Supplemental Data for:
Zuniga A, Monteverde C and Quandt A. 2024. Grapegrower perceptions of climate change impacts and adaptive capacity in Southern California. Am J Enol Vitic 75:0750021. DOI: 10.5344/ajev.2024.24031

APPENDIX

LOCAL WINEGROWING TRENDS AND ADAPTATION TO CLIMATE CHANGE

Introduction:

Dr. Amy Quandt, a professor at San Diego State University (SDSU), and Ph.D. students, Corrie Monteverde and Alessandra Zuniga, are conducting a research study to understand local winegrower's perceptions, observations, and response to a changing climate. You are being asked to participate in this survey because of your experience and/or involvement in the production of winegrape crop and wine. You must be at least 18 years old to participate in this survey.

You don't have to participate in this research study. You can say "no". Saying no will not affect your relationship with San Diego State University. The survey will take approximately 15 minutes to complete. The survey itself will be anonymous and will not ask participants to provide any identifiers. The survey will consist of quantitative and open-ended questions and will allow the participant to decline to answer any question if desired. This study involves minimal potential risks including emotional stress and invasion of privacy. To manage potential risks, surveys will remain anonymous. They will be analyzed in a secure data management system and only authorized research personnel will have access to the data management account with the survey results.

The benefits of this study include providing insight into local winegrowers' observations of climate trends, the impacts of those trends on their crop, how winegrowers manage their vineyards, and whether winegrowers are equipped with the necessary knowledge and resources to adapt to changes in climate. This study will not only benefit the local winegrowing community by providing information relevant to their industry, but also local government officials who wish to gain a better understanding of the current status and needs of an agricultural sector which brings millions of dollars to the local economies. In addition, this study will provide unique insights into climate trends and management practices that other winegrowing regions, with a similar climate to the Southern California region, could benefit from.

We ask that you try to answer all questions. However, you may refuse to answer any questions or stop being in the research altogether. Your answers will be submitted anonymously and will not collect any identifiable information.

If you have felt harmed by the research, or if you have any concerns about the research, or questions about your rights as a participant in this study, please contact the primary investigator, Dr. Amy Quandt at aquandt@sdsu.edu or the Human Research Protections Program at San Diego State University at 619-594-6622 or at irb@sdsu.edu.

If you would prefer not to participate, please do not fill out a survey.

If you consent to participate, please complete the survey.

Would you like to continue with the survey?

- ○ Yes
- ○ No

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APPENDIX *(continued)*

Section 1 (Demographic):

Q1. What is your age? _____

Q2. What is your gender?

- ○ Male
- ○ Female
- ○ Non-binary
- ○ Other: _____
- ○ Prefer not to answer

Q3. What is your race/ethnicity? (select all that apply)

- ☐ White
- ☐ Latino/Hispanic
- ☐ Black/African American
- ☐ Asian/Asian American
- ☐ American Indian/Alaskan Native
- ☐ Native Hawaiian/Pacific Islander
- ☐ Other: _____
- ☐ Prefer not to answer

Q4. What is the highest level of education you have completed? (choose one)

- ☐ K-8
- ☐ High school diploma
- ☐ Associate's degree
- ☐ Bachelor's degree
- ☐ Master's degree
- ☐ Ph.D. degree
- ☐ Professional degree
- ☐ Skilled trade certified
- ☐ Other: _____
- ☐ Prefer not to answer

Q5. What city do you **live** in? _____

Q6. What is your current employment status? (choose one)

- ○ Full-time
- ○ Part-time
- ○ Self-employed
- ○ Intern/volunteer
- ○ Retired
- ○ Other: _____
- ○ Prefer not to answer

APPENDIX *(continued)*

Q7. What is your current position/job title on the vineyard? (select any that apply)

- ☐ Owner/proprietor
- ☐ Vineyard manager
- ☐ Viticulturist
- ☐ Winemaker
- ☐ Cellar master
- ☐ Sales representative
- ☐ Administration
- ☐ Sommelier
- ☐ Tasting room/tour guide
- ☐ Events coordinator
- ☐ Other: _____

Q8. How many years of experience do you have in your current position?
_____

Section 2 (Vineyard Description):

Q9. What year was the vineyard established?_____

Q10. Are you located within an established American Viticultural Area (AVA)?

- ○ Yes
- ○ No
- ○ Don't know/prefer not to answer

Q11. If yes, which AVA?_____

Q12. How large is your vineyard (in acres)?_____

Q13. What are the top 3 winegrape varieties currently grown on your vineyard?
Varietal 1 _____
Varietal 2 _____
Varietal 3 _____

Q14. Enter approximate acreage for each of your top 3 winegrape varieties.
Varietal 1 acreage (enter number)_____
Varietal 2 acreage (enter number)_____
Varietal 3 acreage (enter number)_____

Q15. If you know the approximate heat unit requirements for your top three varietals, please indicate the optimum value for each (in F°).
Varietal 1 heat units (enter number)_____
Varietal 2 heat units (enter number)_____
Varietal 3 heat units (enter number)_____

APPENDIX *(continued)*

Q16. In addition to winegrape production, what other streams of revenue does your vineyard provide? (select all that apply)

- ☐ Tastings
- ☐ Dining
- ☐ Corporate events
- ☐ Weddings
- ☐ Production of other crops
- ☐ Agri-tourism
- ☐ Other: _____
- ☐ Don't know/prefer not to answer

Section 3 (Climate Trends):

Q17. Have you noticed a change in precipitation patterns in the past 10 years? (select all that apply)

- ☐ Increase in number of rain events
- ☐ Decrease in number of rain events
- ☐ More variability in rainfall
- ☐ Increase intensity of rain events
- ☐ Decrease intensity of rain events
- ☐ No changes observed
- ☐ Other: _____
- ☐ Don't know

Q18. Have you noticed a change in drought events in the past 10 years? (select all that apply)

- ☐ More frequent
- ☐ Less frequent
- ☐ More intense
- ☐ Less intense
- ☐ Prolonged events
- ☐ Shorter events
- ☐ No changes observed
- ☐ Other: _____
- ☐ Don't know

Q19. Have you noticed a change in average growing season temperatures in the past 10 years? (select all that apply)

- ☐ Generally warmer
- ☐ Generally cooler
- ☐ More variable
- ☐ No changes observed
- ☐ Other: _____
- ☐ Don't know

Q20. Have you noticed a change in extreme heat events in the past 10 years? (select all that apply)

- ☐ More frequent
- ☐ Less frequent
- ☐ More intense
- ☐ Less intense
- ☐ Prolonged events
- ☐ Shorter events
- ☐ No changes observed
- ☐ Other:_____
- ☐ Don't know

APPENDIX *(continued)*

Q21. Have you noticed a change in frost days in the past 10 years? (select all that apply)

- ☐ More frequent
- ☐ Less frequent
- ☐ More intense
- ☐ Less intense
- ☐ More consecutive frost days
- ☐ Fewer consecutive frost days
- ☐ Date of last frost is later
- ☐ Date of last frost is earlier
- ☐ No changes observed
- ☐ Other: _____
- ☐ Don't know

Q22. In the past 10 years have you noticed a change in the number of growing degree days (GDD) in your region? (select all that apply)

- ☐ Increase in number of growing degree days
- ☐ Decrease in number of growing degree days
- ☐ Date of optimum accumulated heat units is reached earlier
- ☐ Date of optimum accumulated heat units is reached later
- ☐ Variable
- ☐ No change
- ☐ Other: _____
- ☐ Don't know/ prefer not to say

Section 4 (Climate Impacts):

Q23. Have you noticed any shifts in date of first bud burst in the past 10 years? (choose one)

- ○ Earlier
- ○ Later
- ○ Variable
- ○ No change
- ○ Other: _____
- ○ Don't know/ prefer not to answer

Q24. If you have noticed a shift in date of first bud burst, what would you attribute to causing the shift?

_____

Q25. Have you noticed any shifts in your harvest dates in the past 10 years? (choose one)

- ○ Earlier
- ○ Later
- ○ Variable
- ○ No change
- ○ Other: _____
- ○ Don't know/ prefer not to answer

Q26. If you have noticed a shift in your harvest dates, what would you attribute to causing the shift?

_____

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APPENDIX *(continued)*

Q27. Have you noticed any changes in the alcohol levels of your wine in the past 10 years? (choose one)

- ○ Higher
- ○ Lower
- ○ Variable
- ○ No change
- ○ Other: _____
- ○ Don't know/ prefer not to answer

Q28. If you have noticed a change in alcohol levels, what would you attribute to causing this change?

_____

Q29. Have you noticed any changes in the acidity levels of your wine in the past 10 years? (choose one)

- ○ Higher
- ○ Lower
- ○ Variable
- ○ No change
- ○ Other: _____
- ○ Don't know/ prefer not to answer

Q30. If you have noticed a change in acidity levels, what would you attribute to causing the change?

_____

Q31. Have you noticed any changes in pest/disease occurrence on your vineyard in the past 10 years? (select all that apply)

- ☐ More frequent
- ☐ Less frequent
- ☐ More variable
- ☐ New pest/disease observed
- ☐ No pest/disease observed
- ☐ Other: _____
- ☐ Don't know/ prefer not to answer

Q32. If you have noticed an **increase** in pest/disease occurrence, which of the following have you observed? (select all that apply)

- ☐ Pierce's disease
- ☐ Phylloxera
- ☐ Moths
- ☐ Leafhoppers
- ☐ Parasitic nematodes (i.e., roundworm)
- ☐ Eutypa
- ☐ Powdery mildew
- ☐ Downy mildew
- ☐ Black rot
- ☐ Botrytis
- ☐ Other: _____
- ☐ Don't know/ prefer not to answer

APPENDIX *(continued)*

Q33. If you have noticed **new** pests/disease, which of the following have you observed? (select all that apply)

- ☐ Pierce's disease
- ☐ Phylloxera
- ☐ Moths
- ☐ Leafhoppers
- ☐ Parasitic nematodes (i.e., roundworm)
- ☐ Eutypa
- ☐ Powdery mildew
- ☐ Downy mildew
- ☐ Black rot
- ☐ Botrytis
- ☐ Other: _____
- ☐ Don't know/ prefer not to answer

Q34. If you have noticed a change in pest/disease occurrence, what would you attribute to causing the change?

_____

Section 5 (Vineyard Management):

Q35. Do you monitor the micro-climate of your vineyard?

- ○ Yes
- ○ No
- ○ Don't know/prefer not to say

Q36. If so, what type of data do you collect? (select all that apply)

- ☐ Temperature
- ☐ Relative humidity
- ☐ Precipitation
- ☐ Wind speed
- ☐ Solar radiation
- ☐ Soil moisture
- ☐ Other:_____
- ☐ Don't know/prefer not to answer

Q37. Do you use the micro-climate information you collect to determine management choices?

- ○ Yes
- ○ No
- ○ Don't know/prefer not to say

Q38. What type of measurement and/or observations do you make on your grapevines? (select all that apply)

- ☐ Health indicators (i.e., chlorophyll content, leaf health, etc.)
- ☐ Stress indicators (i.e., stem water potential, canopy temperature, greenness, etc.)
- ☐ Growth indicators (i.e., leaf area index, trunk growth, canopy size, etc.)
- ☐ Water use indicators (i.e., stomatal conductance, transpiration, water use efficiency, etc.)
- ☐ Other: _____
- ☐ I do not collect any information
- ☐ Don't know/prefer not to answer

APPENDIX *(continued)*

Q39. Do you use these information to make management choices on your vineyard?

- ○ Yes
- ○ No
- ○ Don't know/prefer not to answer

Q40. Amount of seasonal rainfall affects my irrigation management decisions.

- ○ Strongly disagree
- ○ Disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree
- ○ Don't know/prefer not to answer

Q41. How important are the following factors when deciding to alter or implement a new vineyard management practice?
Not at all important (1)
Slightly important (2)
Moderately important (3)
Very important (4)
Extremely important (5)

	1	2	3	4	5
Risk to fruit yield	○	○	○	○	○
Risk to fruit/wine quality	○	○	○	○	○
Cost of inputs	○	○	○	○	○
Labor	○	○	○	○	○
Sustainability	○	○	○	○	○
Climate change predictions	○	○	○	○	○
Impact to local environment	○	○	○	○	○
Vineyard aesthetic	○	○	○	○	○
Available irrigation water	○	○	○	○	○
Access to new technology	○	○	○	○	○
Sufficient scientific evidence for effectiveness of management practice	○	○	○	○	○
Consensus in wine sector for effectiveness of management practice	○	○	○	○	○

Q42. Have you recently implemented any climate adaptive strategies on your vineyard in the last 5 years?

- ○ Yes
- ○ No
- ○ Don't know/prefer not to answer

APPENDIX *(continued)*

Q43. If so, what type of adaptive strategies have you implemented? (select all that apply)

- ☐ Changes to canopy management (e.g., shoot thinning, training systems)
- ☐ Selection of climate appropriate varieties (e.g., drought/heat tolerant, late ripening varieties)
- ☐ Implement shading for temperature control
- ☐ Improving irrigation efficiency (e.g., regulated deficit irrigation, partial root drying)
- ☐ Changes to soil management for moisture retention (e.g., cover crop, organic amendments)
- ☐ Changes in vineyard design (e.g., row orientation, vine spacing)
- ☐ Micro-climate monitoring
- ☐ Other: _____

Q44. In the past 5 years have you planted any drought and/or heat tolerant grape varieties?

- ○ Yes
- ○ No
- ○ Don't know/prefer not to say

Q45. If yes, what new varieties?

_____
_____
_____
_____
_____

Section 6 (Climate Perceptions):

Q46. Which stressor poses the greatest threat to grape yield? (choose one)

- ○ Heat stress
- ○ Water stress
- ○ Salinization
- ○ Frost damage
- ○ Pest damage
- ○ Smoke taint
- ○ Other: _____
- ○ Don't know/ prefer not to answer

Q47. Which stressor poses the greatest threat to wine quality? (choose one)

- ○ Heat stress
- ○ Water stress
- ○ Salinization
- ○ Frost damage
- ○ Pest damage
- ○ Smoke taint
- ○ Other: _____
- ○ Don't know/ prefer not to answer

APPENDIX *(continued)*

Q48. Which stressor poses the greatest financial impact to your vineyard? (choose one)

- ○ Heat stress
- ○ Water stress
- ○ Salinization
- ○ Frost damage
- ○ Pest damage
- ○ Smoke taint
- ○ Other: _____
- ○ Don't know/ prefer not to answer

Q49. For each stage of grapevine development choose the one stressor that poses the greatest risk to production.

	Heat stress	Drought stress	Salt stress	Frost damage	Pest damage	Don't know
Bud break	○	○	○	○	○	○
Shoot & leaf development	○	○	○	○	○	○
Flowering	○	○	○	○	○	○
Fruit set	○	○	○	○	○	○
Veraison	○	○	○	○	○	○
Dormancy	○	○	○	○	○	○

Q50. Of your top 3 varietals, which is most threatened by a changing climate?
_____

Q51. I am concerned about access to irrigation water in the next 10 years.

- ○ Strongly disagree
- ○ Disagree
- ○ Neither agree nor disagree
- ○ Agree
- ○ Strongly agree
- ○ Don't know/prefer not to answer

Q52. Overall, have the effects of climate change on your vineyard been positive or negative?

- ○ Extremely negative
- ○ Somewhat negative
- ○ Neither positive nor negative
- ○ Somewhat positive
- ○ Extremely positive
- ○ No impact observed
- ○ Prefer not to answer

APPENDIX *(continued)*

Q53. Climate change is a threat to southern California's winegrape crop production.

- ○ Strongly disagree
- ○ Disagree
- ○ Neither agree nor disagree
- ○ Agree
- ○ Strongly agree
- ○ Don't know/prefer not to answer

Q54. I am concerned about the anticipated impacts of climate change on my vineyard.

- ○ Strongly disagree
- ○ Disagree
- ○ Neither agree nor disagree
- ○ Agree
- ○ Strongly agree
- ○ Don't know/prefer not to answer

Q55. I am prepared to overcome any climate change related challenges on my vineyard.

- ○ Strongly disagree
- ○ Disagree
- ○ Neither agree nor disagree
- ○ Agree
- ○ Strongly agree
- ○ Don't know/prefer not to answer

Section 7 (Knowledge & Resource Accessibility):

Q56. Do you feel you have sufficient understanding about the impacts of climate change on viticulture and wine production?

- ○ Yes
- ○ No
- ○ Don't know/ prefer not to answer

Q57. Do you feel you are well-equipped with the necessary resources/tools to overcome the challenges predicted by climate change?

- ○ Yes
- ○ No
- ○ Don't know/ prefer not to answer

Q58. Do you have access to reliable sources to inform yourself on the impacts of climate change on viticulture?

- ○ Yes
- ○ No
- ○ Don't know/ prefer not to answer

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APPENDIX *(continued)*

Q59. Do you consult with any external source(s) regarding your vineyard management choices?

- ○ Yes
- ○ No
- ○ Don't know/ prefer not to answer

Q60. What other places do you seek information and support regarding management choices on your vineyard? (select all that apply)

- ☐ Private consulting firms
- ☐ Government consulting firms
- ☐ Vineyard management companies
- ☐ Academic/research institutions
- ☐ Online sources
- ☐ Literature subscriptions
- ☐ Clubs/associations
- ☐ Neighboring vineyards
- ☐ Other: _____
- ☐ Don't know/ prefer not to answer

Q61. Local county governments are providing the necessary tools, funds, and support for vineyards in combating and preparing for changes in climate and extreme weather events (like drought, heatwaves, floods, etc.)

- ○ Strongly agree
- ○ Agree
- ○ Neither agree nor disagree
- ○ Disagree
- ○ Strongly disagree

Q62. Do you feel you have adequate support to adapt your vineyard and practices to climate change?

- ○ Yes
- ○ No
- ○ Don't know/ prefer not to answer

Q63. If no, what support do vintners need to make winegrowing more resilient? (select all that apply)

- ☐ Identifying barriers to adoption of practices that facilitate adaptation
- ☐ Extension support from local academic institutions
- ☐ Capacity development to lower barriers to adoption
- ☐ Cross-sectoral policy dialogue to better align the objectives of agricultural development and climate policies
- ☐ Preparing investment proposals to access climate funds that are well-integrated in development strategies
- ☐ Agricultural subsidies
- ☐ Other: _____
- ☐ Don't know/ prefer not to answer

Q64. Please provide any other comments/feedback regarding the topics asked within this questionnaire.

_____

We thank you for your time spent taking this survey!