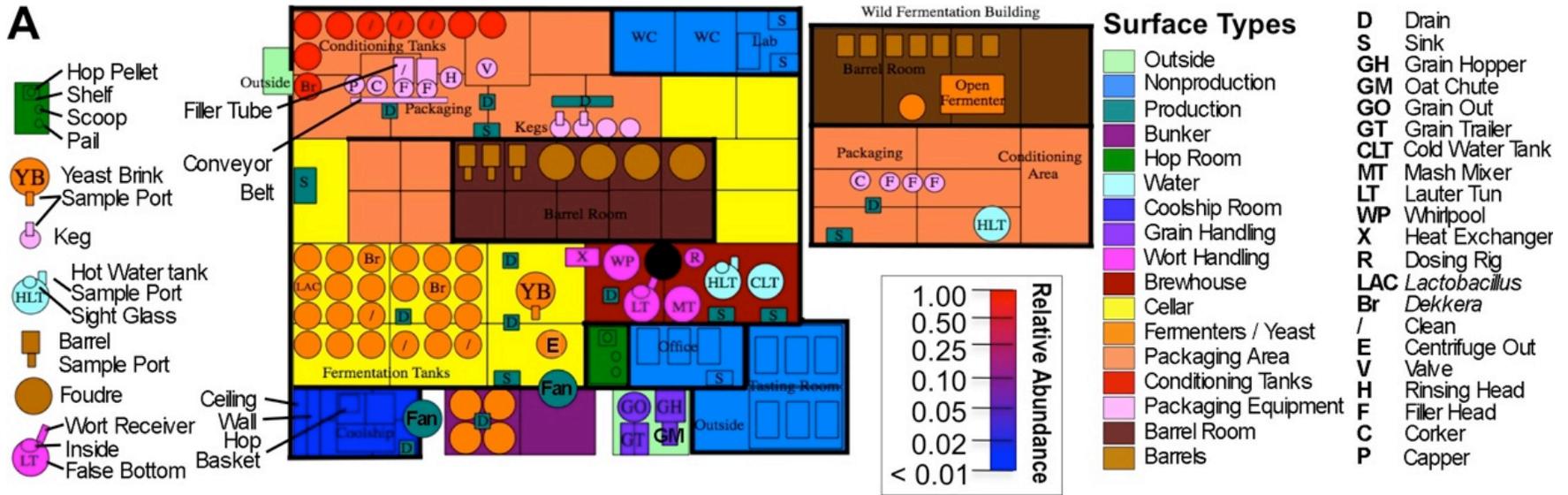


Sake Brewery
AEM (2014)

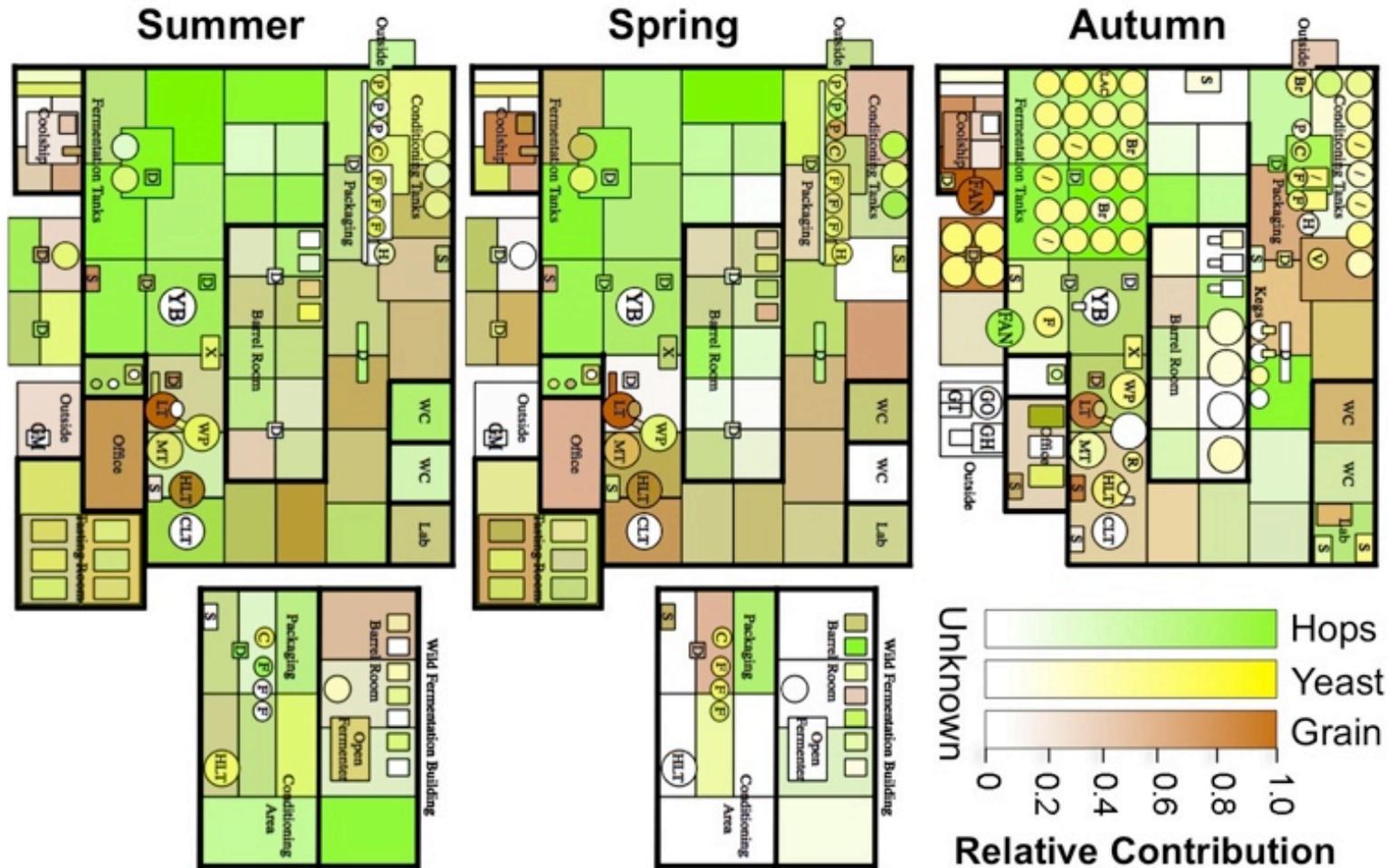
Artisan Cheese
AEM (2013)



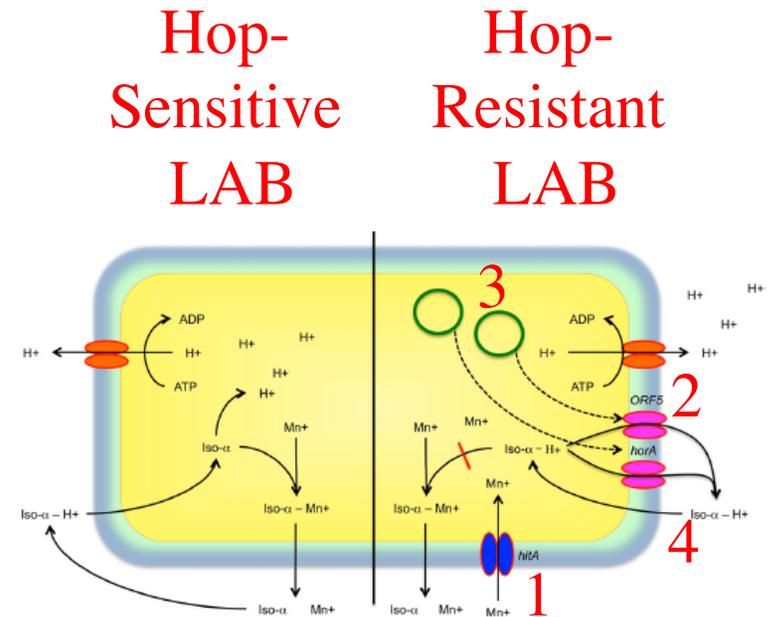
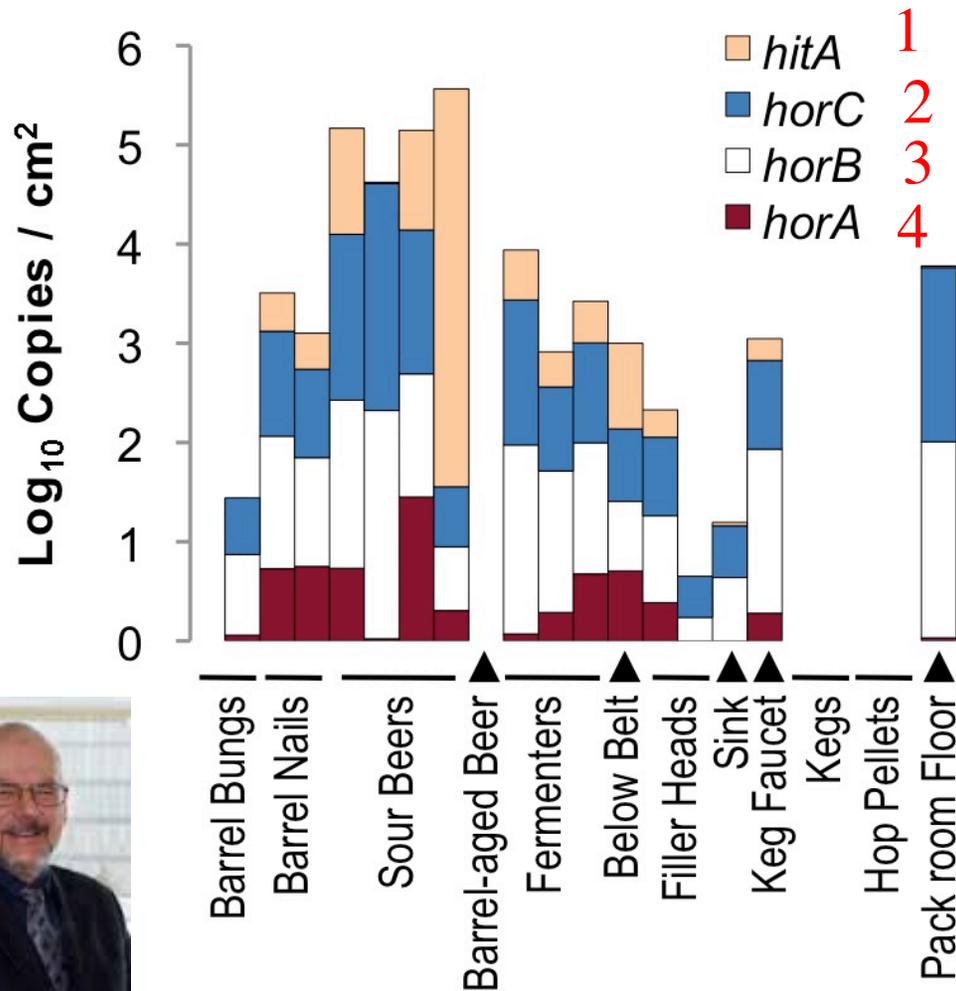
Spontaneous Beer Brewery



Microbial Source Tracking - Lambic Style Brewery



Spoilage Genes Spread By Beer Contact!!!



Barry Ziola + Jordyn Bergsveinson, U Sask

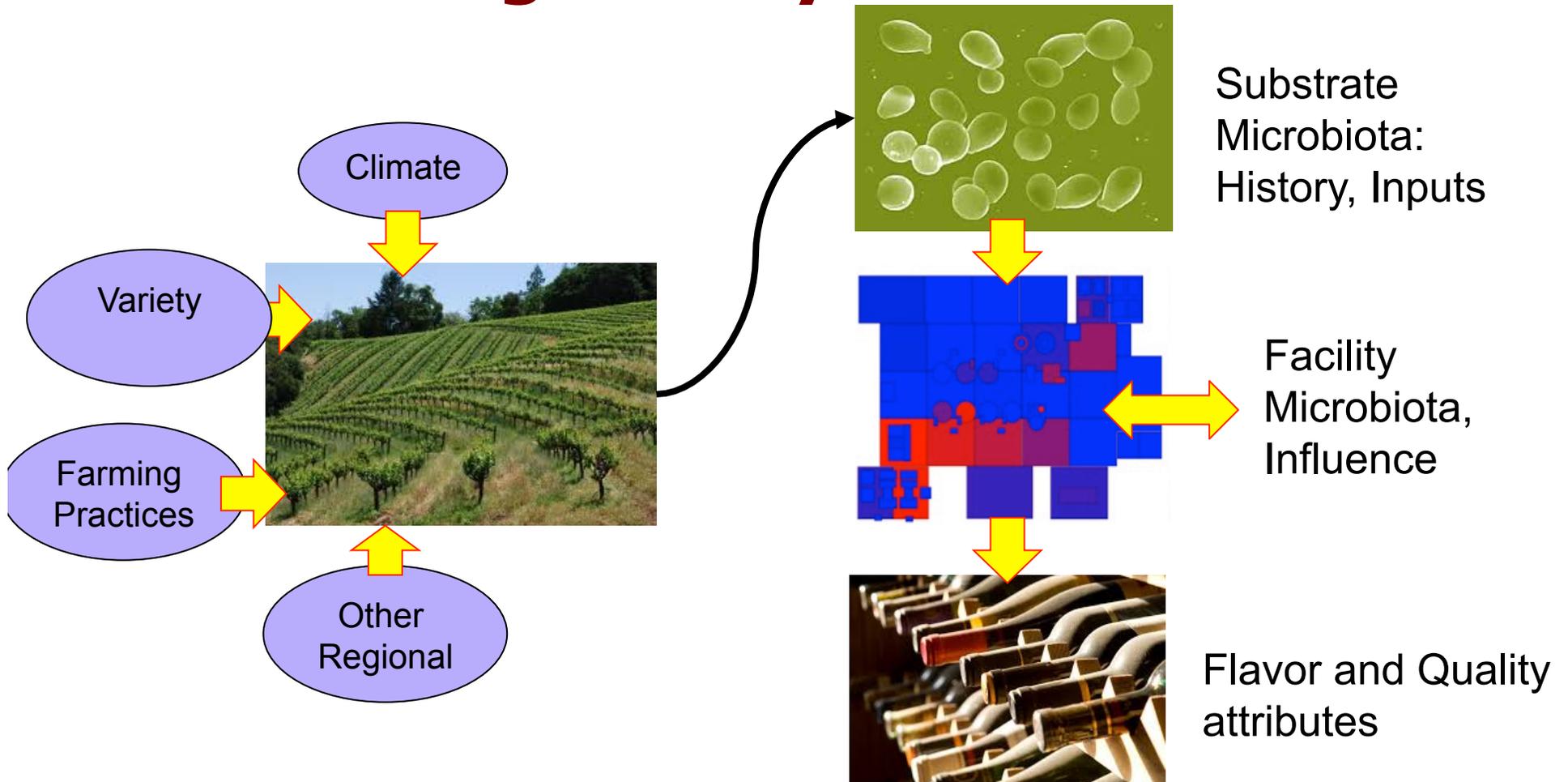
Bokulich et al Elife



Summary

- Next generation sequencing tools enable complete mapping of fungal and bacterial microbiota within the grape—wine and beer continuum
- Regional, subregional and even vineyard specific differences in grape must microbiota can be robustly defined
- Varietal level differences in grape must microbiota can be robustly defined
- In some cases, winery and brewery influence on product microbiota can be observed
- Examining facility microbiome can track microbial flow through production plants

Microbial Regionality?



Microbiology of the Built Environment Program



ALFRED P. SLOAN FOUNDATION

Alfred P. Sloan Foundation

Major Program Areas

- Basic Research
- STEM Higher Education
- Public Understanding of Science, Technology & Economics
- Digital Information Technology
- Economic Performance and Quality of Life
- Select Issues
- Recently Completed Programs

Sloan Research Fellowships

Microbiota analyses



Over the next five years, Sloan's objectives are as follows:

1. To push the research frontier including the development of new techniques and protocols, and to educate a small multidisciplinary university-based **Biology and the University of Oregon**, led by Jessica Green, Brian Charlie Brown.

Department of Viticulture and Enology at UC Davis

Department of Viticulture ... Timeline Recent

Department of Viticulture and Enology at UC Davis
March 21 · Edited

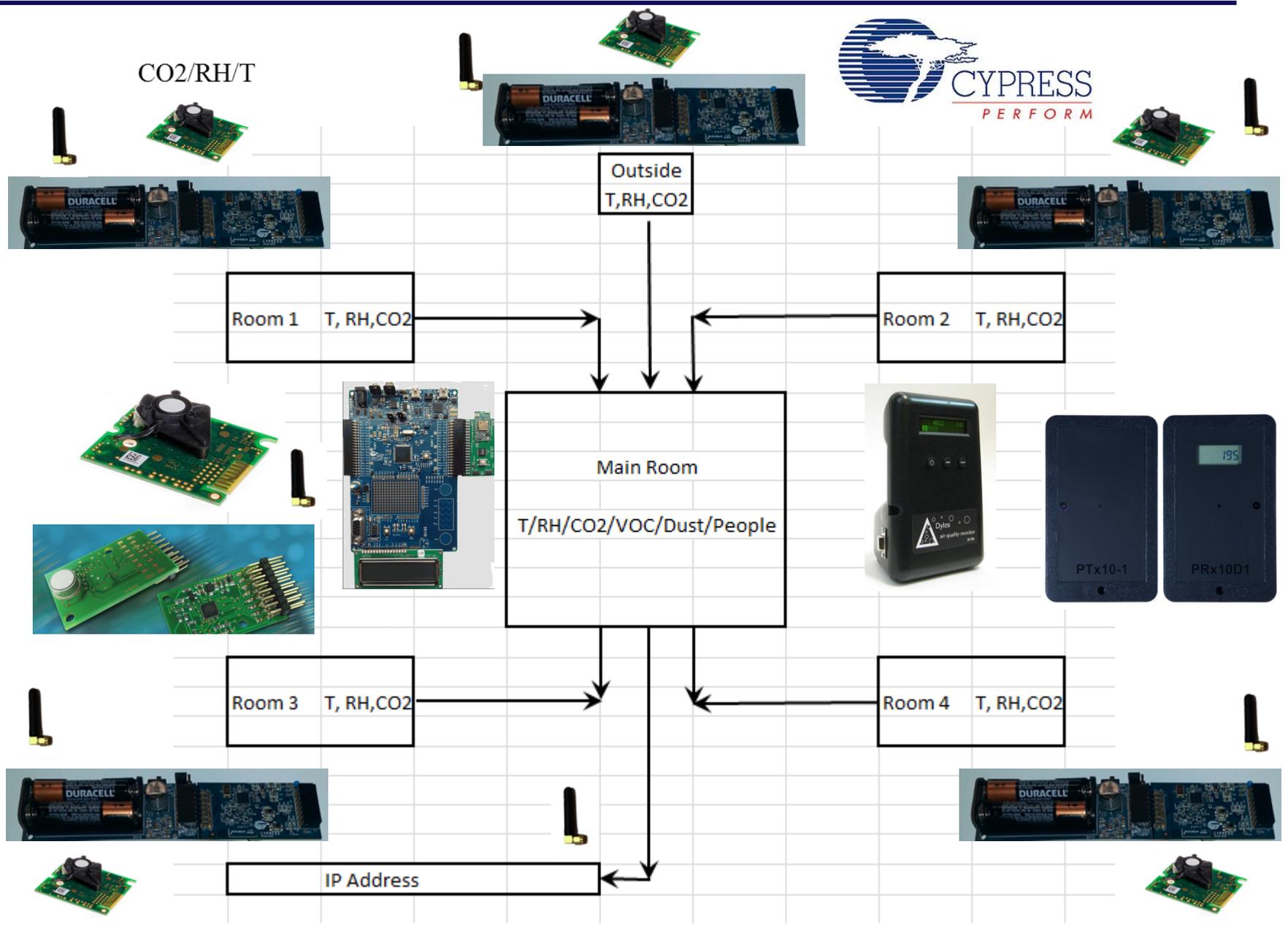
Congratulations to Roger Boulton (VEN), Kyria Boundy-Mills (FST) and David Mills (FST and VEN) who have been awarded a \$300K, grant from the Sloan Foundation to study the Microbial Ecology of Wineries and Dairies. This funding is part of ... [See More](#)



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2

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CO2/RH/T

Outside
T,RH,CO2

Room 1 T, RH,CO2

Room 2 T, RH,CO2

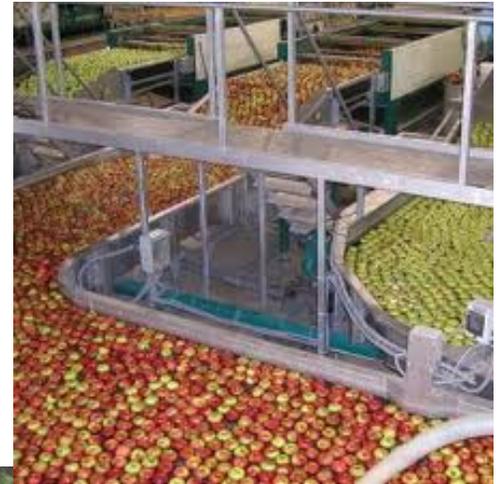
Main Room
T/RH/CO2/VOC/Dust/People

Room 3 T, RH,CO2

Room 4 T, RH,CO2

IP Address

Should we be routinely monitoring the microbiota of all food and beverage production?



Acknowledgements

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Far Niente/Dolce/Nickel & Nickel Wineries

Greg Allen and team

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- ✦ American Wine Society Educational Foundation
- ✦ American Society for Brewing Chemists Foundation

Thanks

