# Future Climate Change will Reduce Growth of the California Endemic Valley Oak (*Quercus lobata*)


*Luke Browne[1], Jessica W. Wright[2], Sorel Fitz-Gibbon[3], Paul Gugger[4], Victoria L. Sork[1]*

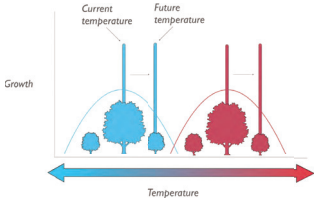
[1] Institute of the Environment & Sustainability, Dept. of Ecology & Evolutionary Biology, UCLA
[2] Pacific Southwest Research Station, USDA-Forest Service
[3] Intitute of Genomics and Proteomics, UCLA
[4] University of Maryland Center for Environmental Science


## Background

- Valley oak (*Quercus loboata*) is an white oak endemic to California threatened by habitat loss and climate change

- Plants are often assumed to be locally adapted to their current climate,

- Climate change, which will alter temperature and preciptation patterns, may lead to maladptation for plant populations

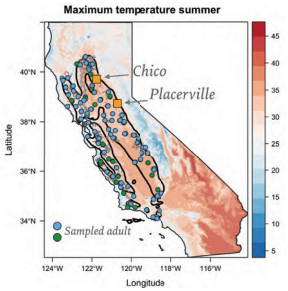



The goals of this study were:
(1) to predict how rising temperatures will affect valley oak growth rates
(2) to use genomic data to identify genotypes that may be resilient to increasing temperatures

## Methods

**Valley oak provenance trial**: ~7,000 individuals from 659 families

- Planted as seedlings into common gardens at Chico and Placerville, CA & managed by USDA Forest Service





Placerville common garden


Measuring stem height

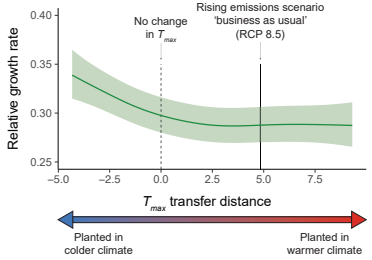
- Measured height of tallest stem annually from 2014-2017

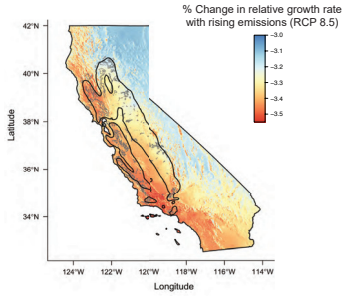
- Modeled relative growth rates using generalized additive models based on **temperature transfer distance**: *the difference in temperature between planting site and original collection site*

- Used Genotyping by Sequencing (GBS) to estimate genomic variation at ~12,000 single nucleotide polymorphisms (SNPs)

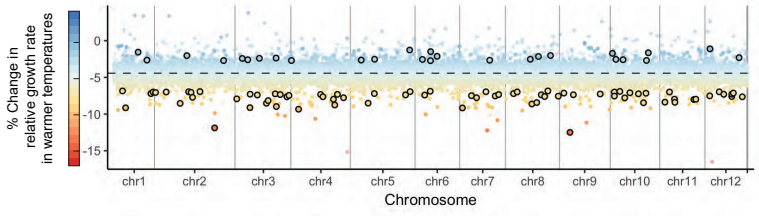
## Results

- Warming temperatures lead to a ~3-4% reduction in growth rates for valley oak
- Valley oak may already be maladapted to temperature

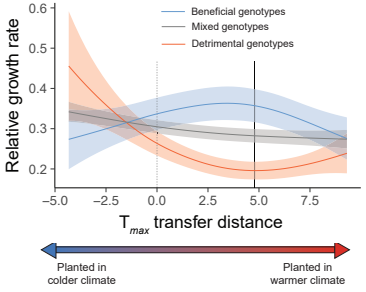


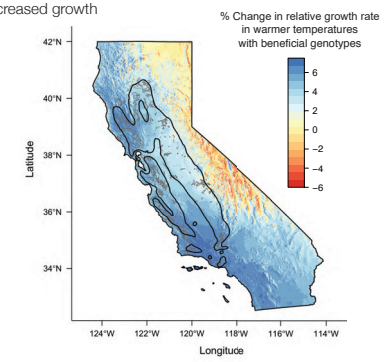



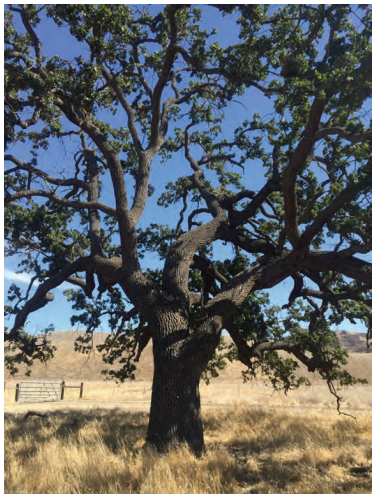

Using SNPs generated by GBS, we identified 25 'beneficial' genotypes and 75 'detrimental' genotypes along valley oak's 12 chromosomes that show either increased or decreased growth rates in warmer temperatures, shown here as circles




Valley oaks with higher numbers of beneficial genotypes showed higher growth rates in warmer temperatures and those with high numbers of detrimental genotypes showed decreased growth





Valley oak - *Quercus lobata*

## Discussion / Outlook

- Valley oak may already be maladapted to current temperatures

- Optimal growth occurs at temperatures cooler than what populations are currently experiencing

- Local provenances may not be the best seed source for restoration efforts

- Negative effects of increasing temperatures could be offset by selecting resilient genotypes for restoration, further work necessary to identify causal genes

- Without action, reduction in valley oak growth rates could have cascading effects on ecological communities and ecosystem function

## Acknowledgements


- We acknowledge and thank the Native peoples of California for their stewardship of the land & oak habitat
- For contributing to the establishment of the Valley oak provenance trial, we thank Annie Mix, former USDA Forest Service technician, for overseeing germination, provenance design at Placerville. Krista Beckley for logistical help, and numerous people who collected acorns and censused gardens each year. For advice on statistical models, we thank Jamie Lloyd-Smith, Graziella DiRenzo, Jesse Lasky, and Steve Keller
- We acknowledge the National Science Foundation Award (NSF Award, PGRP IOS-1444611), USDA Forest Service, and UCLA Seed funding