Placing Recent Droughts in a Long-Term Context with Tree-Ring Reconstructions for the Russian River Valley


Photo: F. McWalter

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Overview

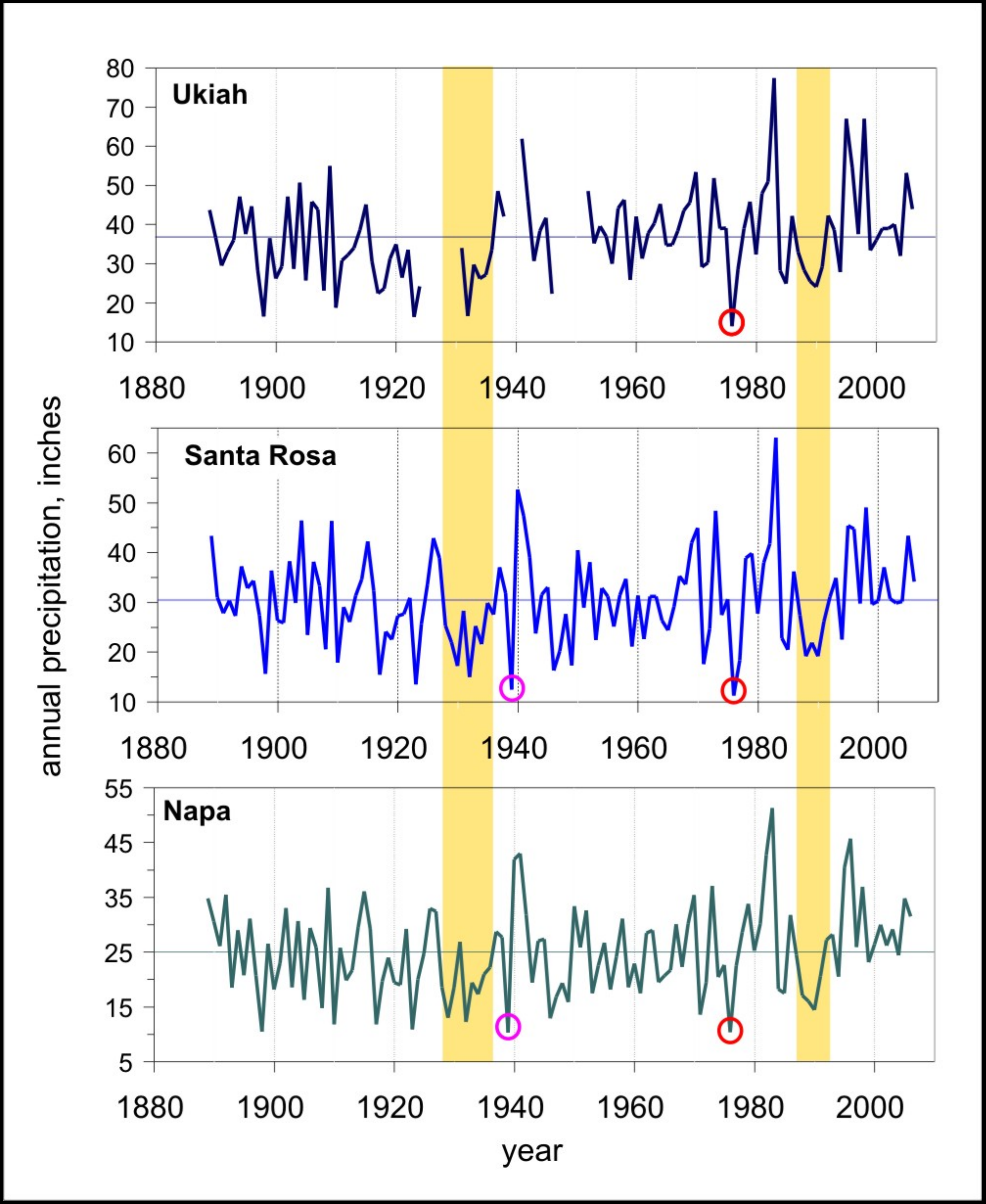
- Why consider the past when planning for the future?
- How do tree rings work?
- What do tree rings tell us about past droughts in the Russian River Valley?
- How is this information being used in water resource planning?

Why consider the past when planning for the future?

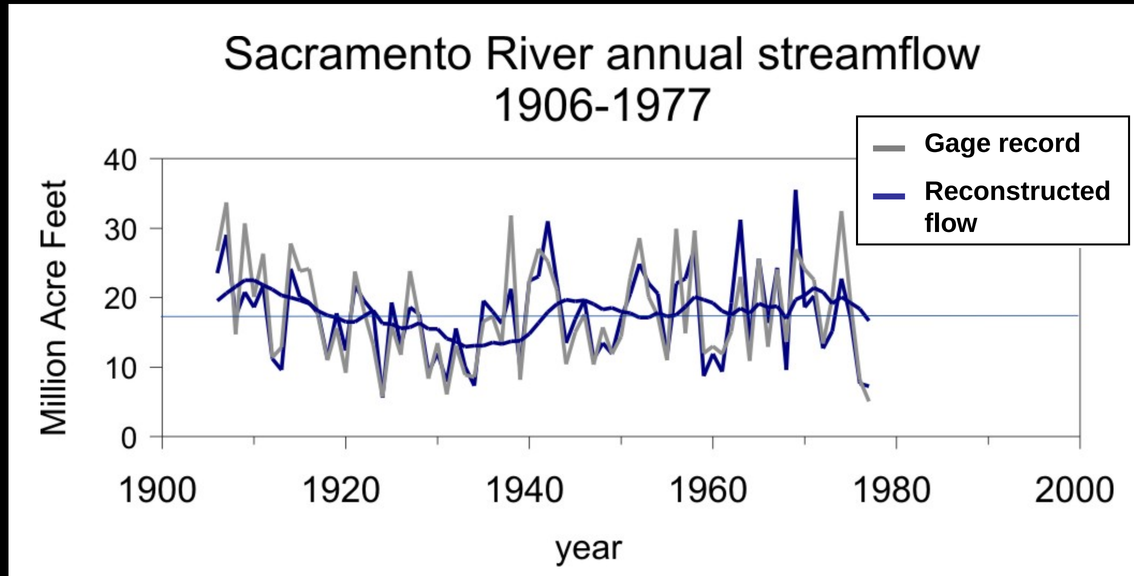
Records from rain gages extend back 125 years, at best.

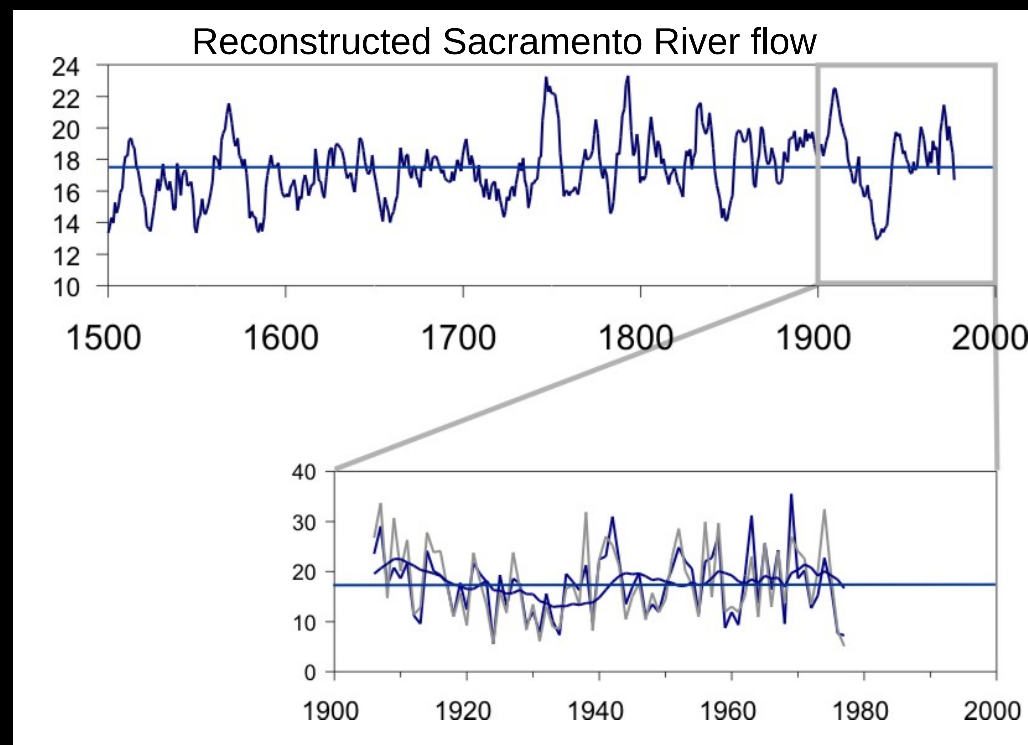
These records document extreme dry year and persistent drought.

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

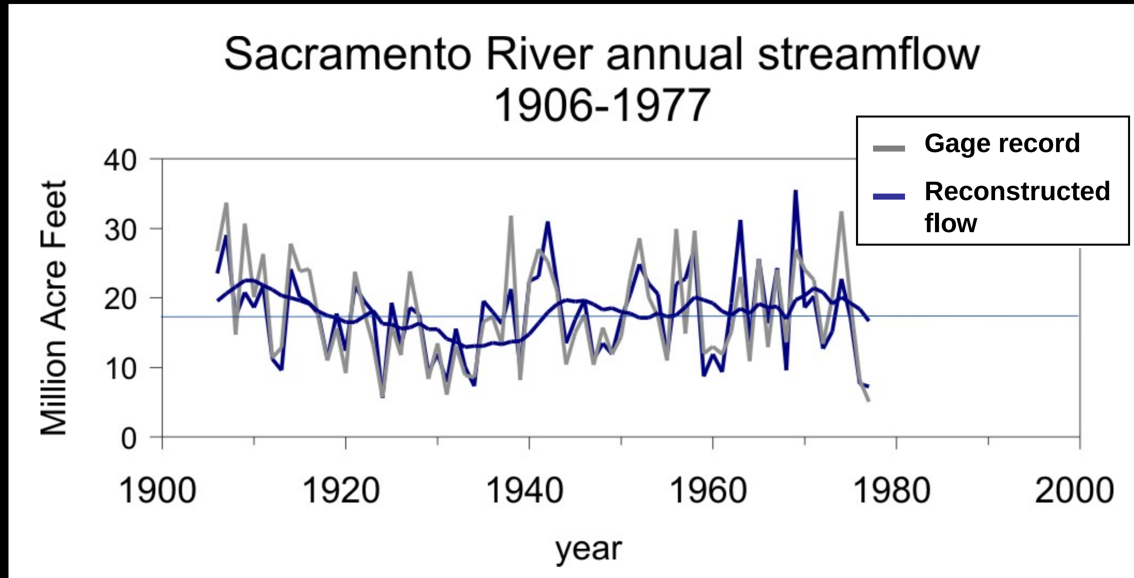


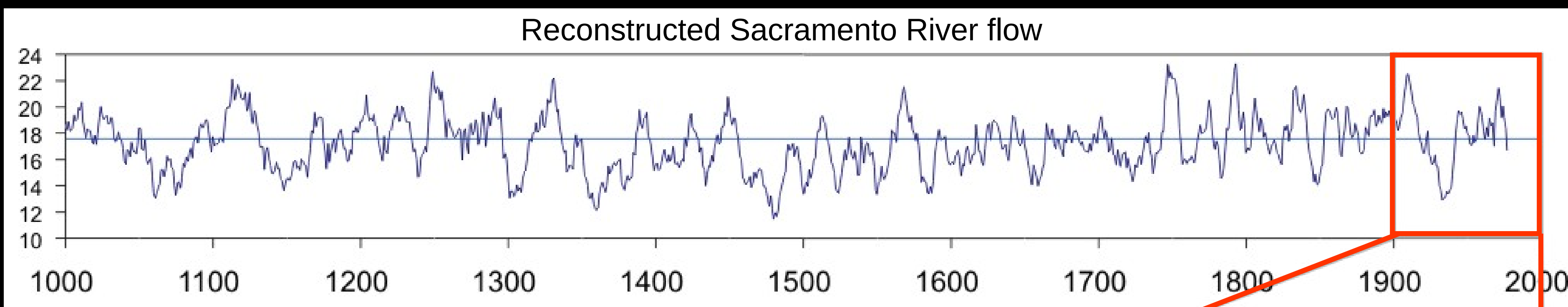
Annual precipitation from 3 stations, 1889-2006.

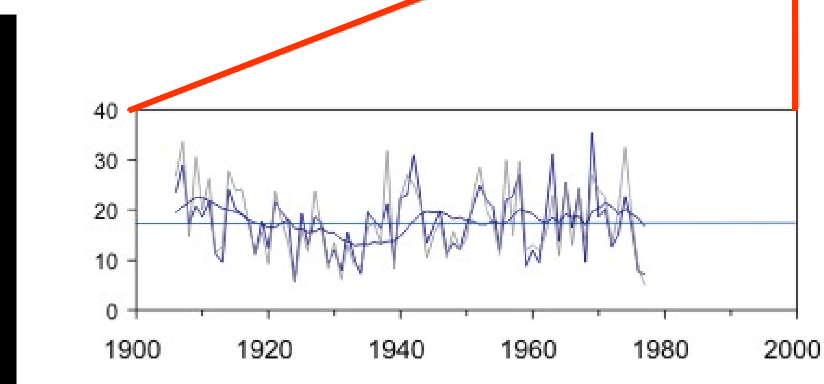




Records of precipitation and streamflow can be extended back in time using tree-ring data







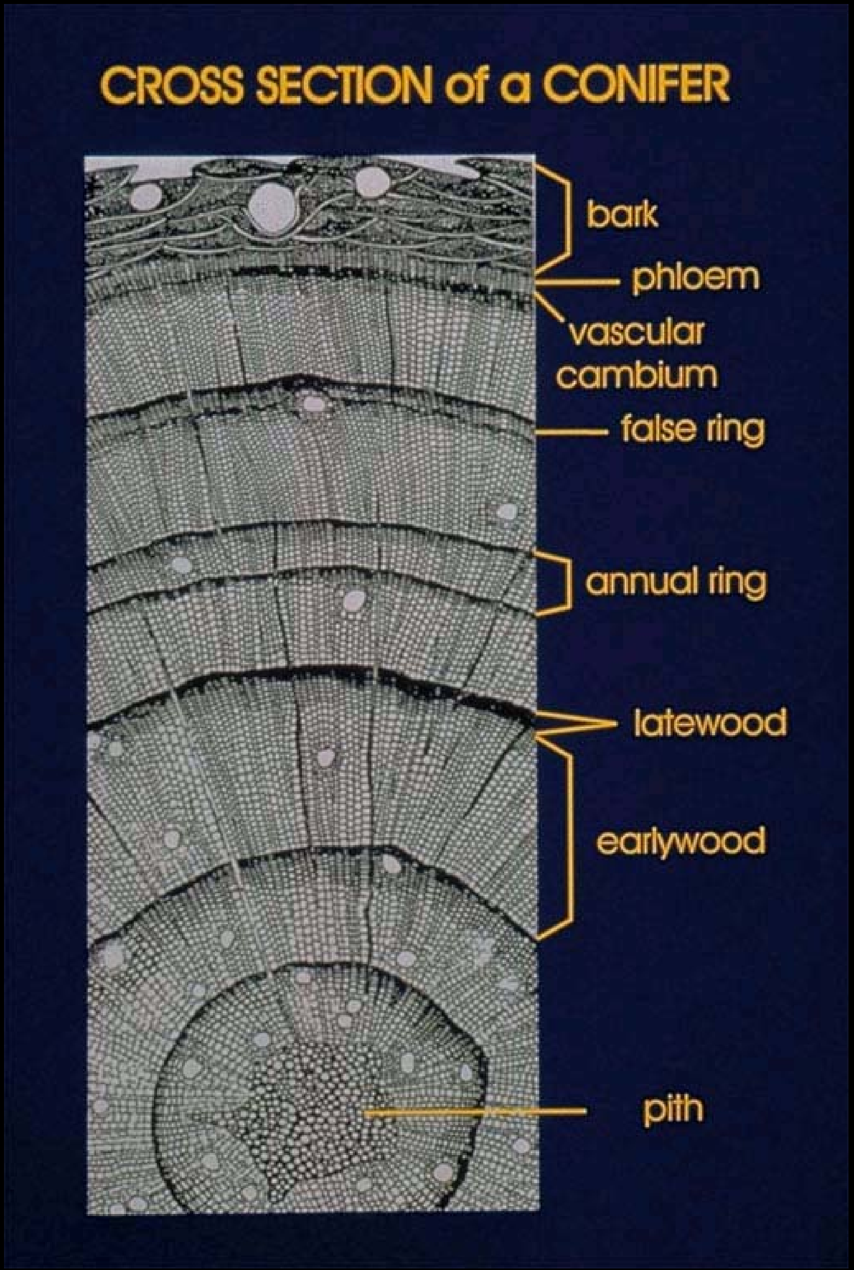
Extended record can provide a long-term context for assessing droughts in the modern climate records

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.

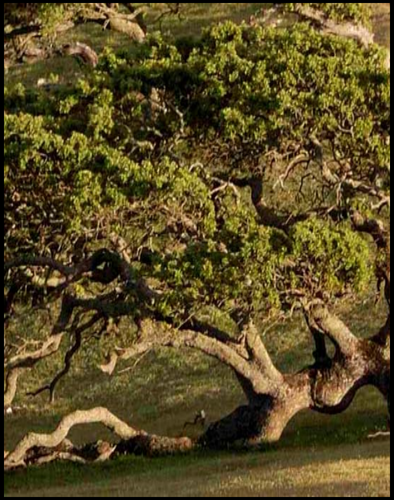
Because of this, ring widths can be used as a proxy for past climate.

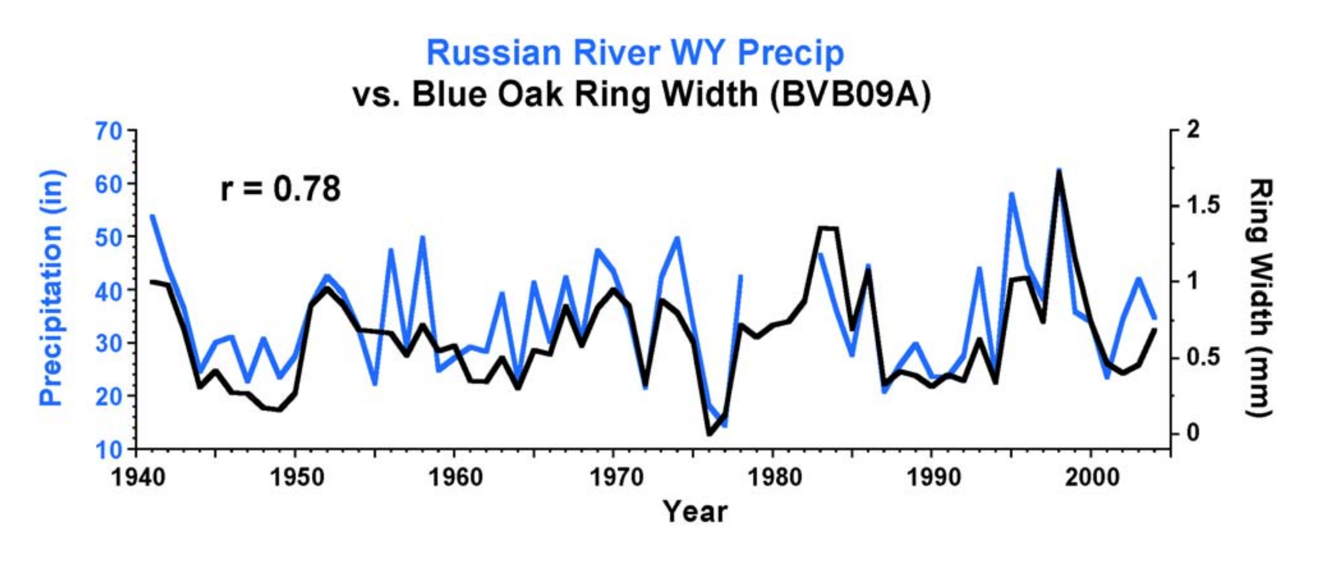


What trees are the best recorders of precipitation, streamflow and drought?

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

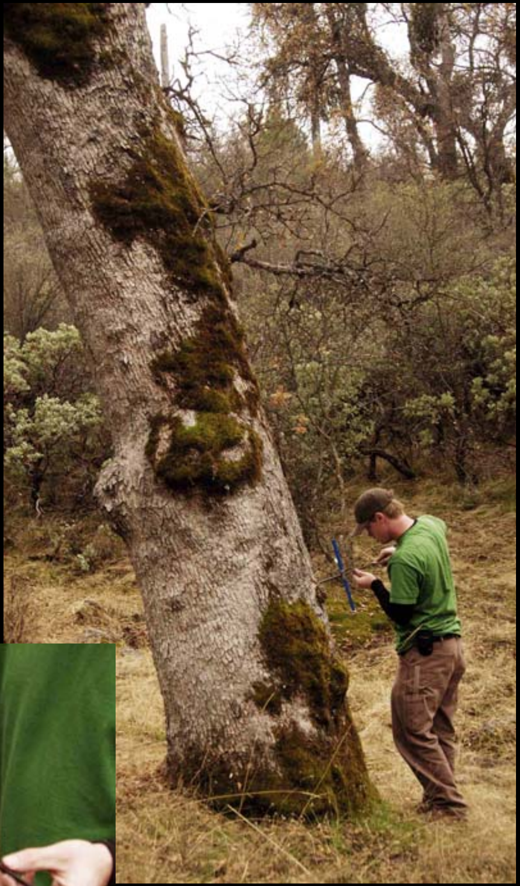
Moisture-stressed trees closely track variations in precipitation



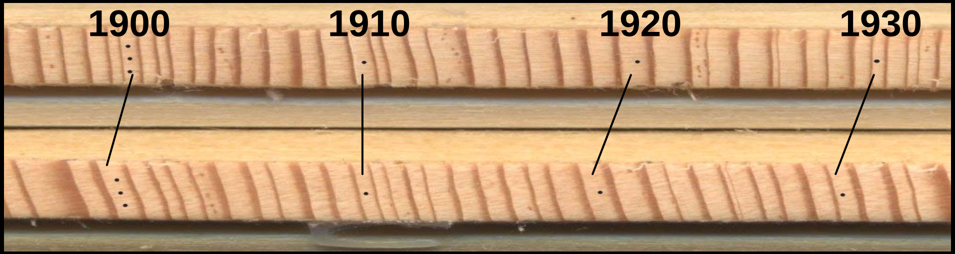


Ring widths from a single tree near Bear Valley are plotted with water year precipitation in the Russian River Valley. (r = 0.78).

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

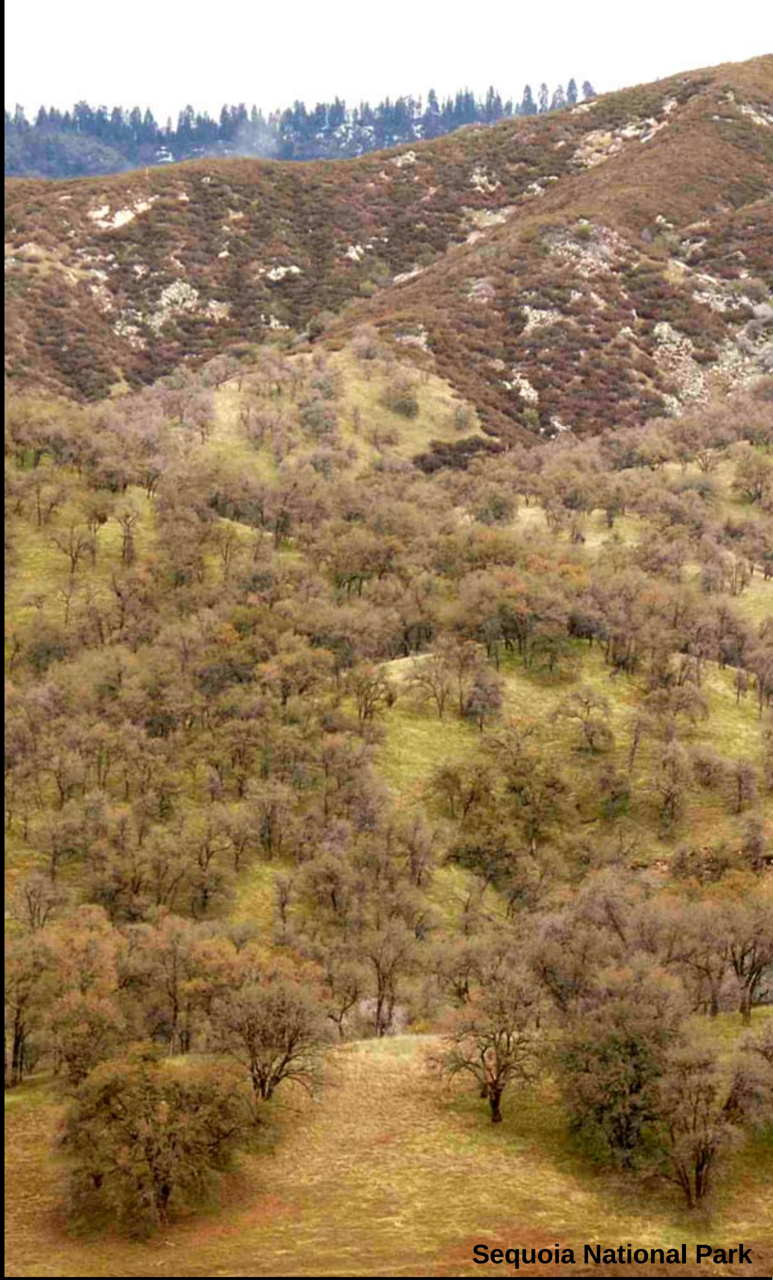


Cores mounted and sanded, then dated, measured, and averaged into site tree-ring chronologies

What do tree rings tell us about past droughts in the Russian River Valley?

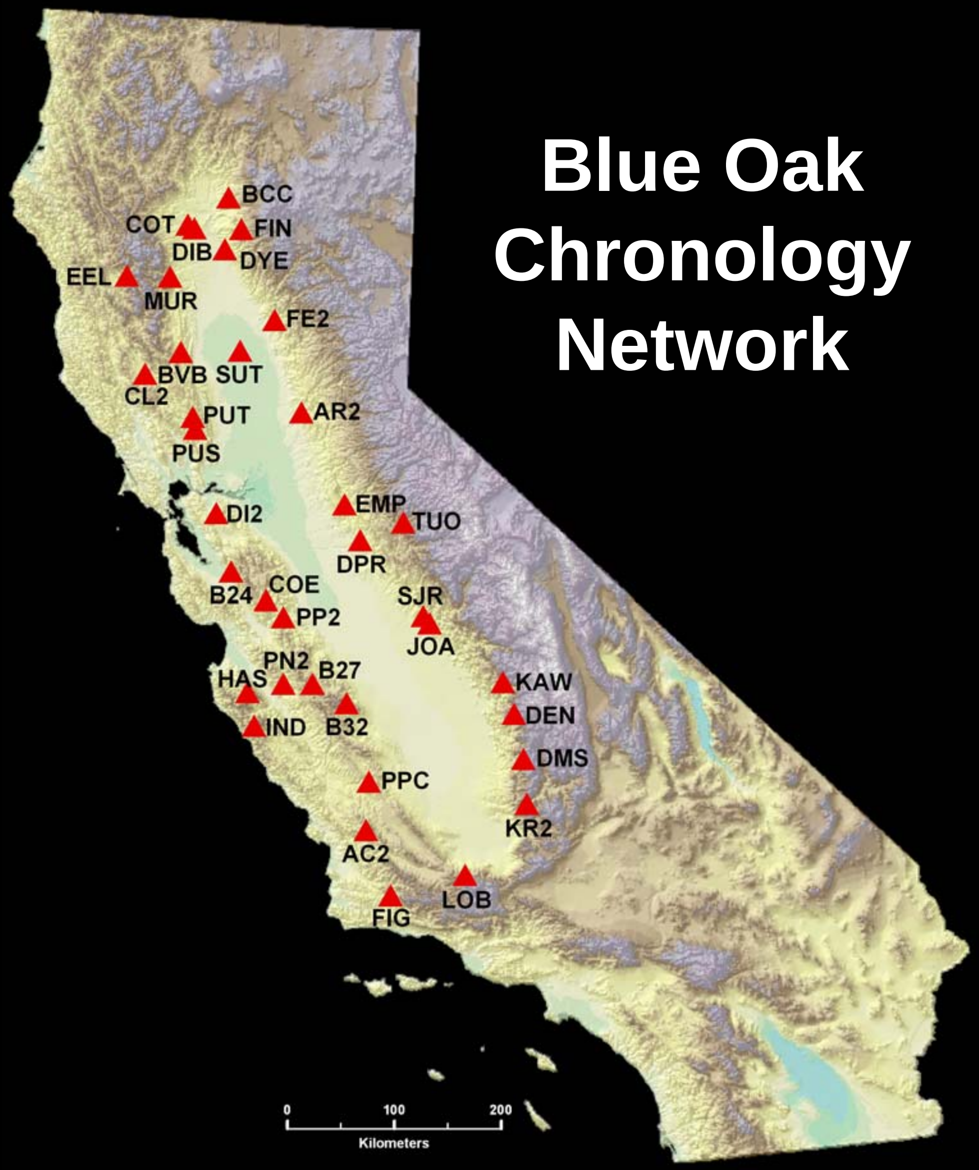
Blue oak (*Quercus douglasii)*

- •California rock oak
- •Douglas oak
- •Foothill oak*
- •Iron oak
- •Jack Oak
- •Mountain white oak
- •Post oak
- •Western white oak

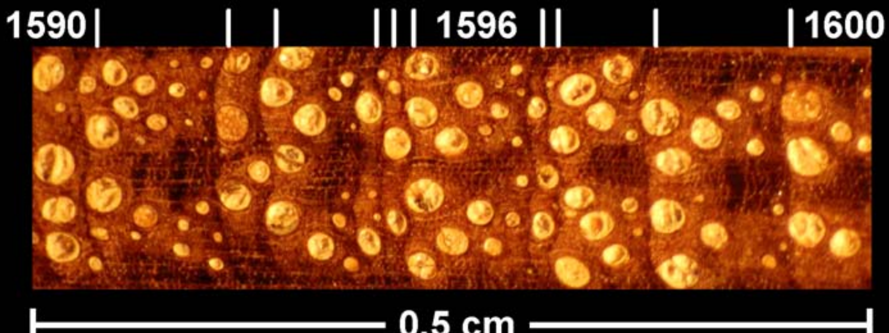


Vegetation Zonation:
Blue oak woodland, chaparral, mixed conifers

Blue Oak Chronology Network

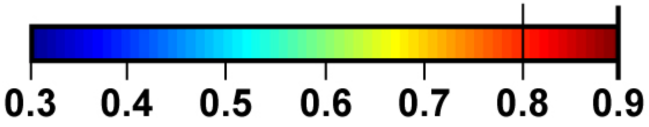


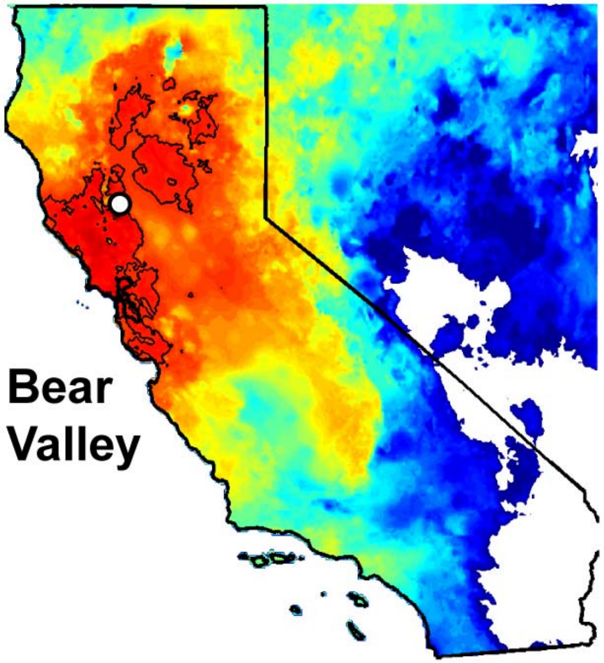
Blue Oak
(*Quercus douglasii*)

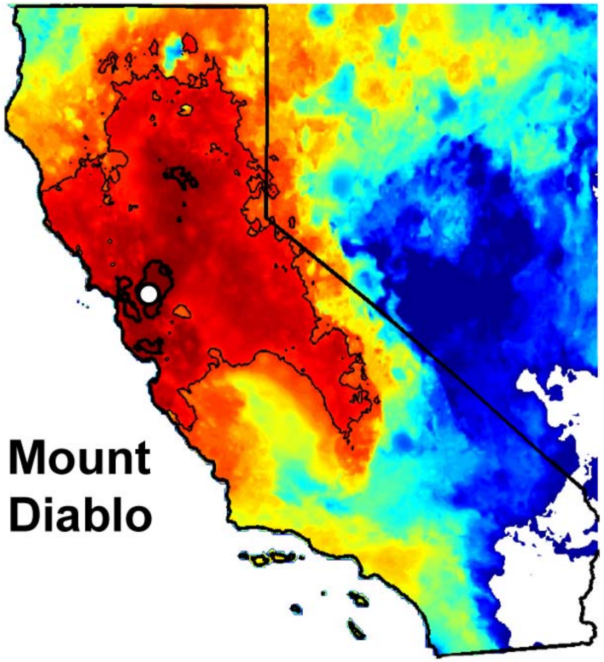


Regional Climate Sensitivity

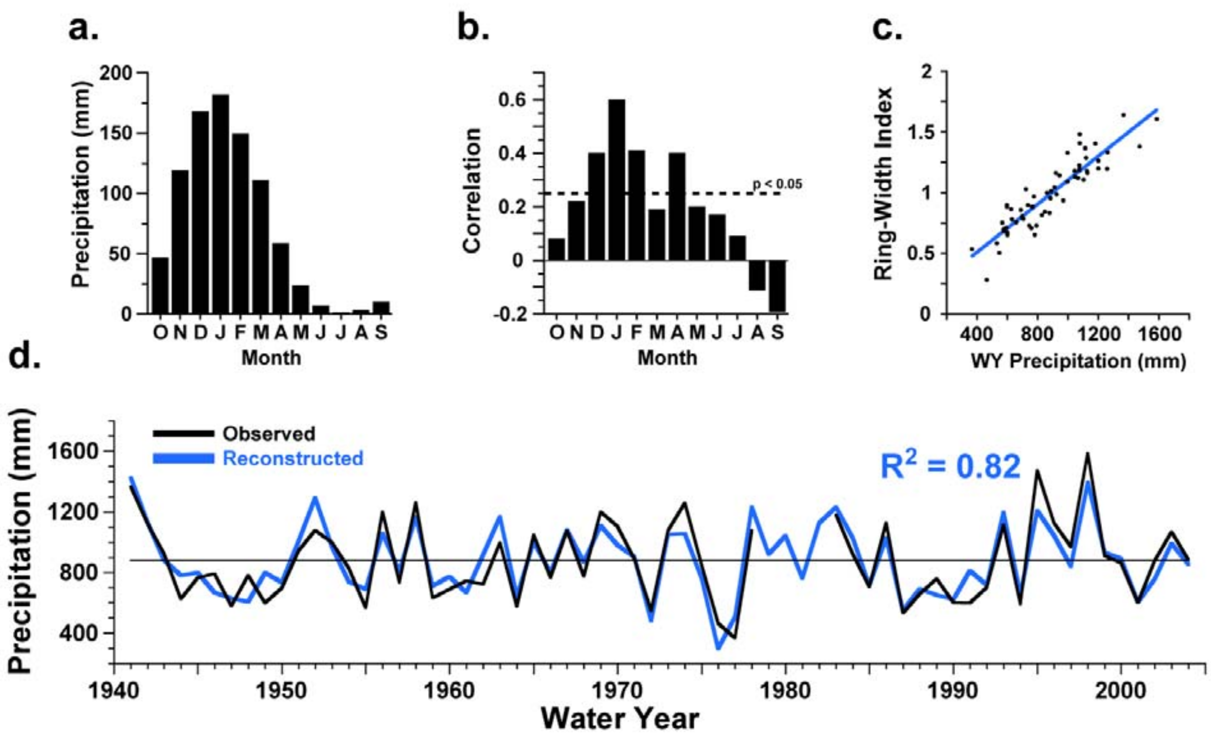
Correlation with
Sept. - May Precipitation
(1951-2003)





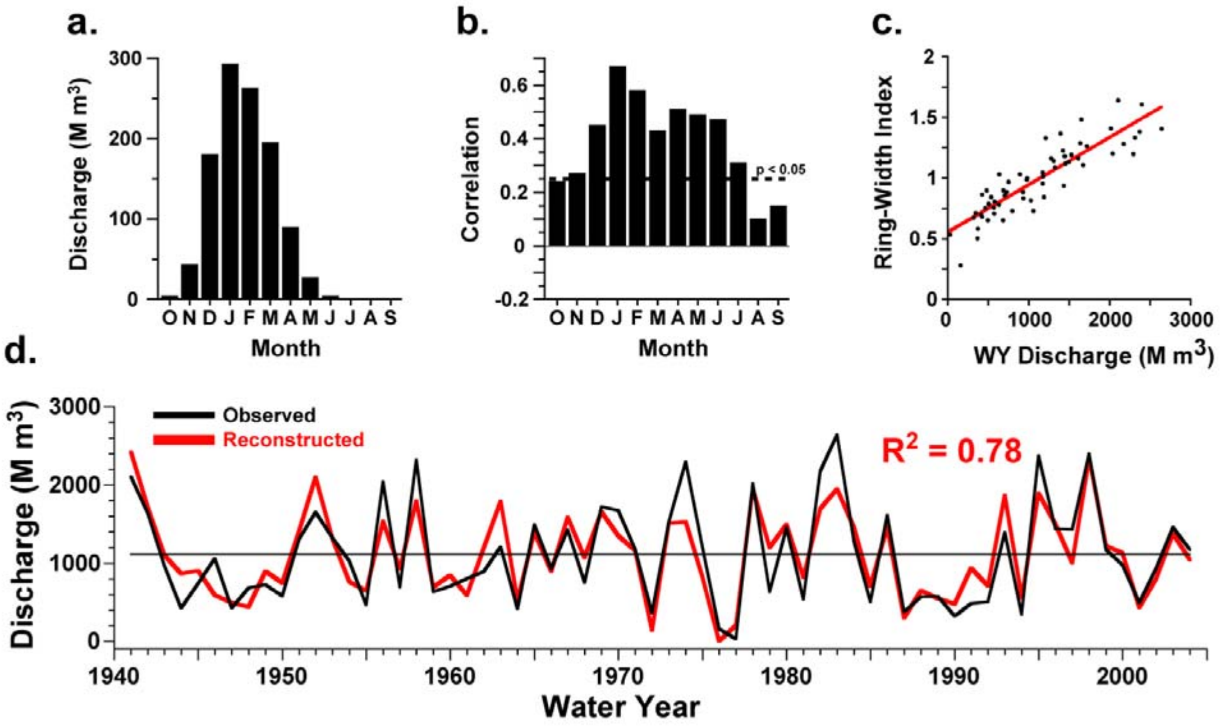


Precipitation

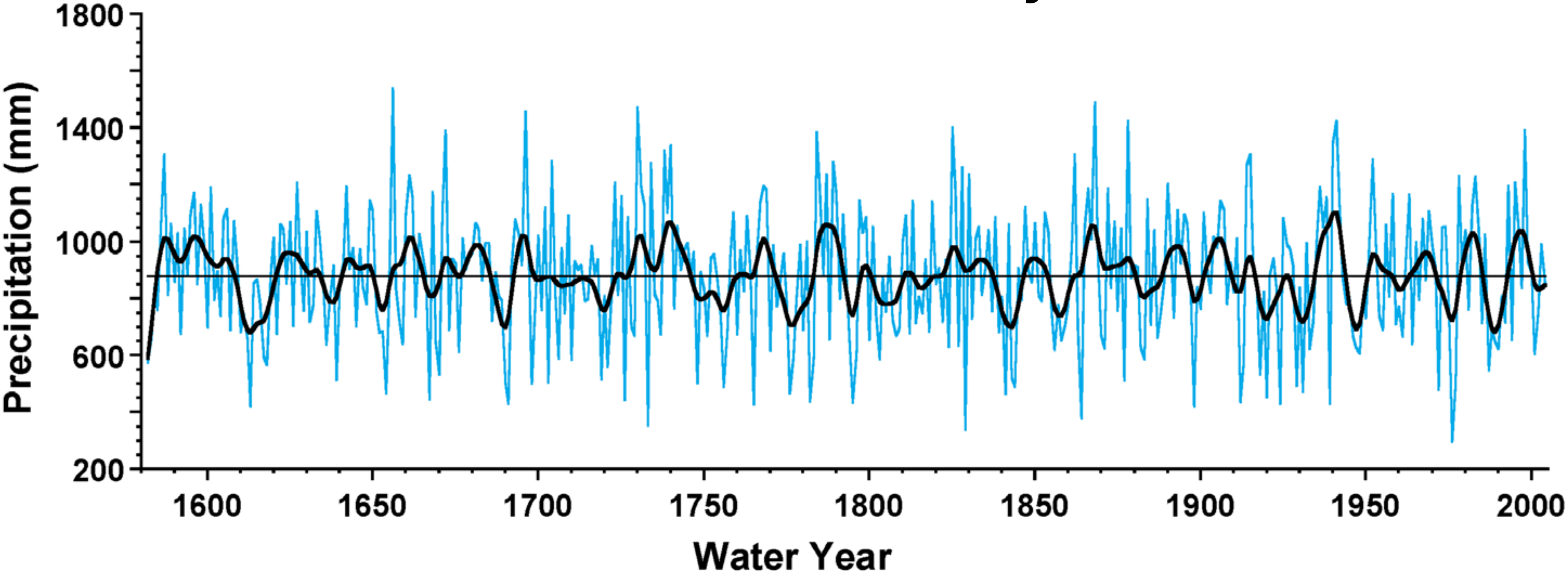



Bear Valley
Ukiah
Russian River
Healdsburg
Santa Rosa
Mt. Diablo
0
25
50 km

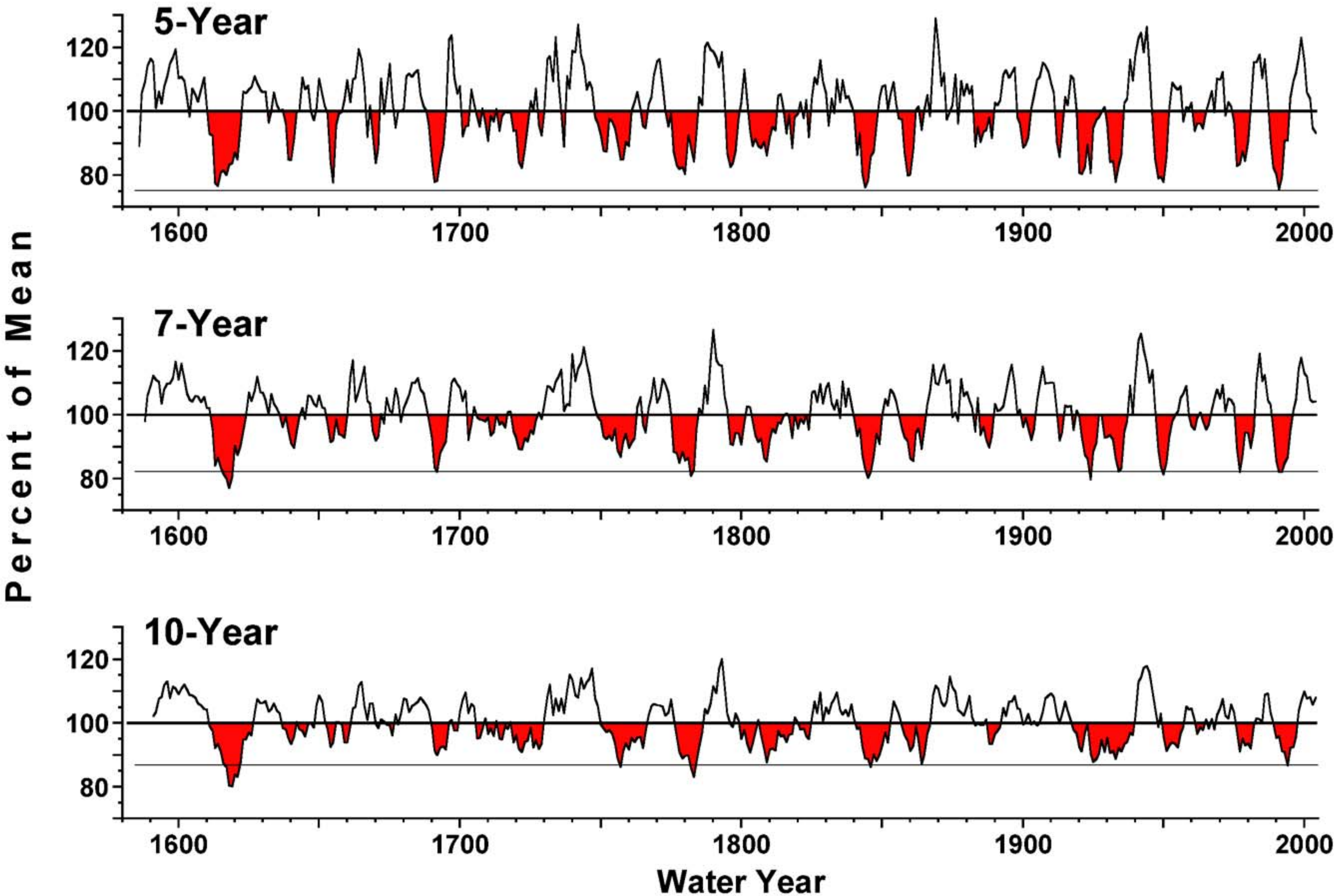
Streamflow


a.
Discharge (M m3)
Month
b.
Correlation
p < 0.05
Month
c.
Ring-Width Index
WY Discharge (M m3)
d.
Observed
Reconstructed
R2 = 0.78
Discharge (M m3)
Water Year

Reconstructed Rainfall 1582-2004
Russian River Valley



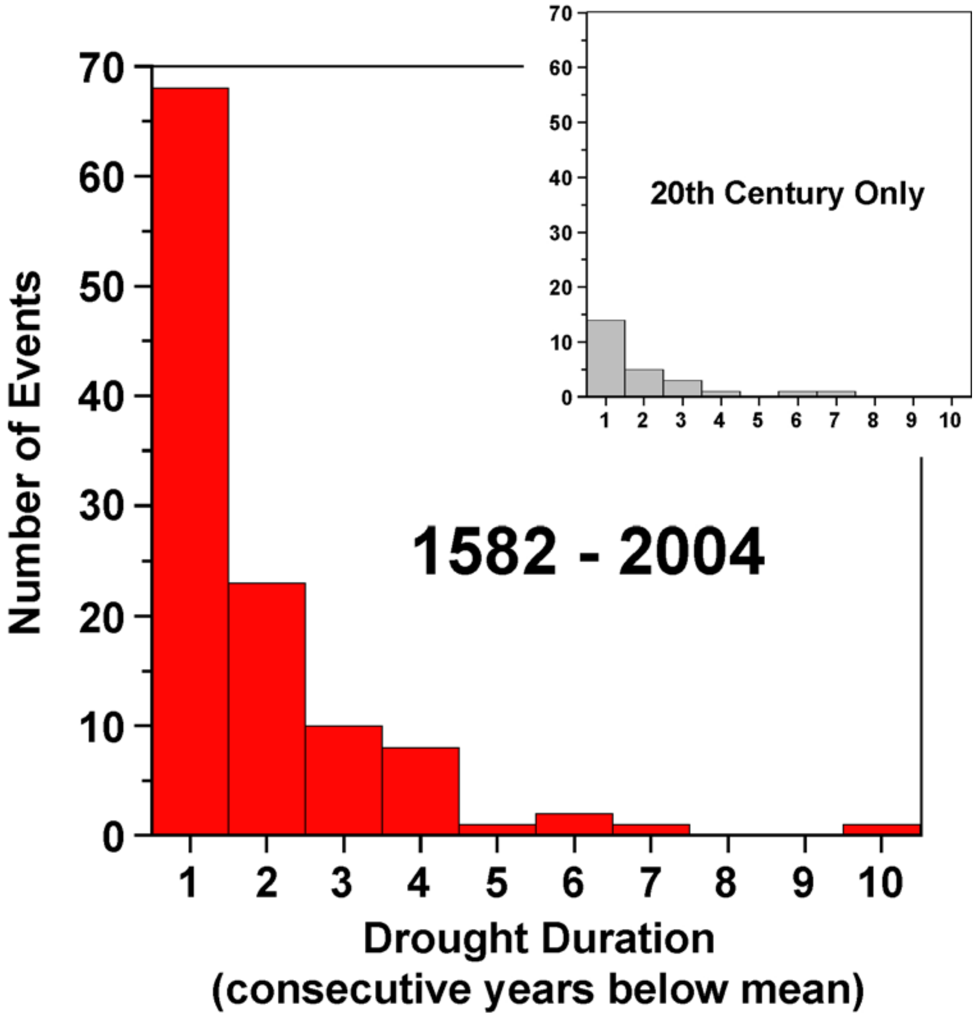
Reconstructed Running Means



n-year running mean drought events

	1-Year Drought		5-Year Drought		7-Year Drought		10-Year Drought	
Rank	Year	%	Year	%	Year	%	Year	%
1	1976	34	1991	75	1618	77	1619	80
2	1829	39	1844	76	1924	80	1783	83
3	1733	40	1614	77	1845	80	1846	86
4	1864	43	1655	78	1782	81	1757	86
5	1898	48	1933	78	1950	81	1994	87

Russian River Drought Frequency



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.

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.