



Reply to van Leeuwen et al.: Planning for agricultural adaptation to climate change and its consequences for conservation

Viticulture will not cease in major wine-growing regions in response to climate change, because vineyard managers will not let that happen. Adaptation measures will be taken to permit continued cultivation of wine grapes. These adaptation measures can place major stress on water resources and freshwater ecosystems (1).

Our models were designed to identify regions in which these adaptation issues might be significant and not to determine the feasibility of wine grape production in the future. The temperature groupings used were appropriate because premium wine-growing regions are most likely to pursue adaptation to maintain quality. Growing degree day (GDD) calculations appear in the literature both capped and uncapped. Uncapped is considered most appropriate for climate change analyses (2). We do not attempt to distinguish among varieties but rather use the entire range of 1,050–1,400 for GDD accumulation and 13–21 °C for average growing season temperature (AvGST) (1).

Several regional studies (3, 4) reached conclusions similar to ours regarding declining suitability in current wine-growing regions, so the global results are likely robust. However, as in any global study, globally applicable methods cannot be fine-tuned to every region. Some regional studies that address GDD variants and ecophysiology (2) are already available, but more peer-reviewed analyses such as these would greatly strengthen our understanding of climate change effects

on the wine industry and possible conservation consequences.

We note with interest that vineyards are already adapting to higher temperatures in the areas described by van Leeuwen et al. (5). The process of viticulture adapting to climate change has begun. How it proceeds in the coming decades will do much to determine the impact of the industry on nature. Early adaptation may be retaining dry farming techniques, but planning and research are needed now to ensure that environmentally friendly adaptation can keep pace with rising temperatures.

Ecosystem services, wildlife, and water resources need to be considered when planning agricultural responses to climate change. The wine industry provides one good example of agricultural adaptation impacting ecosystems, including expansion into important wildlife habitats and possible water use for cooling and irrigation. Let's hope that planning by individuals, industry, and government help ensure that wildlife, freshwater ecosystems, and wine production coexist in the future.

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5 van Leeuwen et al. (2013) Why climate change will not dramatically decrease viticultural suitability in main wine-producing areas by 2050. *Proc Natl Acad Sci USA* 110:E3051–E3052.

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The authors declare no conflict of interest.

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