

Extended Chronology of Drought in South Central, Southeastern and West Texas

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Acknowledgements

- Texas Parks and Wildlife, Guadalupe R. SP
- Dr. Connie Woodhouse, U. of Arizona, for new Guadalupe Peak Douglas-fir chronology
- Private landowners and Ft. Bend County
- Dr. David Stahle, U. of Ark. Tree-Ring Lab for help dating

Objectives

- Investigate South Central, Southeastern, and West Texas drought 1500s to present
- Evaluate available tree-ring chronologies
- Make new tree-ring chronologies
- Evaluate existing reconstructions (Stahle and Cleaveland 1988; Cook et al. 1999) that are short or use trees hundreds of miles away
- Improve reconstructions, particularly length
- Evaluate new reconstructions

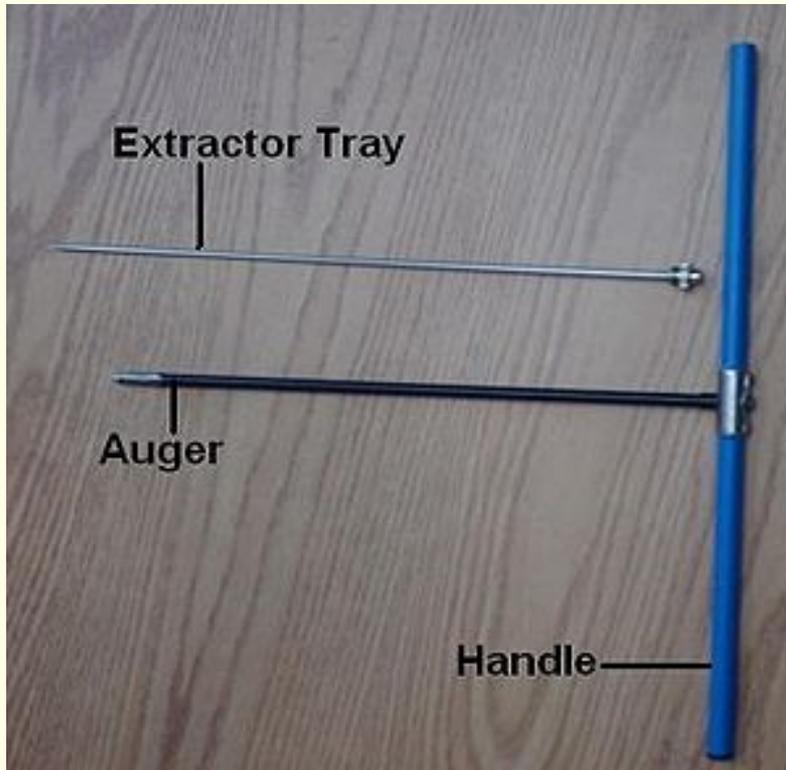
Why Dendrochronology?

- Really bad droughts are rare, and there are less than 150 years of good climate records in Texas
- Tree rings can be used as *proxies* for climate
- Baldcypress have been used elsewhere to reconstruct climate: drought indices, precipitation, streamflow

What Is Dendrochronology?

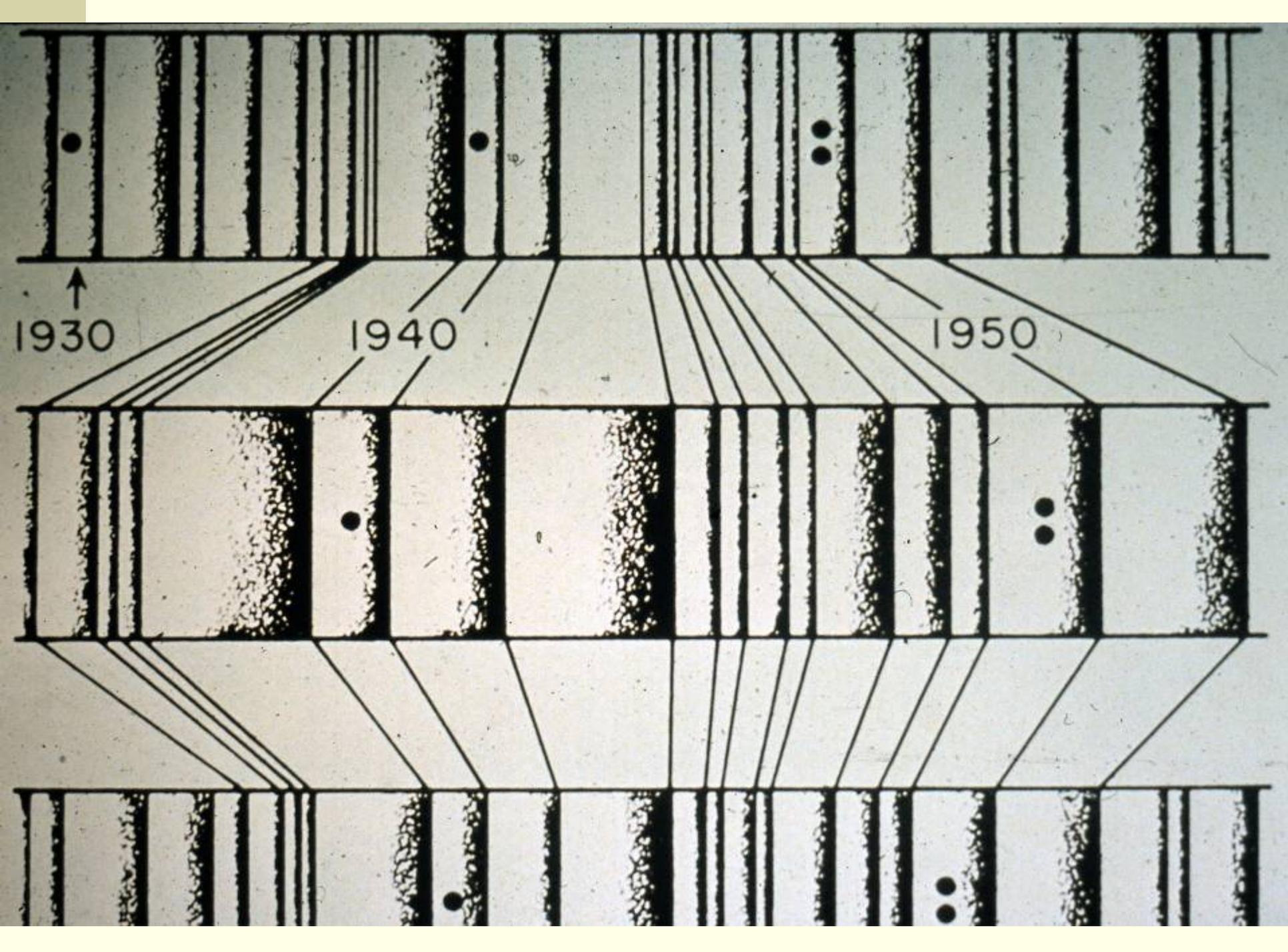
- Dating method accurate to the year, matches patterns of wide and narrow rings
- Climate creates the matching patterns, can be reconstructed from ring widths or other ring characteristics
- Crossdating (pattern matching) essential to detect anomalies such as missing or false rings

Increment Borer



Baldcypress Tree Rings ~ 50x





The Big Tree, Big Tree Ranch



**Is this
an old
tree or
a young
tree?**



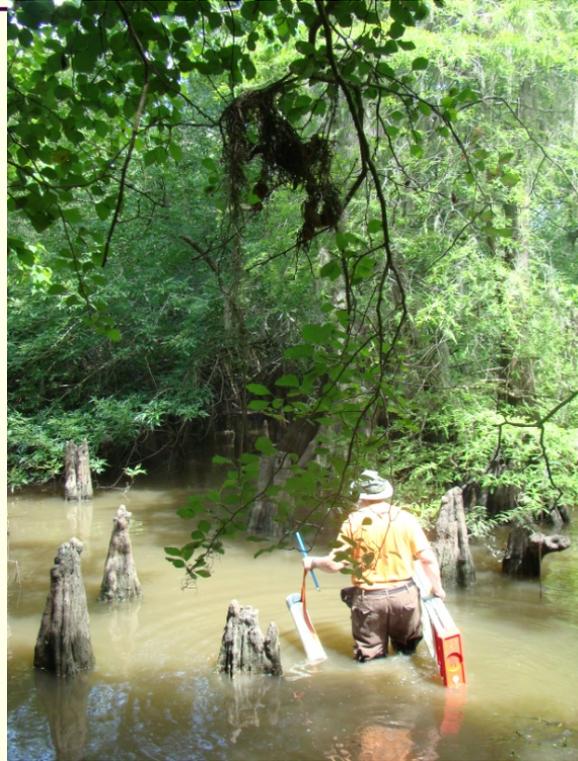
Life in the Floodway

Upstream



Downstream

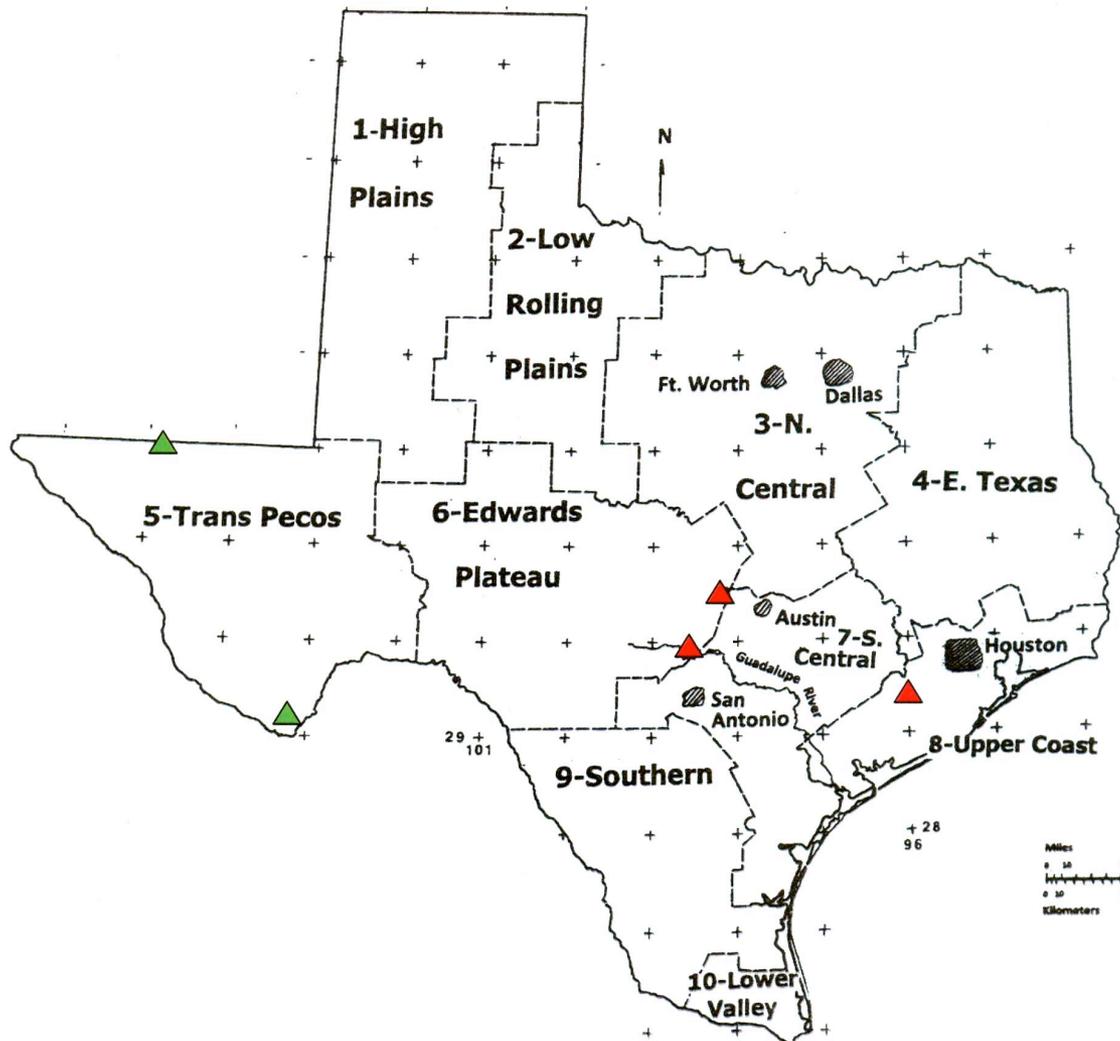
Getting There is Half the Fun



Some Details of This Study

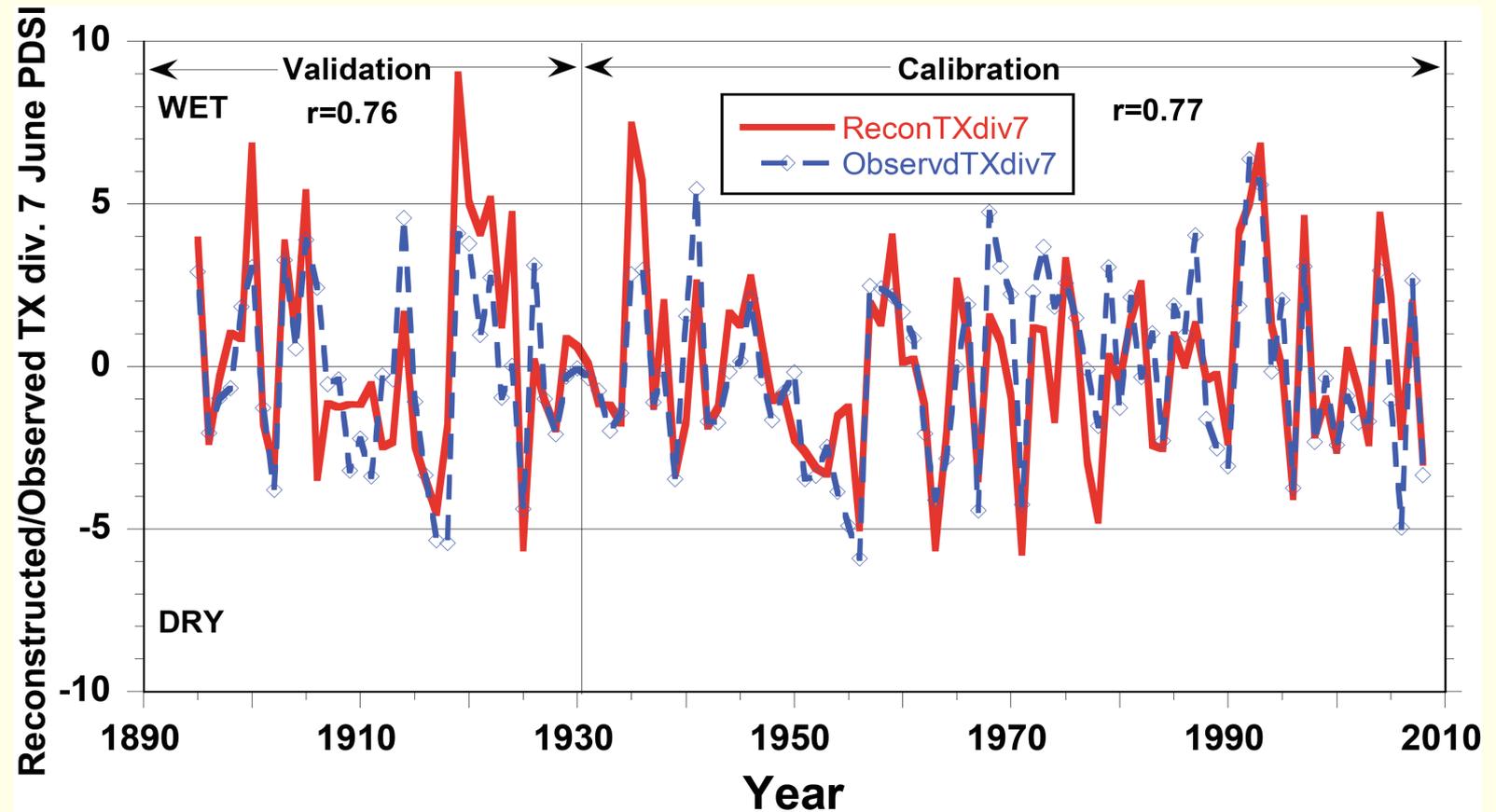
- 8 sampling sites, with many additional sites investigated
- 289 of the most promising baldcypress sampled
- 752 cores taken
- Oldest tree, 582 years, was a sapling in 1426
- Prior to this study most dendrochronologists thought no trees over 300 years existed in South Central Texas

This study focused on divisions 6 & 7,
however the chronologies improve
reconstructions for 5 and 8.

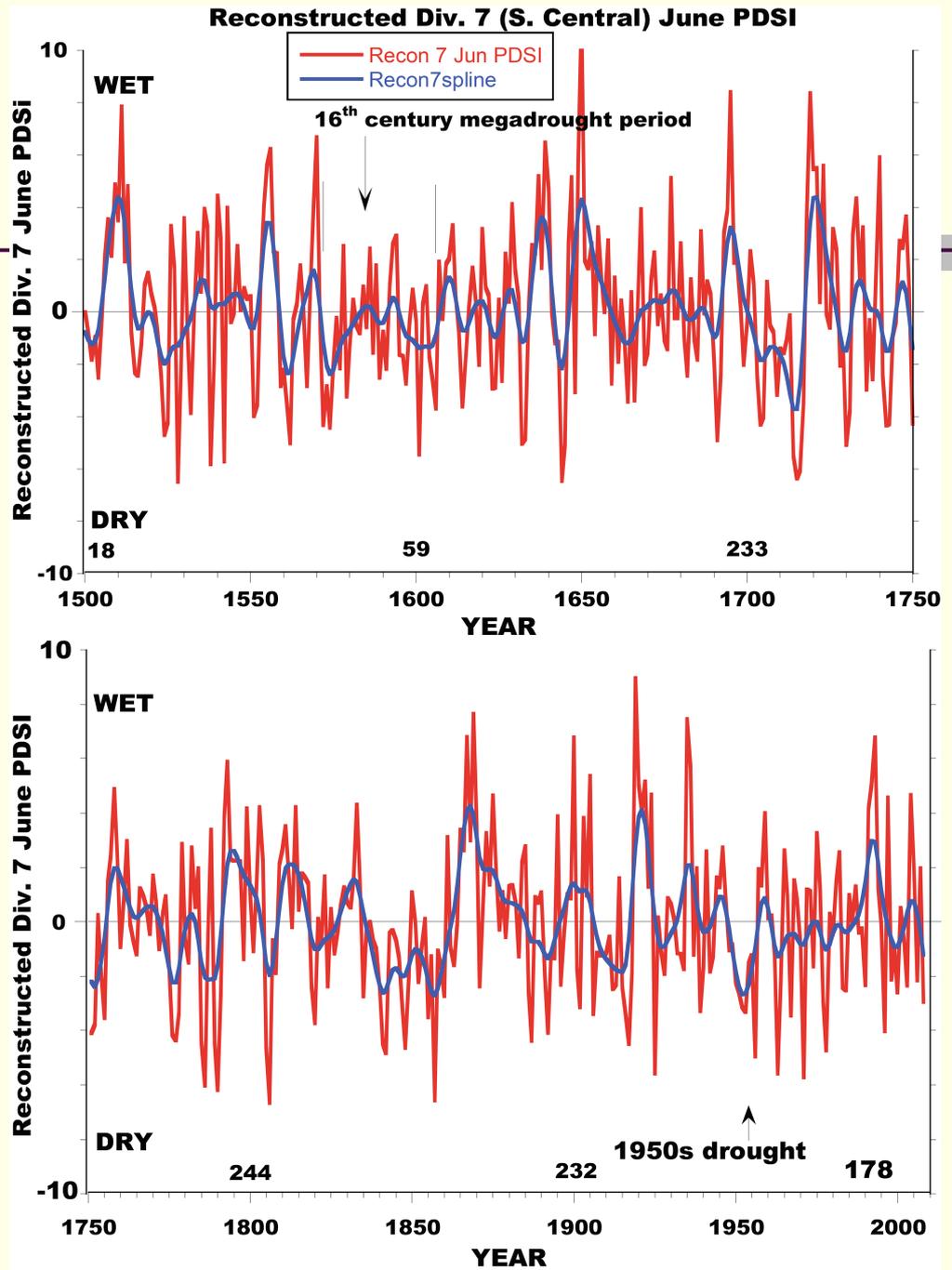


Observed vs. Reconstructed, Div 7 (South Central)

Calibrated 1931-208, $r=0.77$, Verified 1895-1930, $r=0.76$



Reconstructed Div. 7 June PDSI



Climate Reconstruction Analysis Div. 7, Eliminating Overlaps, 1500-2008

- *Worst 3 consecutive years:* **1714-16**,
1789-91, 1643-45, 1750-52, 1805-07
- *Worst 5 consecutive years:* **1713-17**,
1571-75, 1952-56, 1855-59, 1559-63
- *Worst 10 consecutive years:* **1708-17**,
1840-49, 1947-56, 1851-60, 1571-80
- *Worst 20 Consecutive years:* **1841-60**,
1698-1717, 1773-92, 1561-80,
1948-1967

Climate Reconstruction Analysis Div. 6 & 7

- 1950s unquestionably worst since 1895; 1960s were bad, too
- 1950s are not the worst long-term, the 1700s and mid1800s were worse
- 1930s Dust Bowl not as serious for Texas as the northern and central Plains

Climate Reconstruction Analysis Div. 5, Eliminating Overlaps, 1500-2008

- *Worst 3 consecutive years:* **1666-68**,
1953-55, 1818-20, 1714-16, 1862-64
- *Worst 5 consecutive years:* **1953-57**,
1666-70, 1860-64, 1729-33, 1804-08
- *Worst 10 consecutive years:* **1948-57**,
1667-76, 1748-57, 1859-68, 1804-13
- *Worst 20 Consecutive years:* **1950-59**,
1572-91, 1860-79, 1654-73, 1801-20

Climate Reconstruction Analysis Div. 8, Eliminating Overlaps, 1500-2008

- *Worst 3 consecutive years:* **1789-91**,
1714-16, 1750-52, 1560-62, 1703-05
- *Worst 5 consecutive years:* **1713-17**,
1521-25, 1750-54, 1952-56, 1787-91
- *Worst 10 consecutive years:* **1708-17**,
1840-49, 1947-56, 1517-26, 1855-64
- *Worst 20 Consecutive years:* **1841-60**,
1699-1718, 1773-92, 1948-67,
1598-1617

Austin Precipitation Reconstruction

- Dr. Cleaveland has recently used the regression equation to reconstruct Austin precipitation 1500-2008. We have not analyzed the reconstruction yet. January-July precipitation in Austin was 240.5mm in 2011. He counted 22 of 156 years less than 300mm (14%) since 1856. The lowest was in 1925, 168.7mm. Yet 3 out of the last 4 years (2008, 2009, 2011) have been less than 300mm.

Summary

- **1940s - 1950s Drought of Record was very severe, particularly for West Texas**
- **Yet, Central & Southeast Texas have had droughts that were more severe & longer in duration than the Drought of Record**
- **Local tree-ring chronologies better than distant chronologies for reconstructions**
- **Distant chronologies account for less climate variance, but it is significant and they are considerably longer (1,000+ years)**
- **We need more chronologies from baldcypress in Texas & Mexico, also historical building materials**

Summary

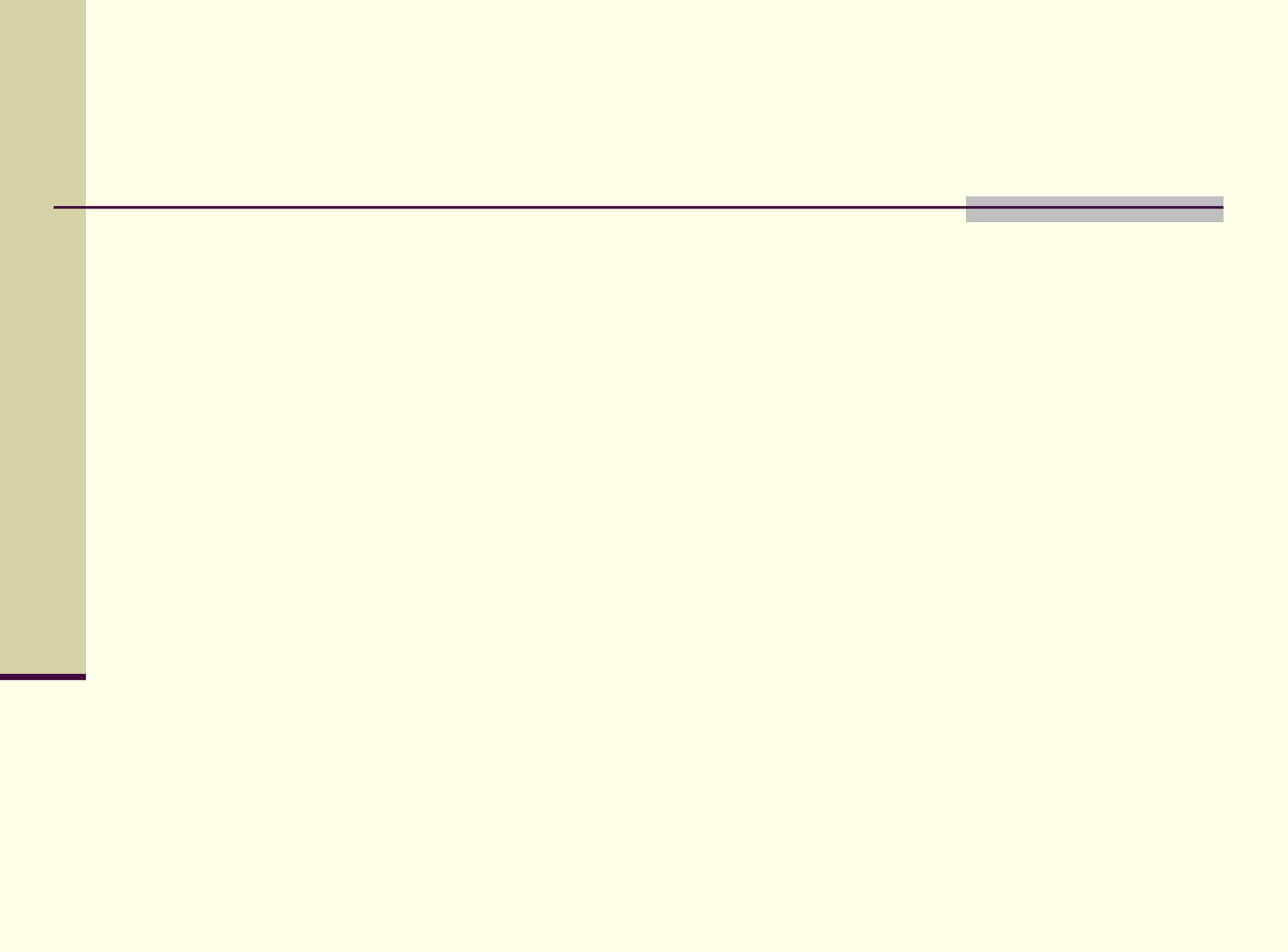
- **Should we be using the maximum reconstructed drought instead of the drought of record for regional water planning, or at least should we evaluate the state water plan on this basis?**
- **Should we give more thought about what we could do if we are in a drought worse than the drought of record?**

Additional Information on this Research

- <http://www.esi.utexas.edu/treeproject/>
- Cleaveland, Malcolm K., Todd H. Votteler, Daniel K. Stahle, Richard C. Casteel, Jay L. Banner, “Extended Chronology of Drought in South Central, Southeastern and West Texas,” *Texas Water Journal*, Vol. 2, Iss. 1 (2011): 54 – 96.

Thank you. Any questions?



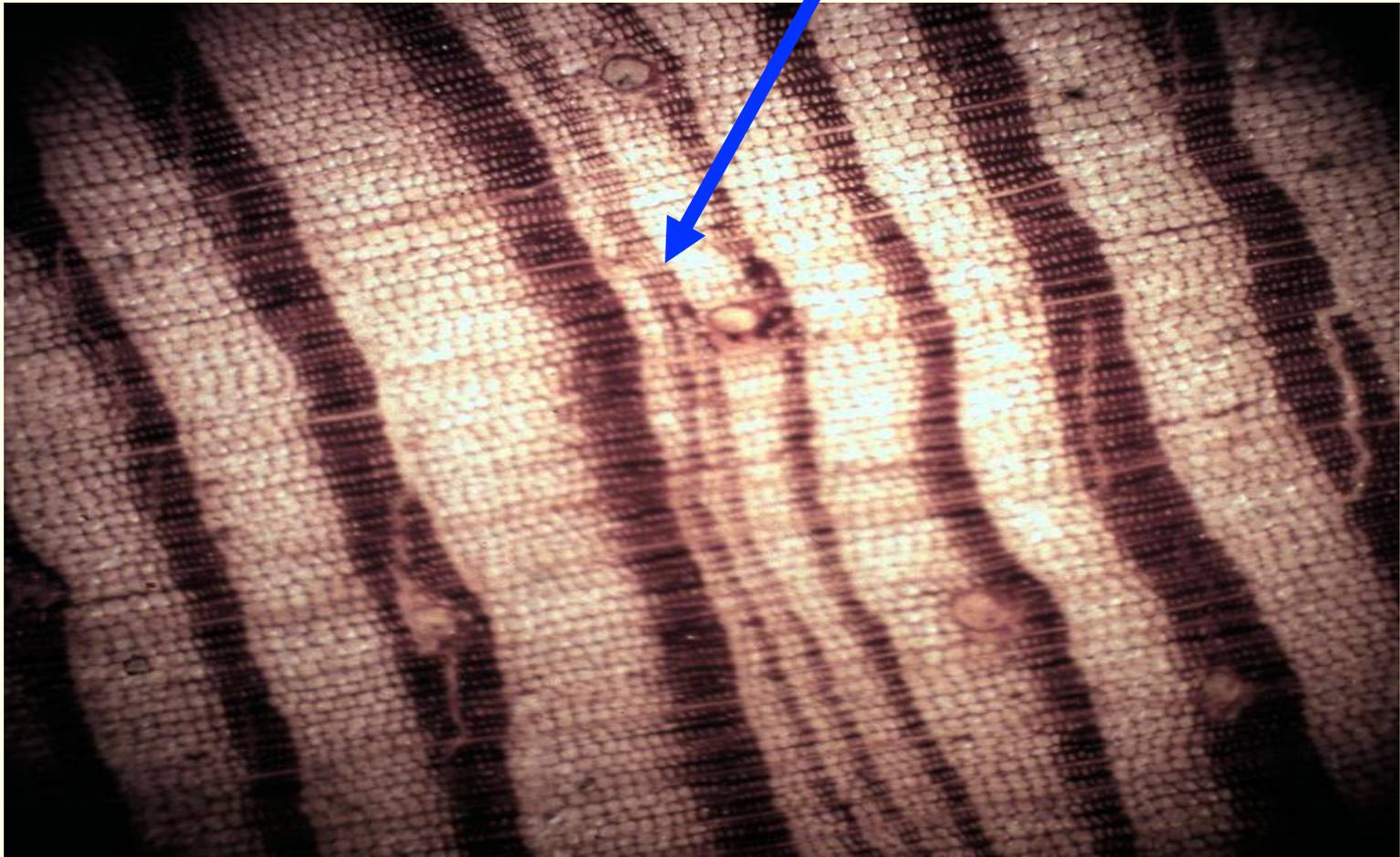


Anomalies: Missing Rings

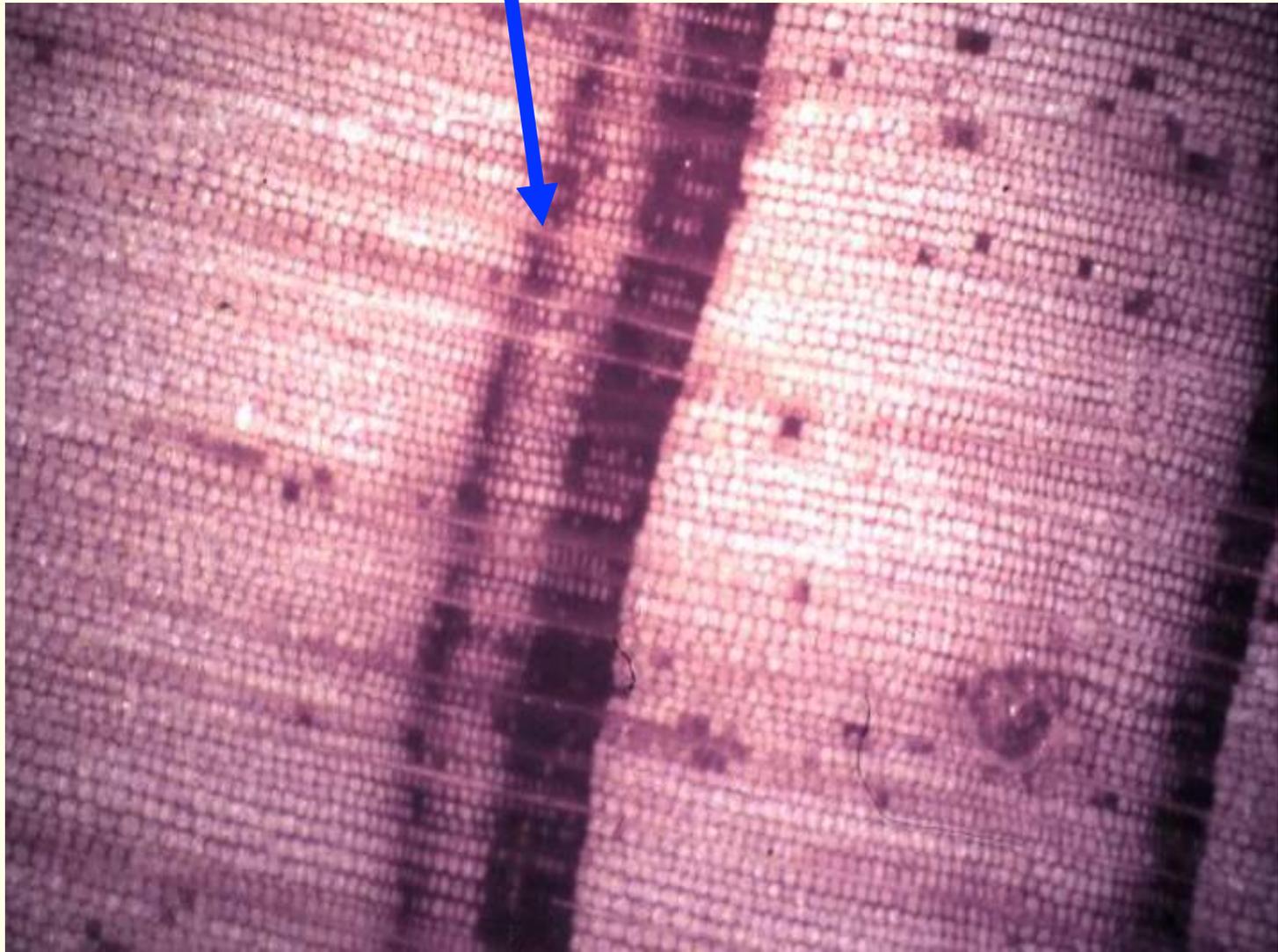
- Created when tree is stressed, by drought, pollution, flooding, etc.
- Growth starts at top of tree, but the plant growth hormones (auxins) may not make it to the bottom in a bad year
- Can only be detected by crossdating

As close as we can come to show you something that is not there!

- Note little ring that merges at top



Anomalies: False Rings



Climate Reconstruction: Complicated

- Create chronologies/use old ones
- Choose calibration/validation periods
- Autoregressively model tree-ring and climate variables, make them AR-0 (no persistence)
- Do Principal Components Analysis (PCA) on the chronologies, new variables max variance
- Regress the PCA variables (independent variables) on the climate (dependent variable)
- Use the regression coefficients to reconstruct climate
- Add in the climate AR model, increase the variance to match observed climate

San Bernard R., Ft. Bend County



Guadalupe River State Park



Sampling Krause Springs, Spicewood

