

# Placing Recent Droughts in a Long-Term Context with Tree-Ring Reconstructions of Precipitation

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Water Conditions and Drought  
Preparedness**

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# Overview

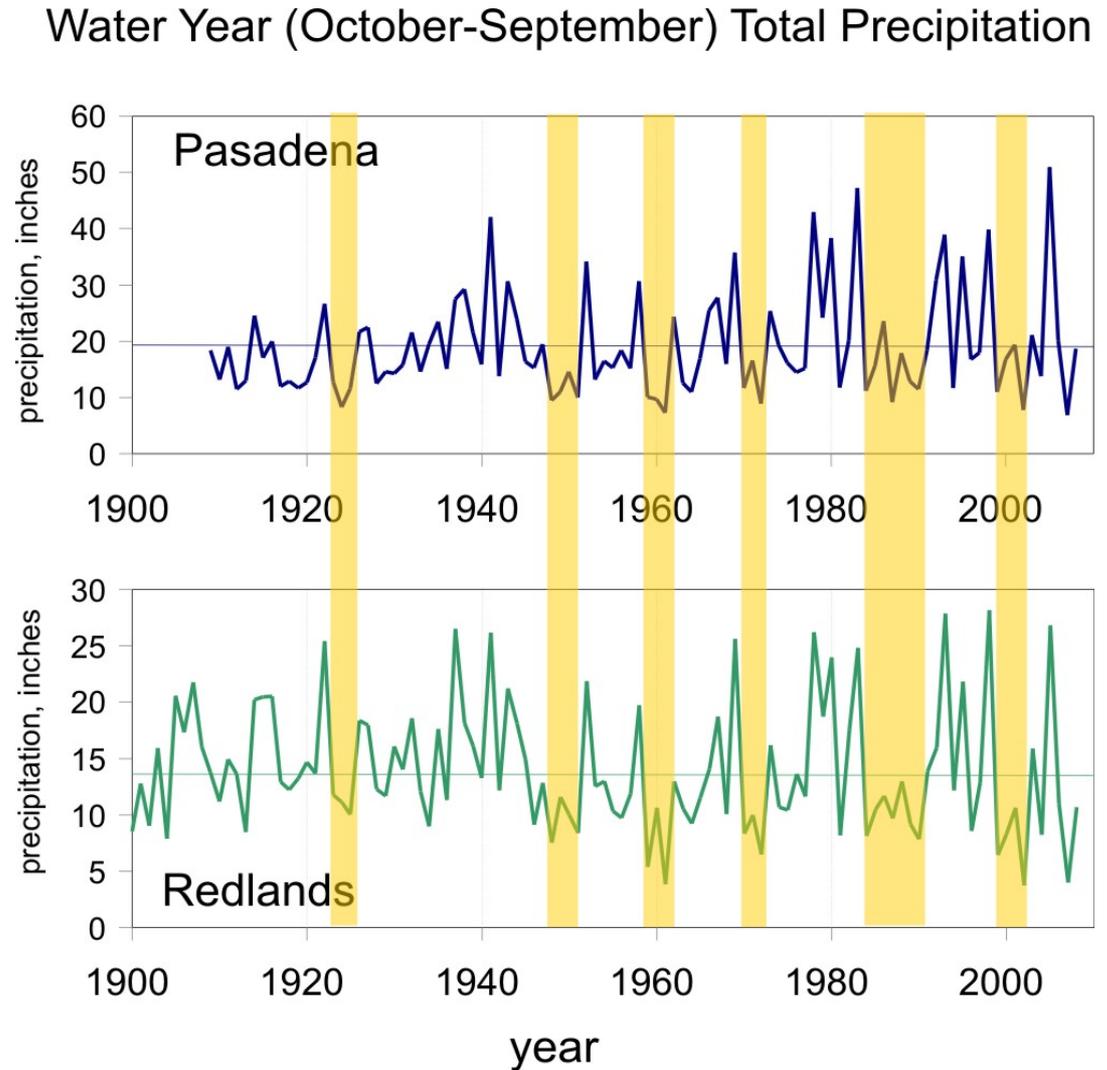
- Why consider the past when planning for the future?
- How do tree rings work?
- What do tree rings tell us about past droughts in southern California?
- How is this type of information is being used in water resource planning?

Why consider the past when planning for the future?

Records from rain gages in Southern California extend back 125 years, at best.

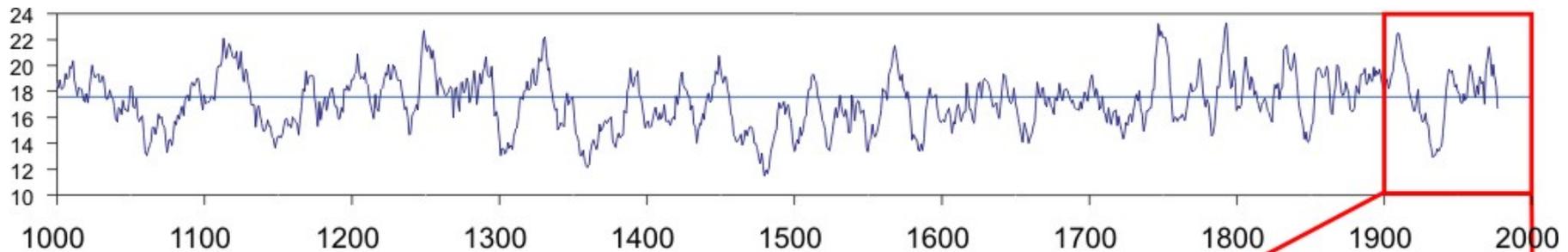
These records document extreme dry years and persistent drought.

How representative are these records and the drought events they contain?

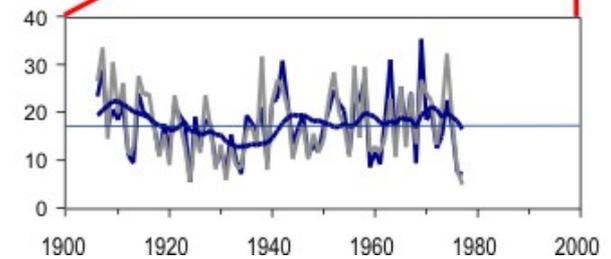


Records of precipitation, drought, and streamflow can be extended back in time using tree-ring data

Reconstructed Sacramento River flow



Extended record provide a long-term context for assessing droughts in the modern climate records



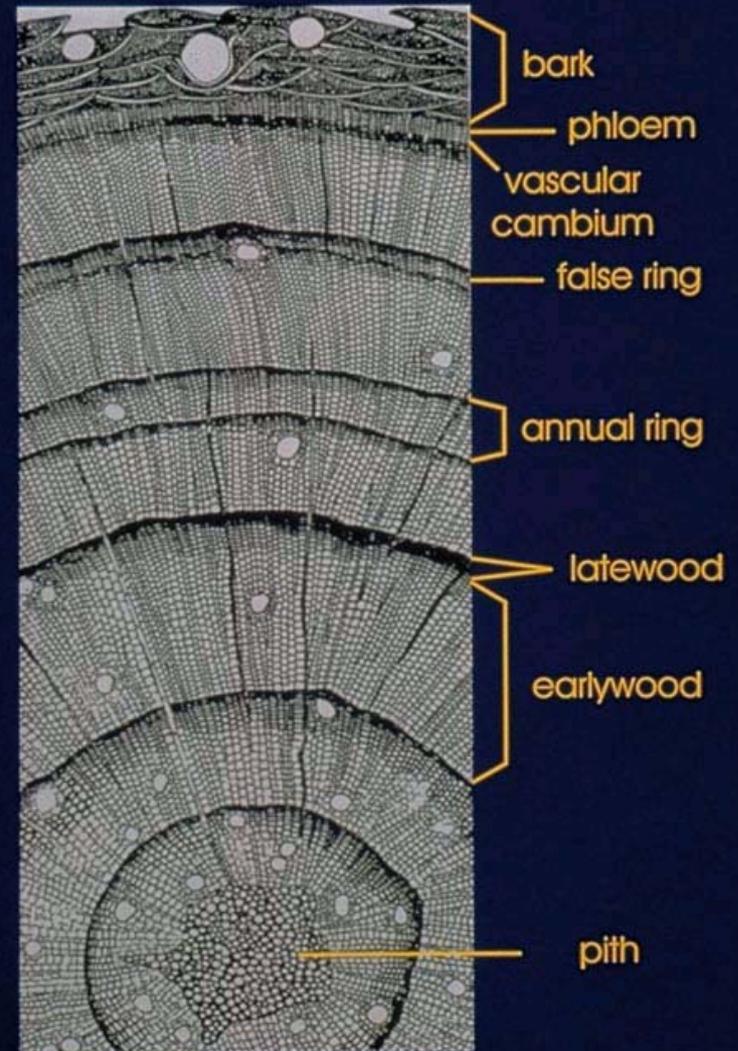
How do tree rings work?

**Variations in annual ring widths reflect the conditions that influence tree growth.**

Climate is often the primary influence on growth.

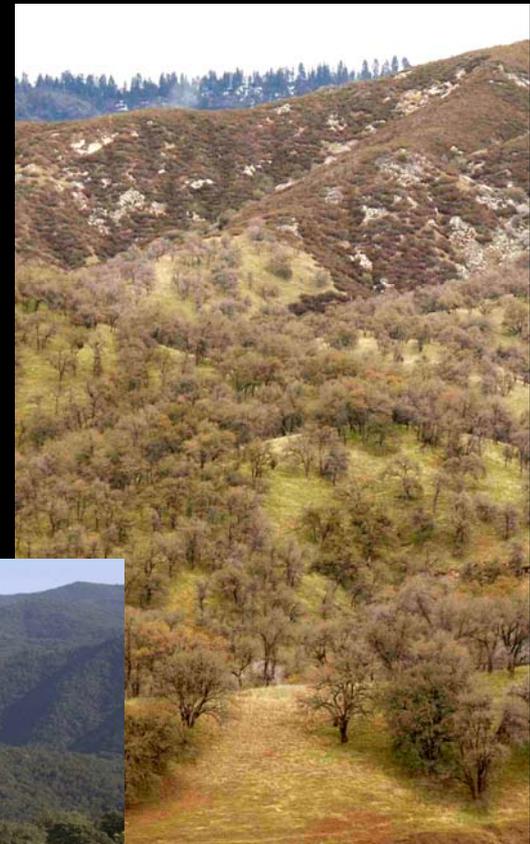
Because of this, ring widths can be used as a proxy for past climate.

## CROSS SECTION of a CONIFER

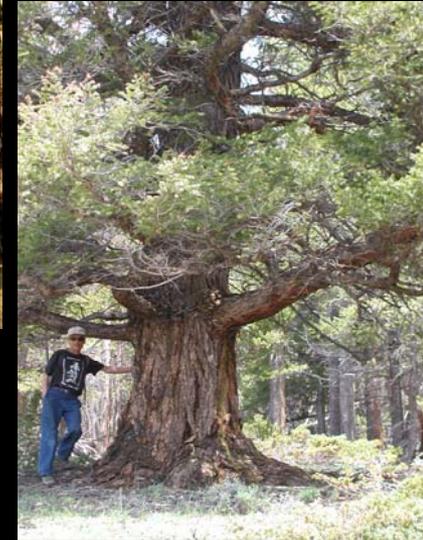


# What trees are the best recorders of precipitation and drought?

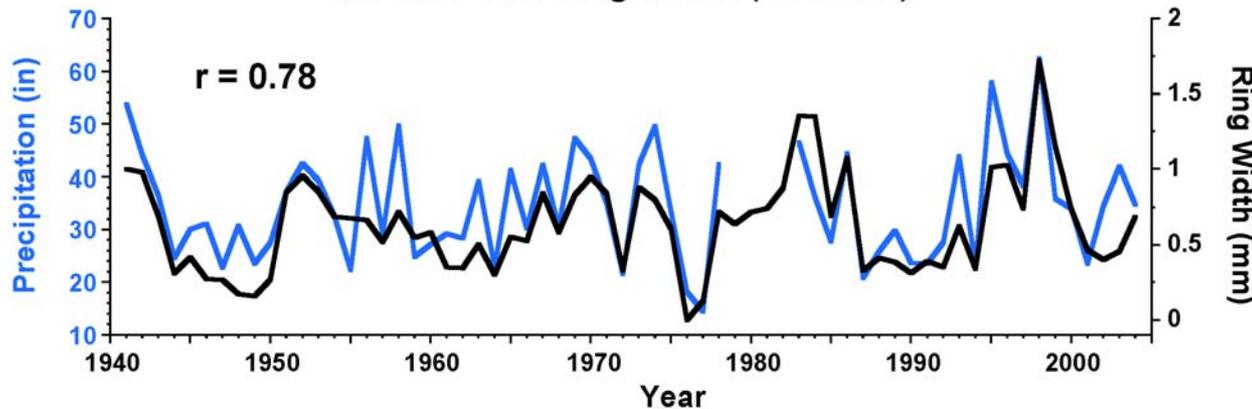
Moisture-sensitive tree species growing on open, well drained sites reflect moisture variability in their ring widths and are targeted for collection.



# Moisture-stressed trees closely track variations in precipitation



Russian River WY Precip  
vs. Blue Oak Ring Width (BVB09A)

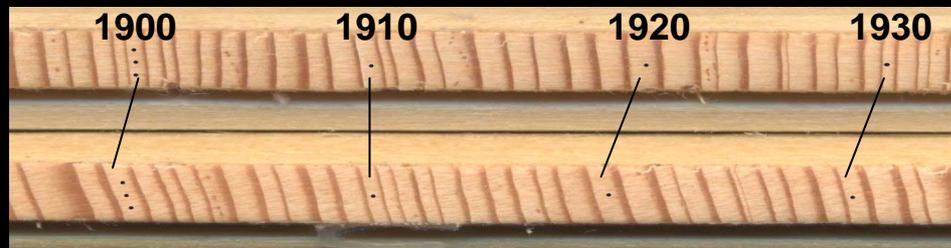


Ring widths from a single tree near Bear Valley are plotted with water year precipitation in the Russian River Valley. ( $r = 0.78$ ).

# Collecting tree ring data and compiling site tree-ring chronologies



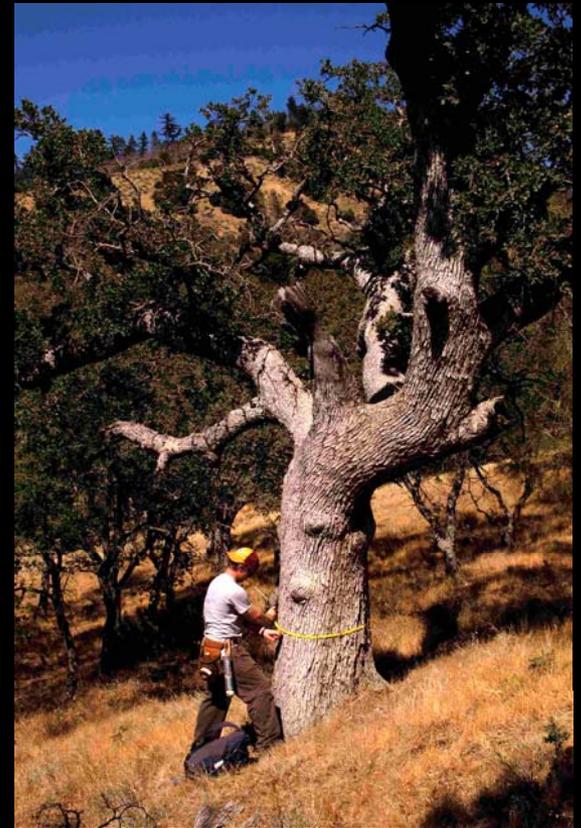
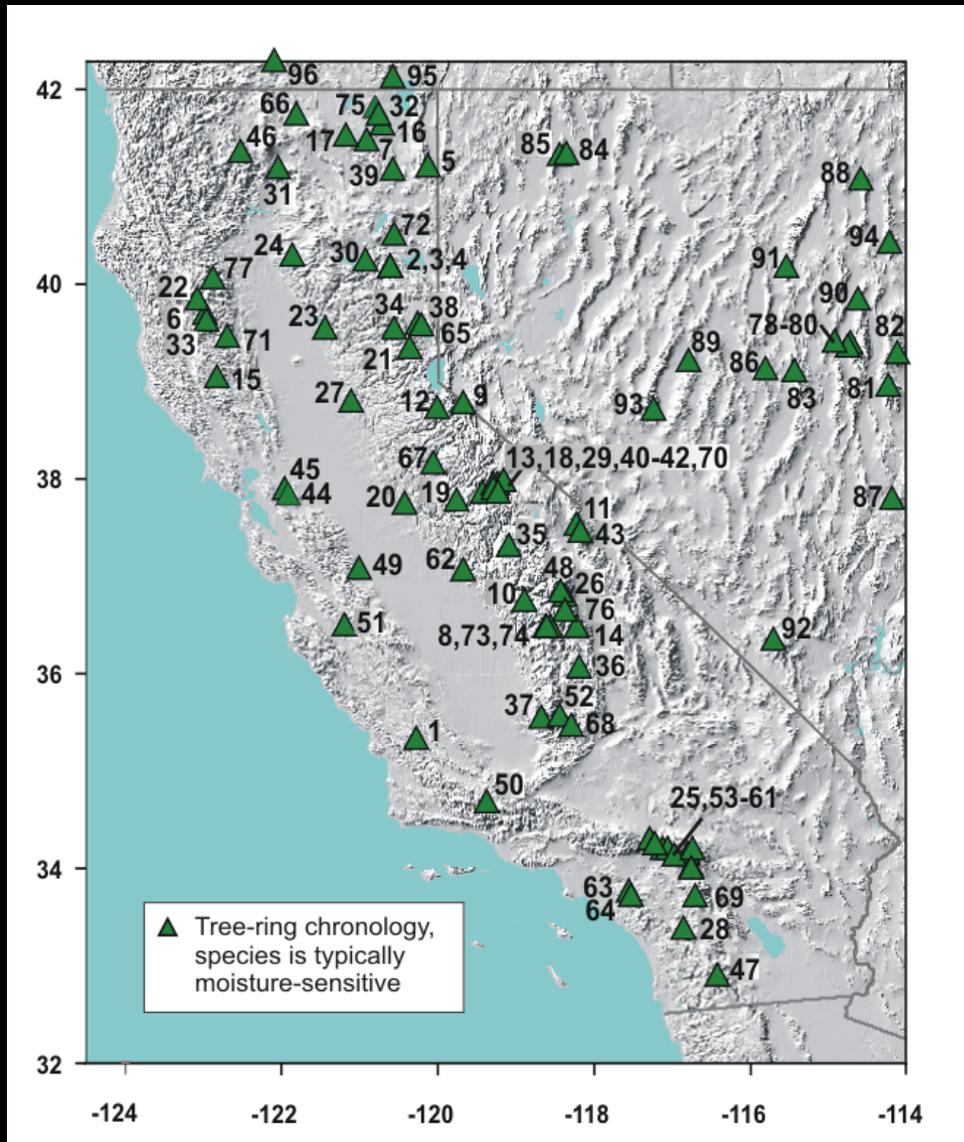
An increment borer is used to sample cores from about 20 trees at a site



Cores mounted and sanded, then dated, measured, and averaged into site tree-ring chronologies



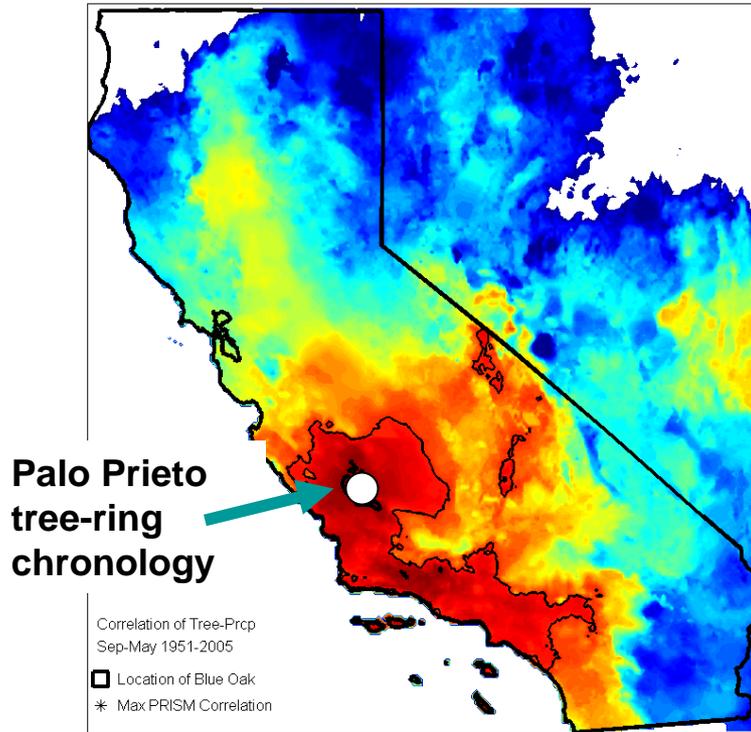
# Tree-Ring Chronologies in California and Nevada



Blue oak is one of the most moisture-sensitive species

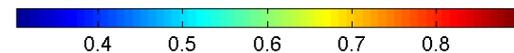
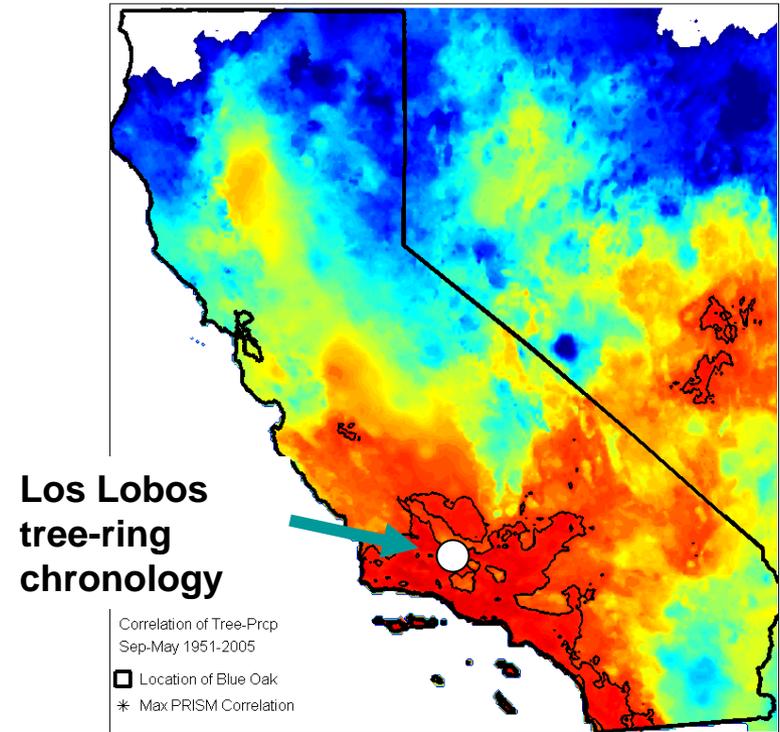
# Blue oak tree growth is strongly correlated with precipitation over a large region

PaloPrietoCanyon



Correlation with precipitation

LosLobos

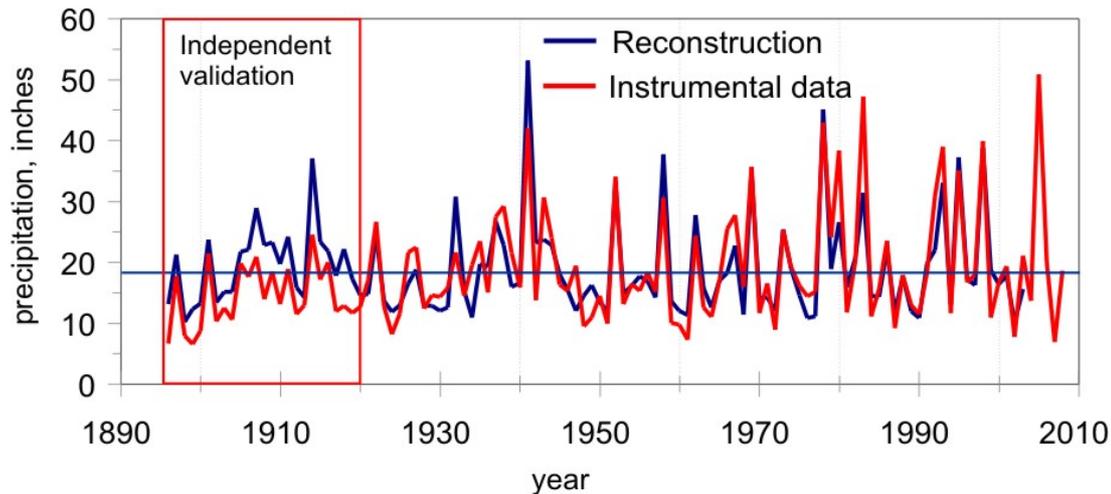


Correlation with precipitation

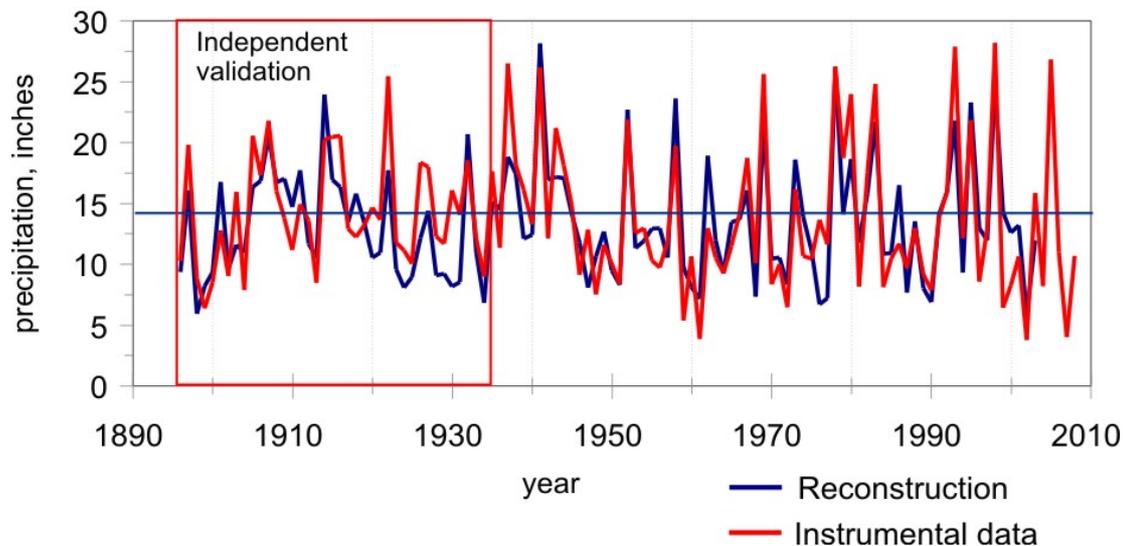
# New Precipitation Reconstructions for Southern California



## Pasadena, observed vs reconstructed data



## Redlands, observed vs reconstructed data



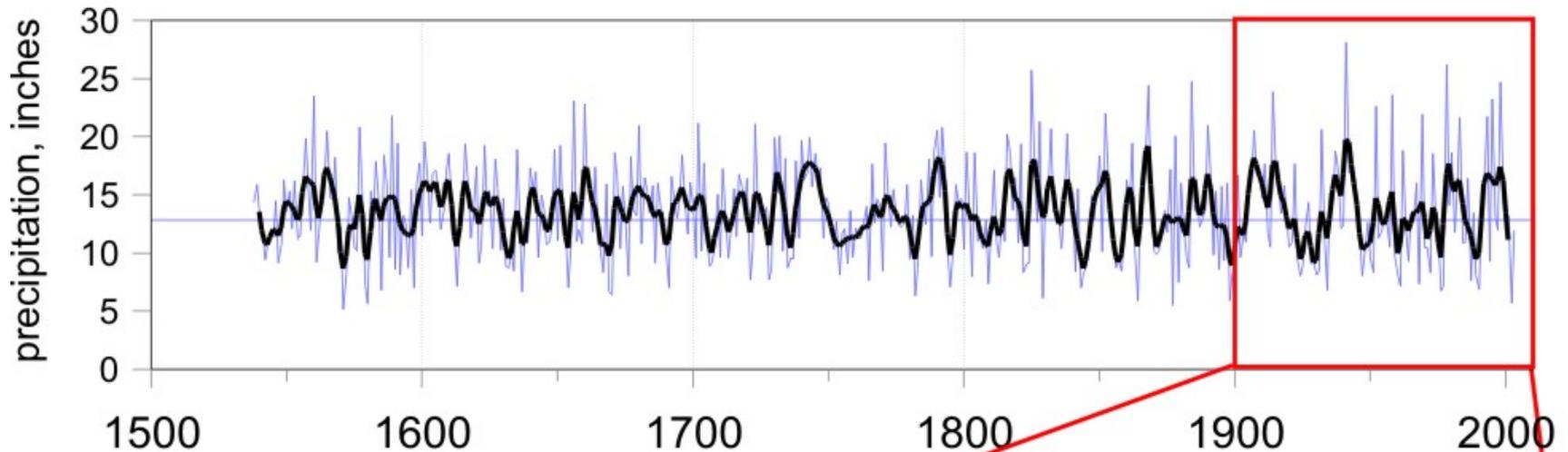
# Tree-Ring Reconstructions of Water Year Precipitation

About 70% of the variability in the observed record is accounted for in the reconstructions.

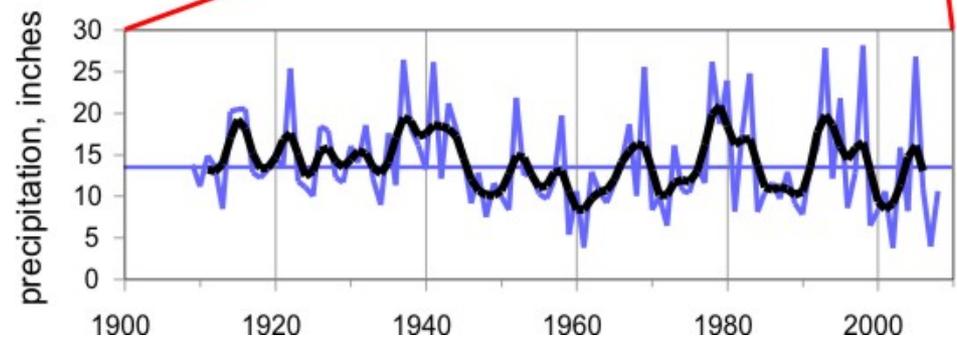
The reconstruction is tested on part of the data not used to generate the reconstruction model.

# Comparison of the Redlands observed precipitation with the 471 year precipitation reconstruction

## Redlands Water Year Precipitation Reconstruction, 1538-2003

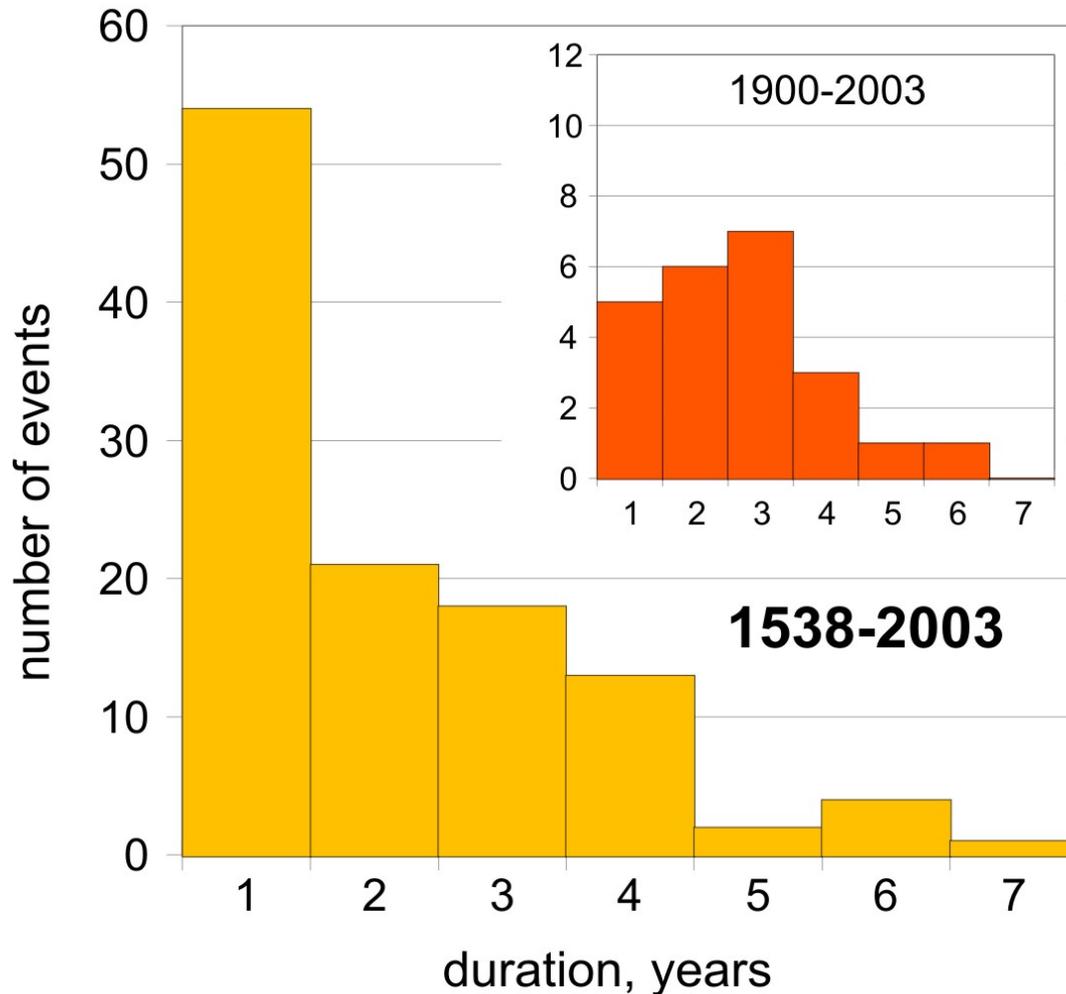


## Redlands Water Year Precipitation, observed, 1909-2008



What do tree rings tell us about past droughts  
in southern California?

# Redlands Droughts

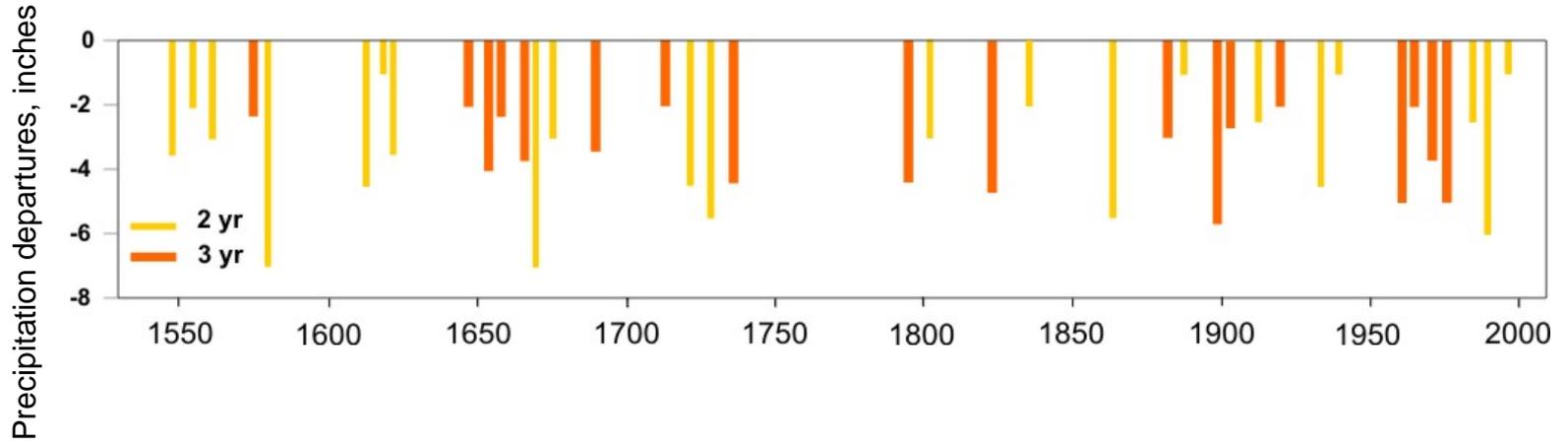


**Here, drought is defined as one or more consecutive years below the long-term mean.**

**The 20th century represents a subset of the droughts in the full reconstruction period.**

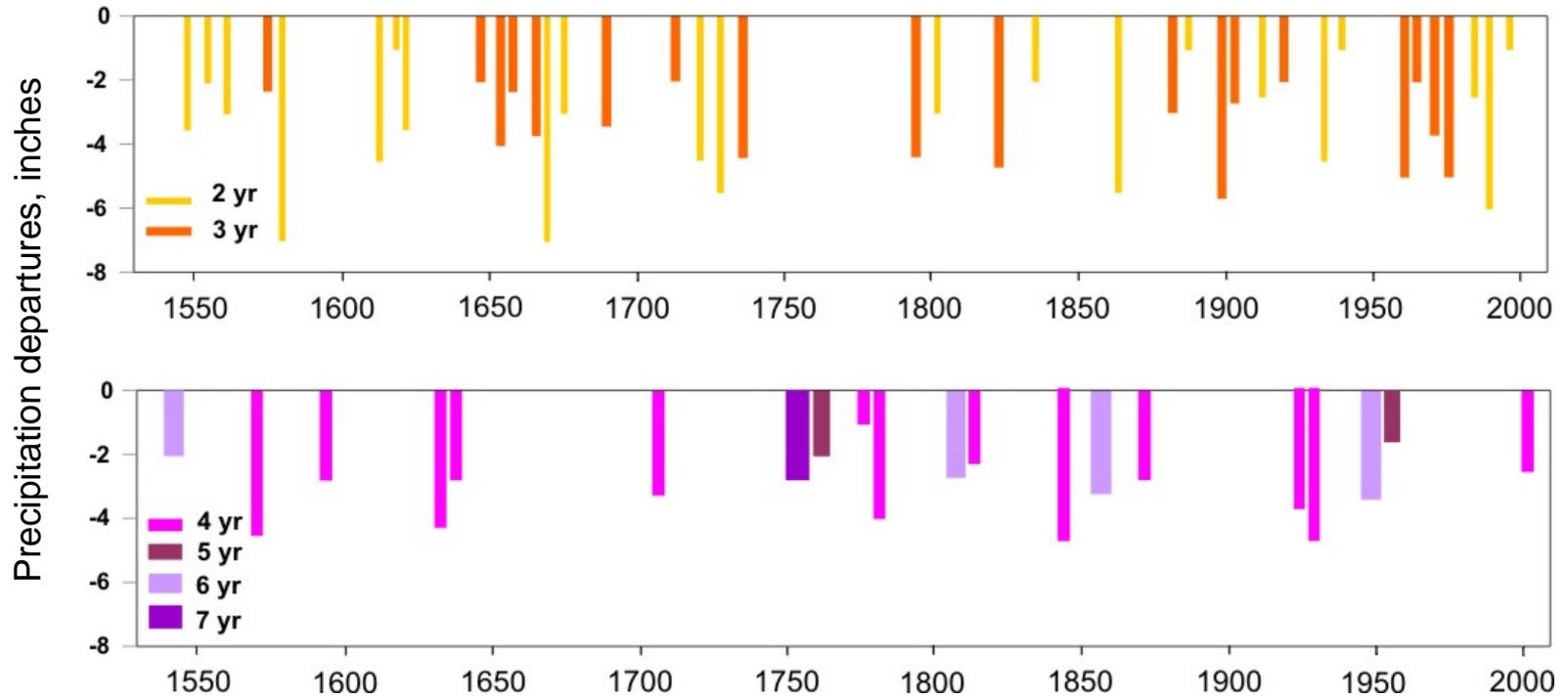
# Reconstructed Redlands Droughts

## Distribution, Duration, and Magnitude



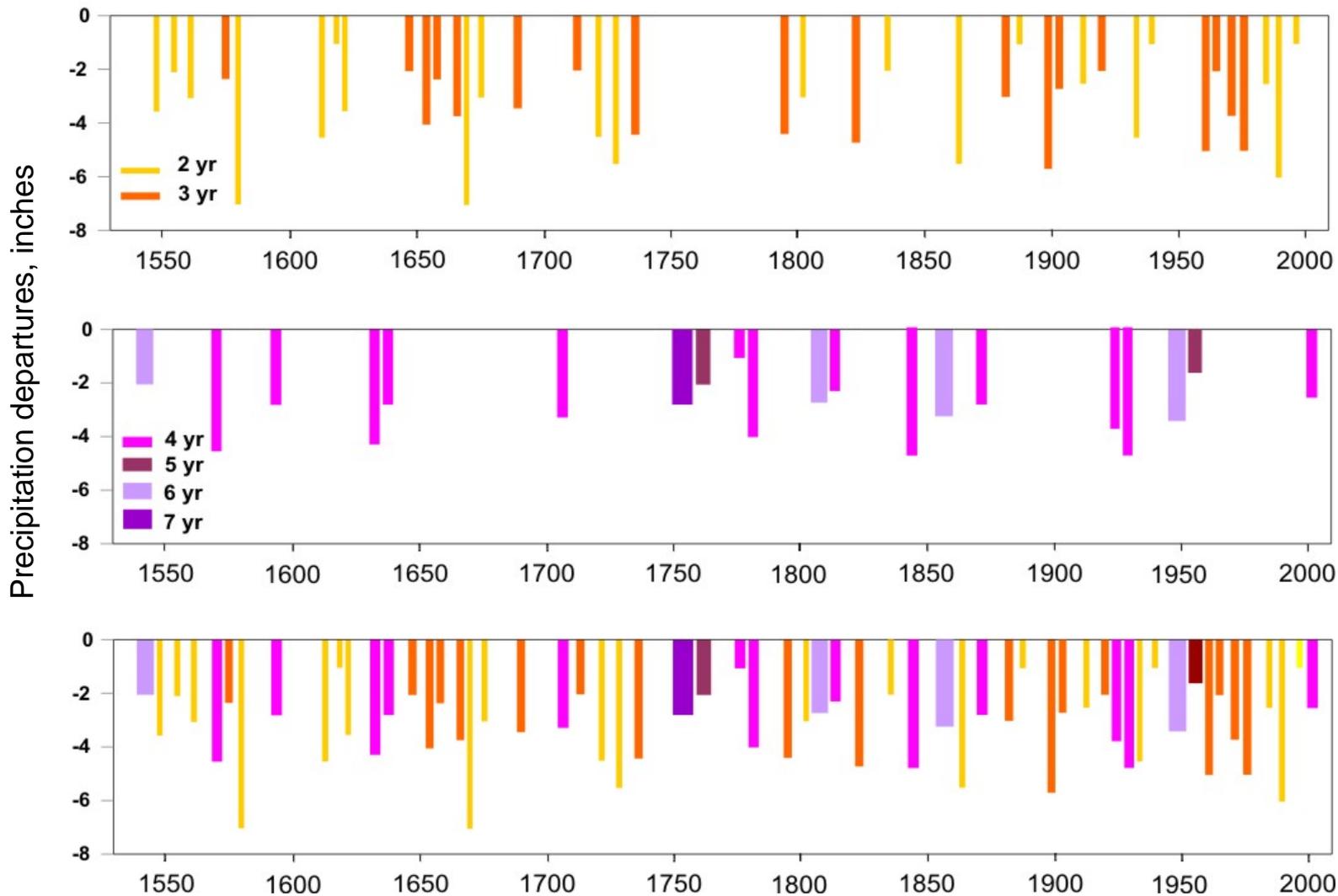
# Reconstructed Redlands Droughts

## Distribution, Duration, and Magnitude



# Reconstructed Redlands Droughts

Distribution, Duration, and Magnitude



**Driest 3-yr average: 1899-1901**

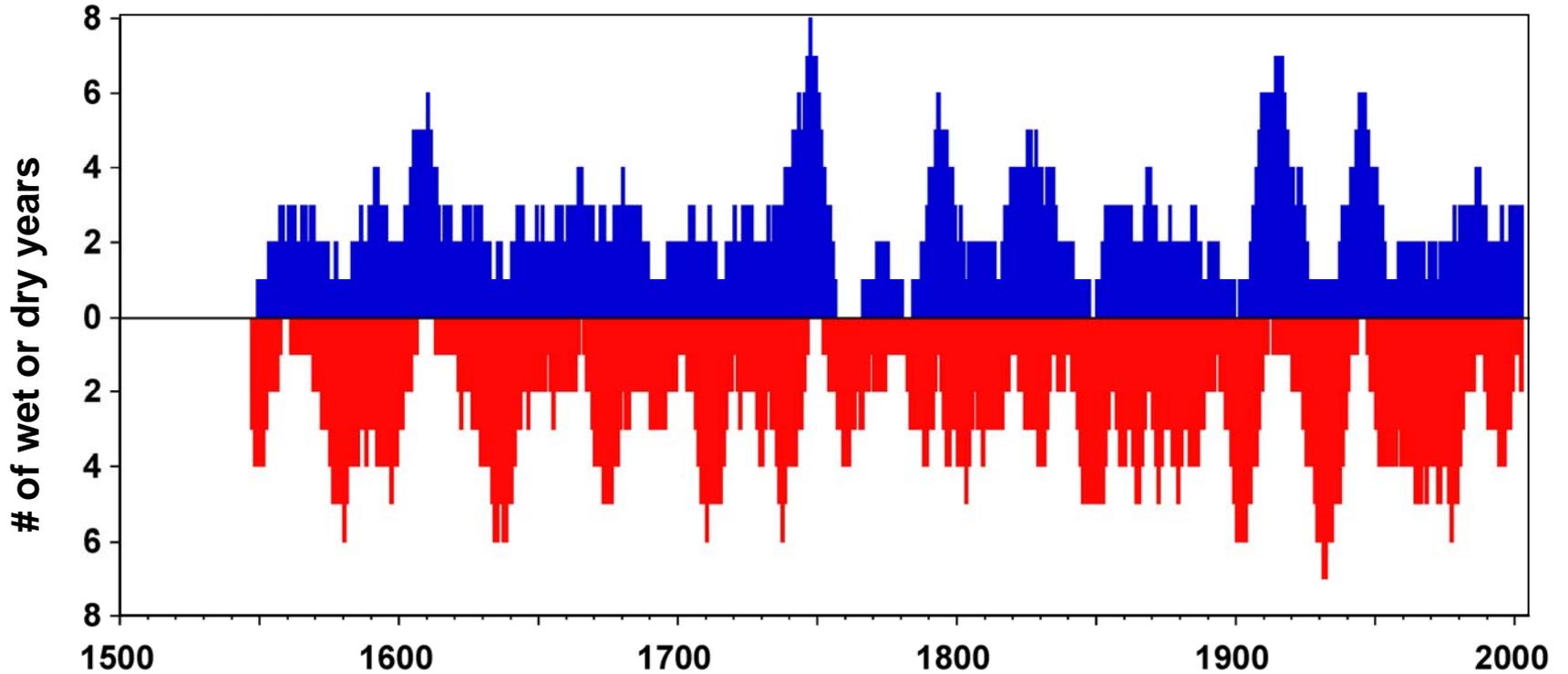
**Driest 5-yr average: 1668-1672**

**Driest 10-yr average: 1922-1931**

**Driest 20-yr average: 1751-1770**

# Reconstructed Redlands Precipitation

numbers of wet (>120%) and dry (< 80%) years per decade



# How is this information being used in water resource planning?

- Worst case scenarios for drought planning
- Water supply system resilience, using tree-ring data as input in water supply system models
- Blending information about the past and with climate projections for the future for robust planning

# Will the climate of the past 100 years be an adequate baseline for future planning?

Probably not, but extended records of past climatic variability from paleoclimatic data, such as tree rings, can provide additional information for understanding the range of conditions that may be expected under natural variability.

