



Shifts in High Quality Wine Producing Regions in the Western United States Associated with late 21st Century Climate Change

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Climate change in the western United States has altered and is likely to further alter the states and fluxes of water, carbon, and nutrients with consequent impacts for biological and physical systems. In contrast to natural or quasi-natural systems, in which many ecosystem constituents are geographically fixed and have limited ability to rapidly adapt to changing climates, agricultural systems are highly adaptable, with primary restrictions from land ownership and competing land use practices. Here we explore the impacts of climate change on winegrape production in the coastal western United States (Washington, Oregon, and California). We first review prior literature and demonstrate that long-term climate cycles, such as the Pacific Decadal Oscillation (PDO), especially through interaction with the El Niño-Southern Oscillation (ENSO), have the potential to significantly affect winegrape production. In the late 20th century, the warm phase of the PDO generally favored high-quality winegrape production while poor vintages were associated with earlier occurrences of cool PDO coupled with neutral ENSO. Mid- to late-20th century secular climate change in the western United States has tended to improve the thermal regime for most wine-producing regions but if current trends continue, many of the current premium wine-producing areas, including the Napa and Sonoma Valleys, may become too warm by the late 21st century. We calculated a new multivariate index describing climate suitability for wine production and, through use of a high-resolution regional climate model, showed that by the late 21st century the counties most suitable for winegrape production will shift from northern and central coastal California to the coastal Pacific Northwest. Unfortunately, while the suggestion of a geographical shift may seem to imply merely a relocation of the winegrape industry, we also show that the counties likely to support a favorable thermal regime in the future climate will also experience a nearly two-fold precipitation increase during the critical completion of the growing season and initiation of the ripening season--a factor likely to increase problems with diseases and pests.