Photo Credit: Dr. Jacobsen

Photo Credit: Dr. Perez de Lis

Oak trees and their response to drought and climate events

SURE students: Jessica Espinoza & Dorothy Tran

Mentor: Dr. Perez de Lis

"Team Dendro"

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SURE Program 2021

Acknowledgements

- All 2021 SURE participants from the Jacobsen and Pratt labs: Natalie Hernandez, Wyatt Beller, Karely Rodriguez, Ms. Jordan Holmes, Antonio Mateiro, Angel Davila, and Mr. Jacob Spriester

- Mitchell Coleman and the Tejon Ranch Conservancy

- Andrea Medina, SURE program coordinator

- Funding

  - Chevron Corporation

  - Department of Education, Title Vb

  - Fulbright + Xunta de Galicia

Photo Credit: Dr. Brandon Pratt

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Introduction

Trees grow in size by producing a new layer of vascular tissue called xylem.

A layer of xylem is produced annually for each growth period.

The multiple xylem layers within a tree trunk are called growth rings

Tree growth is influenced by environmental factors such as resources, competition, and water availability.

Photo Credits: Google Images

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Introduction

- Growth rings tell us about age, catastrophic events and is used to date archaeological sites.

- Wide & broad rings = high rainfall, good conditions

- Narrow & scarce rings = drought, high stress, high competition
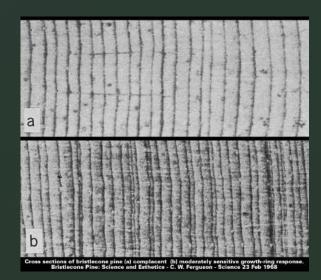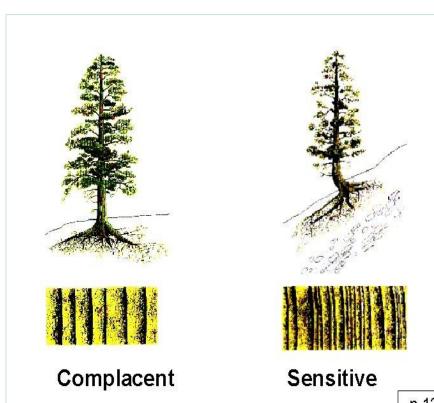

a

b

Cross sections of bristlecone pine (a) complacent (b) moderately sensitive growth-ring response.
Bristlecone Pine: Science and Esthetics - C. W. Ferguson - Science 23 Feb 1968

Photo Credit: Google images

Complacent   Sensitive

p 128

Complacent Rings:
Evenly spaced and little to no variation

Sensitive Rings:
High variability in annual growth, responds strongly to conditions

Photo Credit: Google Images

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Introduction
Topic: Drought Sensitivity of Valley Oak

- **Question:** How will Valley oak trees in differing elevations of Tejon Ranch react to extreme drought events?

- **Hypothesis:** Differences in drought sensitivity will vary across trees in differing elevations.

- **Prediction:**

  - Low elevation trees will have high drought sensitivity in extreme events

Tunis Ridge – High elevation

Chanac Creek – Low elevation

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Introduction
Topic: Oak Species Sensitivity

Photo Credit: Dr. Perez de Lis
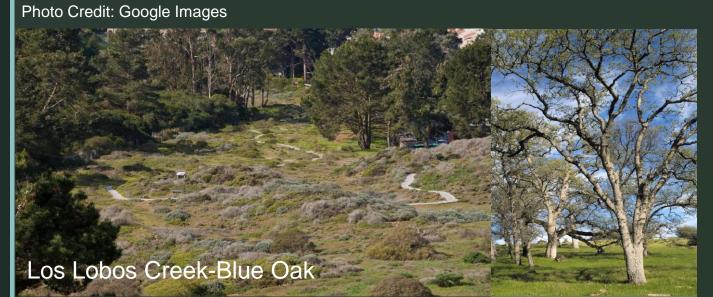

Photo Credit: Google Images

- **Question:** Is there a difference between species, Valley oak compared to Blue oak, for sensitivity when exposed to climate variability?

- **Hypothesis:** Varying climate will expose the different sensitivity levels between two oak tree species.

- **Predictions:**

  - Blue oak will be more sensitive than Valley oak.

  - Both species will be similar at high elevations, and differ at low elevations.

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Methods

Photo Credit: Dr. Perez de Lis

Tunis Ridge (Tejon Ranch)-Valley Oak

Photo Credit: Dr. Perez de Lis

Chanac Creek (Tejon Ranch)-Valley Oak

Photo Credit: Google Images

Los Lobos Creek-Blue Oak

Sites include:
- Tunis Ridge (elevation ≈ 1,200–1,400 m)
- Chanac Creek (elevation ≈ 400 m)
- Los Lobos Creek (elevation ≈ 620 m)

Species:
Quercus lobata (Valley Oak)
Quercus douglasii (Blue Oak)

Sample size:
- 2 cores per tree*
- 4 trees each for Tunis Ridge and Chanac Creek
- 34 cores total for Los Lobos Creek (ITRB by Stahle *et al.*)
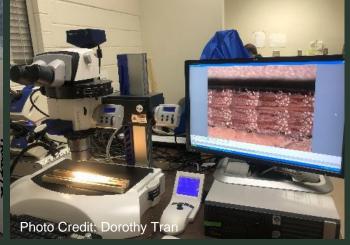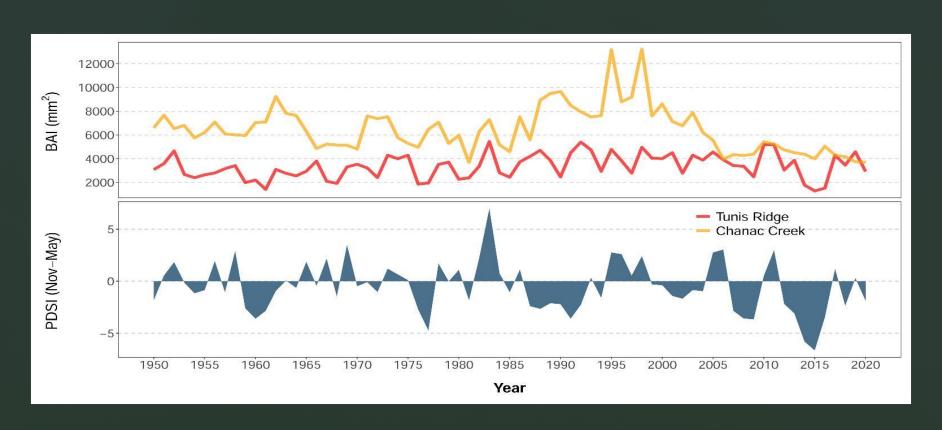
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Photo Credit: Dr. Perez de Lis
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Photo Credit: Dr. Jacobsen
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Photo Credit: Dr. Jacobsen
Photo Credit: Jessica Espinoza
Photo Credit: Dorothy Tran

Methods

- Increment borer
- Sliding microtome
- Power sander
- Dissecting microscope
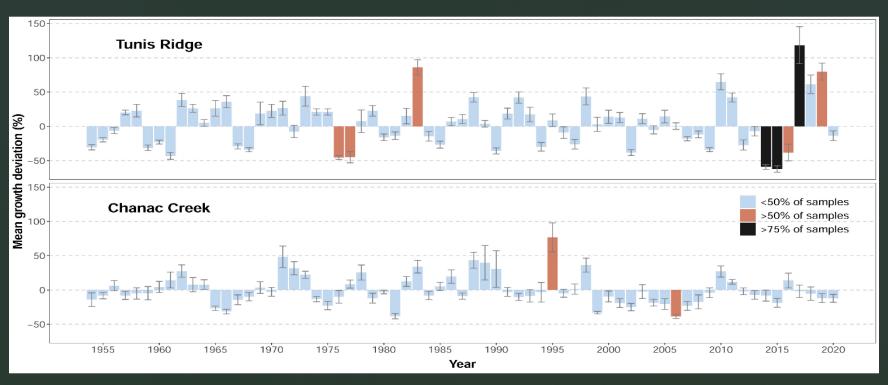
Statistical Analyses
- Detrending using a spline
- Transforming TRW into BAI using diameter
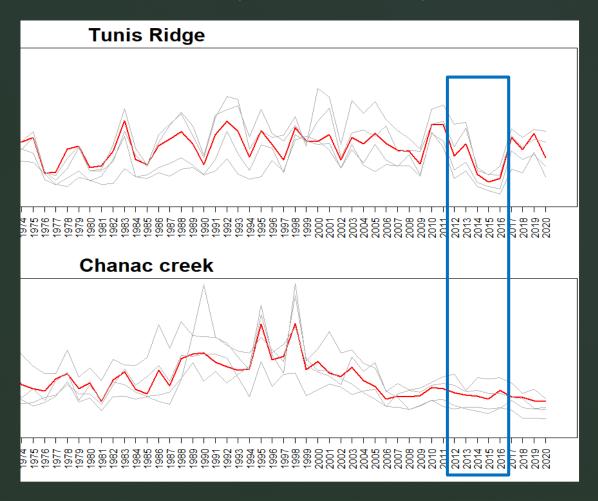- Analysis using R (dplR and pointRes)

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Results
Topic: Drought Sensitivity of Valley Oak

- BAI – Basal Area Increment – measures of tree ring size each year
- PDSI – Palmer Drought Severity Index – estimates relative dry periods
- Chanac Creek – higher growth, but decrease in tree ring growth past decade
- More extreme drought events in past decade

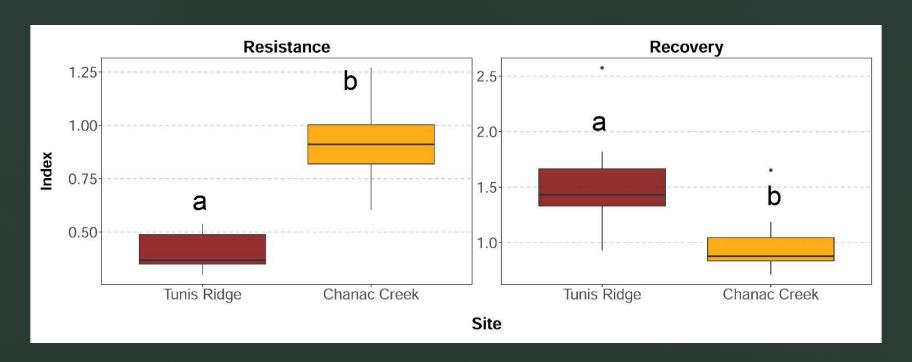# Topic: Drought Sensitivity of Valley Oak

- MGD shows pointer years (i.e., extremely large or small years) using relative growth change, compared to previous 4 years
- Changes in color represent how many samples from each site were affected
- Tunis Ridge has a larger amount of deviation, more sensitive to extreme drought, especially 2012 – 2016 period

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Results
Topic: Drought Sensitivity of Valley Oak

Extreme drought event from 2012 – 2016:

- Tunis Ridge – sharp decline, growth ring width reduced; high stress, low rainfall

- Chanac Creek – little variation in growth rings; not clearly affected by drought
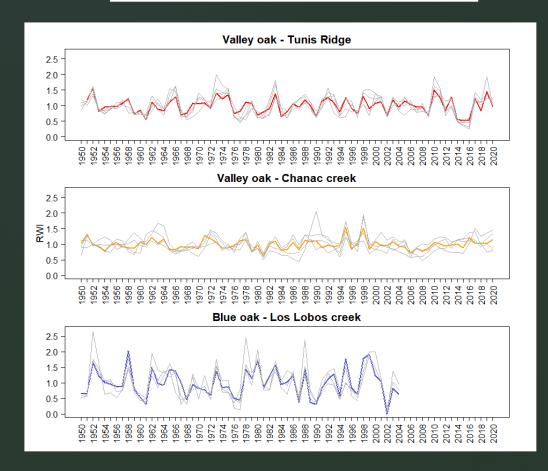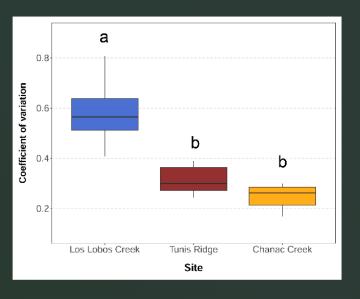
Results
Topic: Drought Sensitivity of Valley Oak

- Tunis Ridge has low resistance – more susceptible to drought, but with high recovery post drought
- Chanac Creek – high resistance to drought, low recovery after drought (but no drought effect to recover from)
- Using one way ANOVA , results were significant $P < 0.05$

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Topic: Species Sensitivity Results

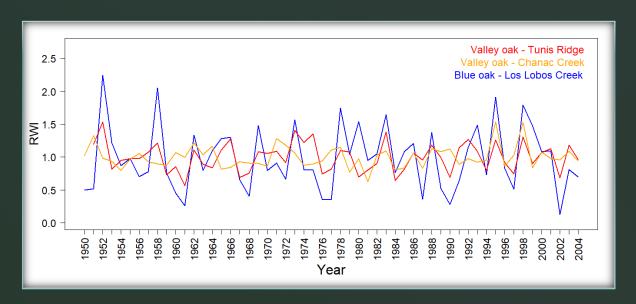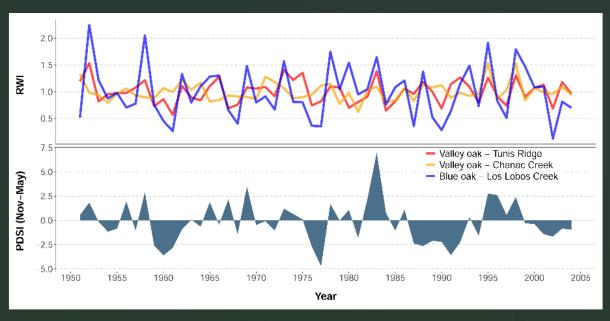| Site	Tunis Ridge	Chanac Creek
Los Lobos Creek	0.63	0.20
Tunis Ridge		0.27

- Correlation table to compare each of the sites

- Mean chronologies for each of the sites with the individual core chronologies included*

- Coefficient of variation

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Topic: Species Sensitivity Results

- Comparison of tree chronologies from the three sites starting from the 1950s until 2004*

- Growth ring width (RWI = Relative Width Increment) for Tunis Ridge and Chanac Creek sites compared to climate (PDSI)

- Correlation table

	Tunis Ridge	Chanac Creek	Los Lobos Creek
PDSI	0.405	0.172	0.621

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Summary and Conclusions
Topic: Drought Sensitivity

- Creek-side trees at low elevation sites were not as heavily impacted by drought events compared to Ridge-line high elevation trees.

  - During drought period, little change in growth

  - Water supply of creek acting as buffer compared to ridge trees

- Hypothesis was supported, our prediction was incorrect.

Summary and Conclusions
Topic: Species Sensitivity

- Los Lobos Creek (Blue oak) mean chronology was similar to Tunis Ridge (Valley oak), but chronologies between the two sites of the same species (Valley oak at Tunis Ridge and Chanac Creek) were not strongly correlated.*

- Tree rings from both Los Lobos Creek and Tunis Ridge were "sensitive" to climate variability, but Chanac Creek was more "complacent."

Final Conclusion

- Chanac Creek may be a climate change refuge for Valley Oak, but increasing drought events might change this in the future

- Future experiments could focus on collecting more core samples and their chronologies from all the sites.

- Potential to developing longer chronologies to reveal past extreme weather events, which could further support climate change

Chanac Creek – low elevation Valley Oak
(red locations mark sampled trees)

Tunis Ridge – high elevation Valley Oak

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