Dendrohydrology: The Use of Tree Ring Data in Paleo Reconstructions

Glenn Tootle[1] and Matt Therrell[2]
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Lake Mead above Hoover Dam – early 2000's

Lake Lanier – late 2000's

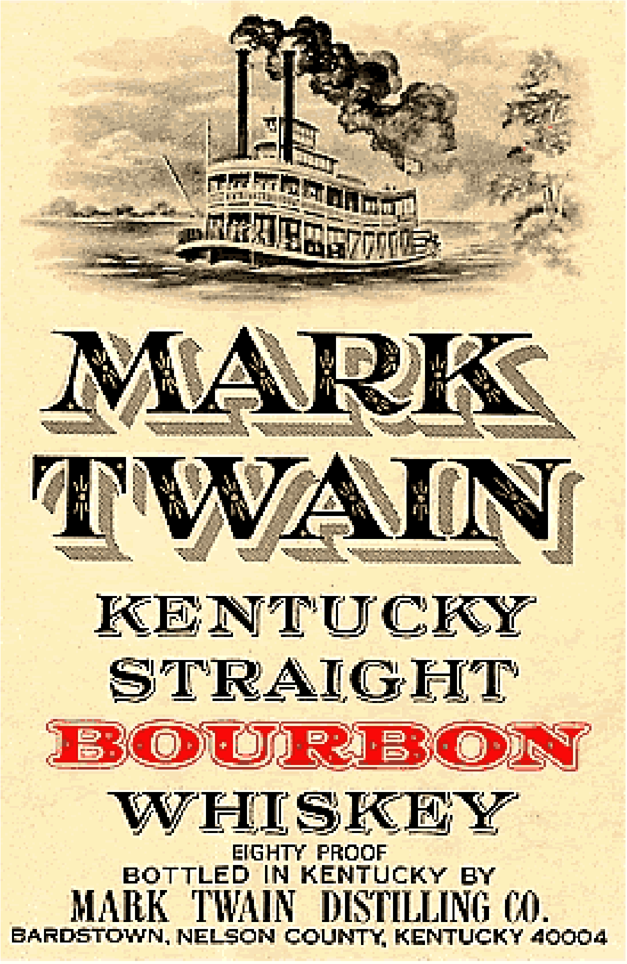
Outline

- Western US Water & Colorado River Compact
- Paleohydrology
  - Past Research in the Upper Colorado River Basin
- Developing a Tree Ring Chronology (TRC)
- Developing a Streamflow Reconstruction
- Reconstruction Potential in the SE US
- Questions

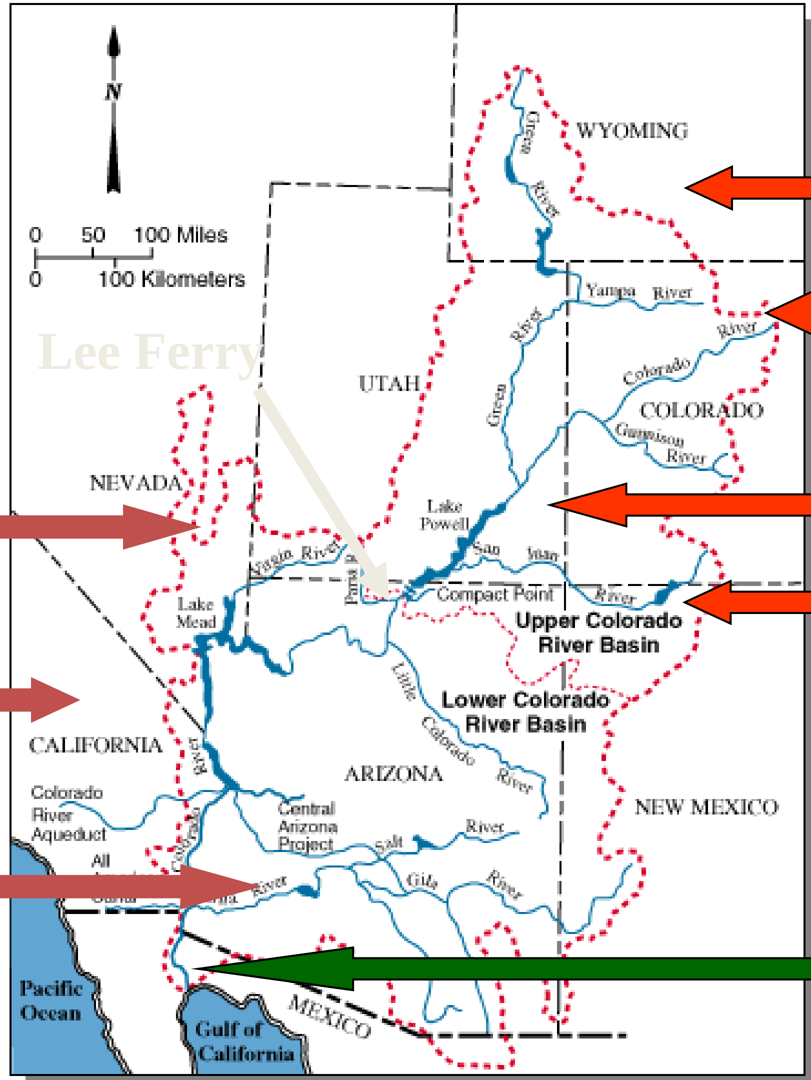
Mark Twain's View

"Whiskey is for drinking; water is for fighting over"

"Water, taken in moderation, cannot hurt anybody"



Allocation of Colorado River Water [16.5 million acre-ft (MAF)]



Upper Basin (7.5 MAF)

WY – 1.0 MAF

CO – 3.9 MAF

UT – 0.9 MAF

NM – 1.7 MAF

Lower Basin (7.5 MAF)

NV – 0.3 MAF

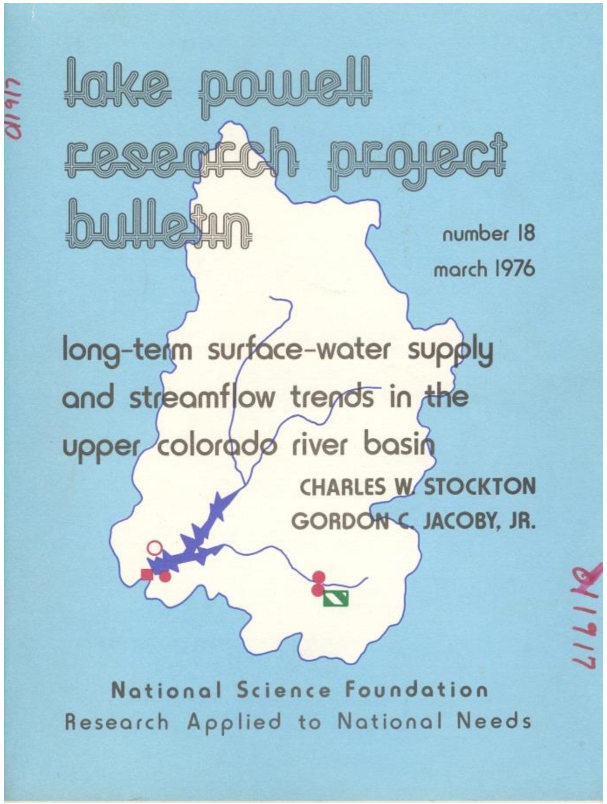
CA– 4.4 MAF

AZ – 2.8 MAF

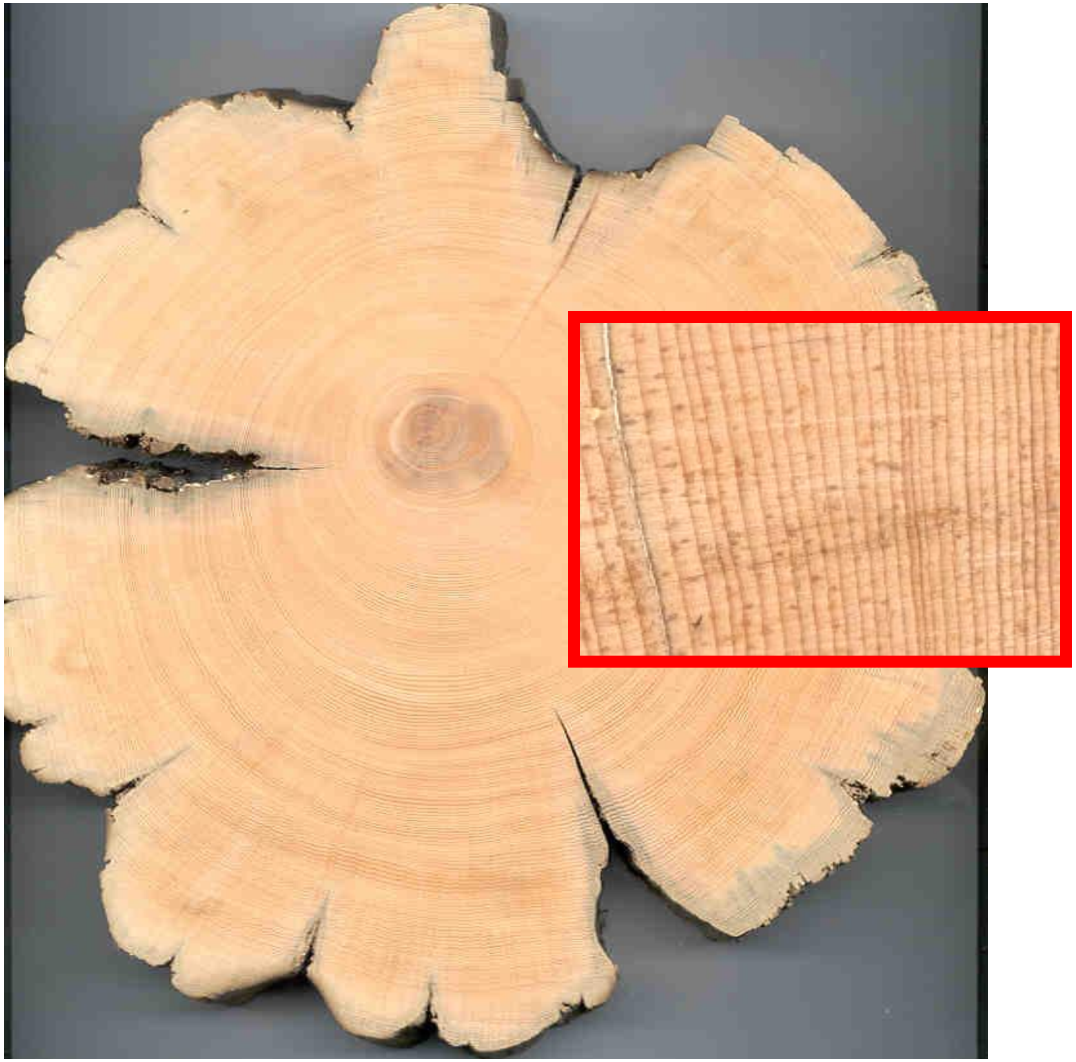
Mexico – 1.5 MAF

Water Education Foundation, 1999

Stockton and Jacoby (1976)



First statistical recon-
struction of streamflow
from tree rings



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RECONSTRUCTED STREAMFLOWS FOR THE HEADWATERS OF THE WIND RIVER, WYOMING, UNITED STATES[1]

Thomas A. Watson, F. Anthony Barnett, Stephen T. Gray, and Glenn A. Tootle[2]

Upper Green River Basin (United States) Streamflow Reconstructions

F. Anthony Barnett, M.ASCE[1]; Stephen T. Gray[2]; and Glenn A. Tootle, M.ASCE[3]

Abstract: The Upper Green River represents a vital water supply for southwestern Wyoming and Upper/Lower Colorado River Compact states. Rapid development in the southwestern United States combined with the recent drought has greatly stressed the water supply of the Colorado River system, and concurrently increased the interest in long-term variations in streamflow. The current research developed six new tree-ring chronologies in and adjacent to the Upper Green River Basin (UGRB). Nine proxy reconstructions (three main-stem streams and six headwater streams) of UGRB streamflow were created by combining these new tree-ring chronologies with existing tree-ring chronologies from sites adjacent to the UGRB. All UGRB streamflow reconstructions extended back to the year 1615 or earlier. The variance explained (r^2) by these reconstructions ranged from a low of 0.44 at one headwaters gauge to 0.65 for the lowest main-stem gauge in the drainage. An extended reconstruction of the main-stem Green River gauge near Greendale, Utah extends back to 1439. As a group, the nine reconstructions show that strong regional coherency in interannual flow variability and multiyear to decadal flow regimes are consistent features of the preinstrumental period. Focusing on the Green River at Greendale reconstruction, our analyses point to unusual wetness in the 20th century and a regional hydroclimate characterized by inherent nonstationarity. Overall, these results suggest that instrumental records capture a relatively small subset of potential streamflow variability in the UGRB.

DOI: 10.1061/(ASCE)HE.1943-5584.0000213

CE Database subject headings: Streamflow; Reconstructions; Droughts; River basins; Colorado River; Wyoming.

Author keywords: Streamflow; Reconstructions; Drought; Dendrochronology.

Case Study

Case Study of Drought Frequency and Risk Analysis in the Upper Green River Basin, Wyoming

John Bellamy, M.ASCE[1]; Glenn Tootle[2]; Snehalata Huzurbazar[3]; Larry Pochop[4]; and Anthony Barnett[5]

Abstract: The limited length of instrumental streamflow data impacts the true magnitude of natural interdecadal variability of water delivered from the Upper Green River Basin (UGRB). This limited period of instrumental record can be expanded by utilizing proxy records (reconstructed streamflow) derived from tree rings. Recent research has resulted in the development of nine streamflow reconstructions spatially located throughout the UGRB. This paper utilizes four of these nine reconstructed streamflow records and instrumental records to compare and analyze differences between the two streamflow records—human and natural. Three approaches were used for comparison and analysis: (1) Weibull distribution, (2) compound renewal, and (3) drought risk using bivariate probability distribution functions. This analysis has resulted in magnitude-duration-frequency curves for UGRB drought. Such probability curves and stochastic analysis can then be utilized in light of compact agreements and system storage to answer questions such as "How bad is it right now and what can we expect to happen next year?" This case study is intended to show statistical and observed differences between human (short-term) and natural (long-term) streamflow records and specifically target differences in long-term drought characteristics for this drainage basin.

DOI: 10.1061/(ASCE)HE.1943-5584.0000698.

CE Database subject headings: Droughts; Streamflow; Wyoming; River basins; Risk management; Case studies.

Author keywords: Drought; Paleo; Streamflow.

USGS science for a changing world

TREE-RING RESEARCH, *Vol. 68(2), 2012, pp. 105–114*

SNOWPACK RECONSTRUCTIONS INCORPORATING CLIMATE IN THE UPPER GREEN RIVER BASIN (WYOMING)

SALLYROSE ANDERSON[1]*, CODY L. MOSER[1], GLENN A. TOOTLE[1], HENRI D. GRISSINO-MAYER[2], JANAK TIMILSENA[3], and THOMAS PIECHOTA[4]

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Using Pacific Ocean climatic variability to improve hydrologic reconstructions

SallyRose Anderson [a,*], Oubeid Aziz [a], Glenn Tootle [a], Henri Grissino-Mayer [b], Anthony Barnett [c]

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RECONSTRUCTIONS OF SOIL MOISTURE FOR THE UPPER COLORADO RIVER BASIN USING TREE-RING CHRONOLOGIES[1]

SallyRose Anderson, Glenn Tootle, and Henri Grissino-Mayer[2]

National Science Foundation Paleo Perspectives on Climate Change (P2C2) (AGS-1003393)

Tree ring records have been cross-dated to provide to date historic events

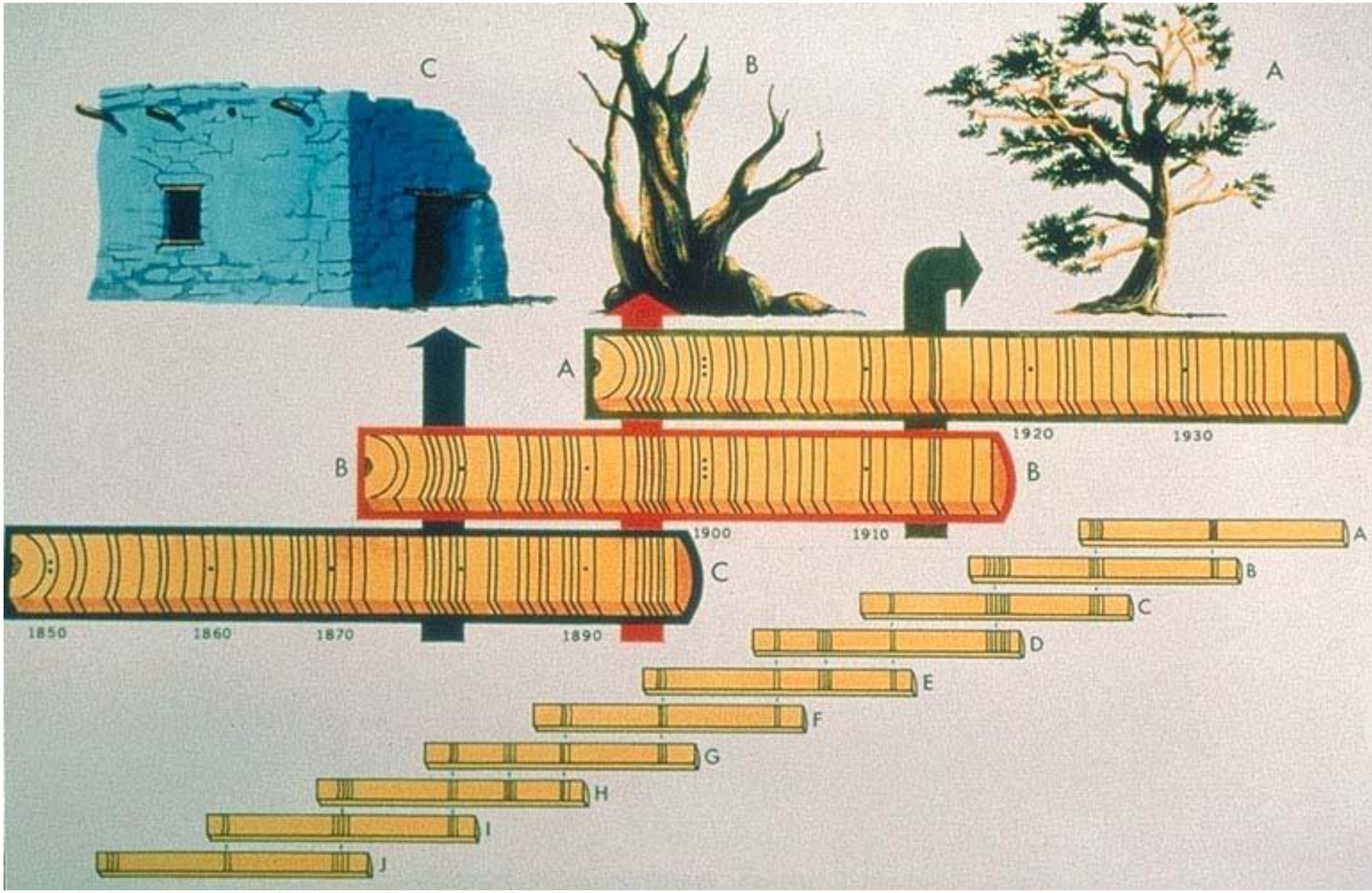
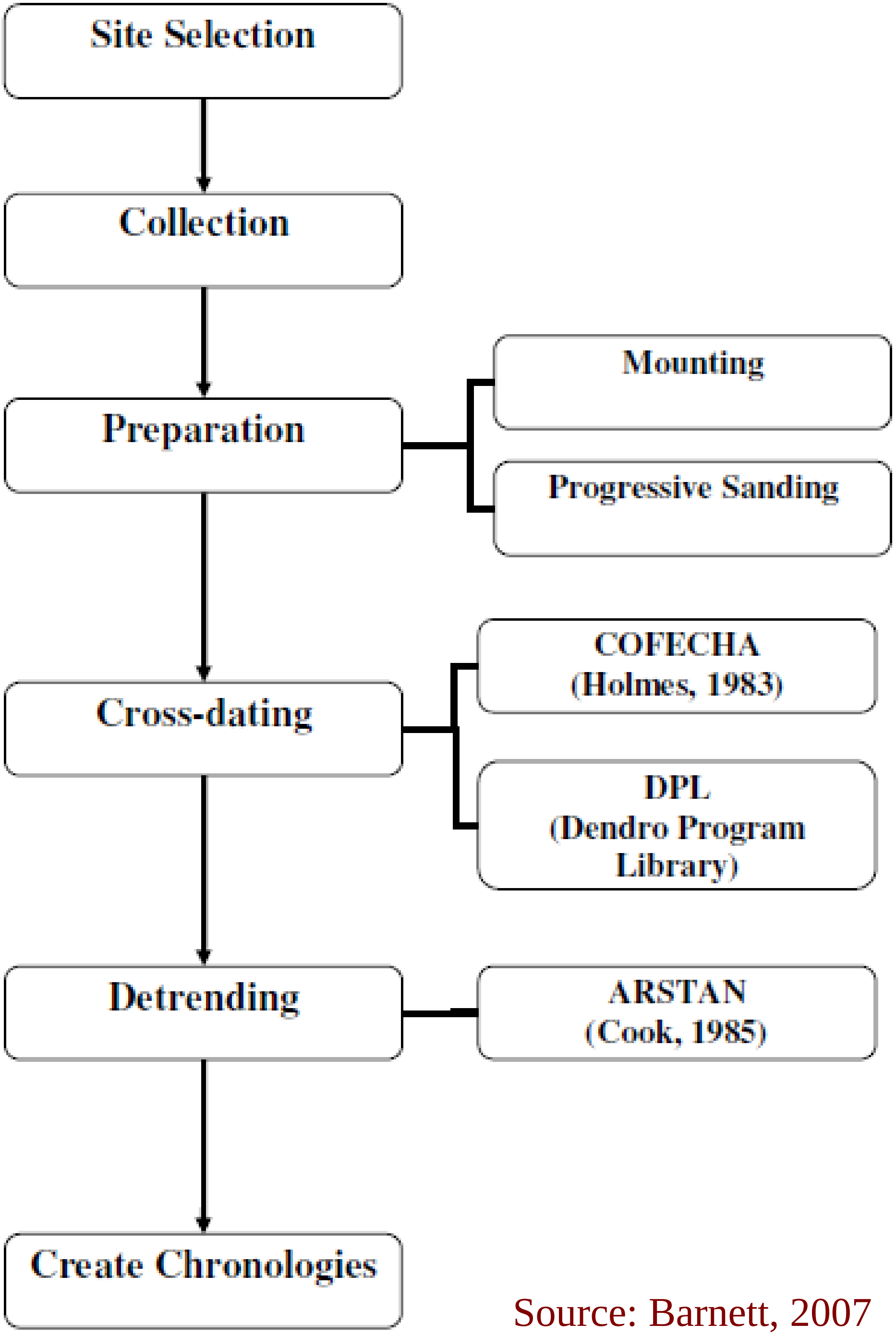
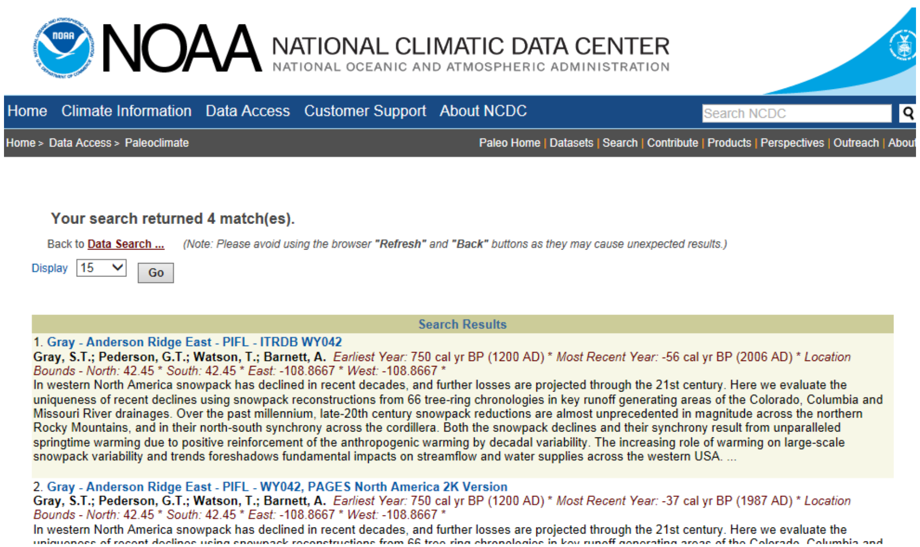


Image courtesy of LTRR (U. AZ)

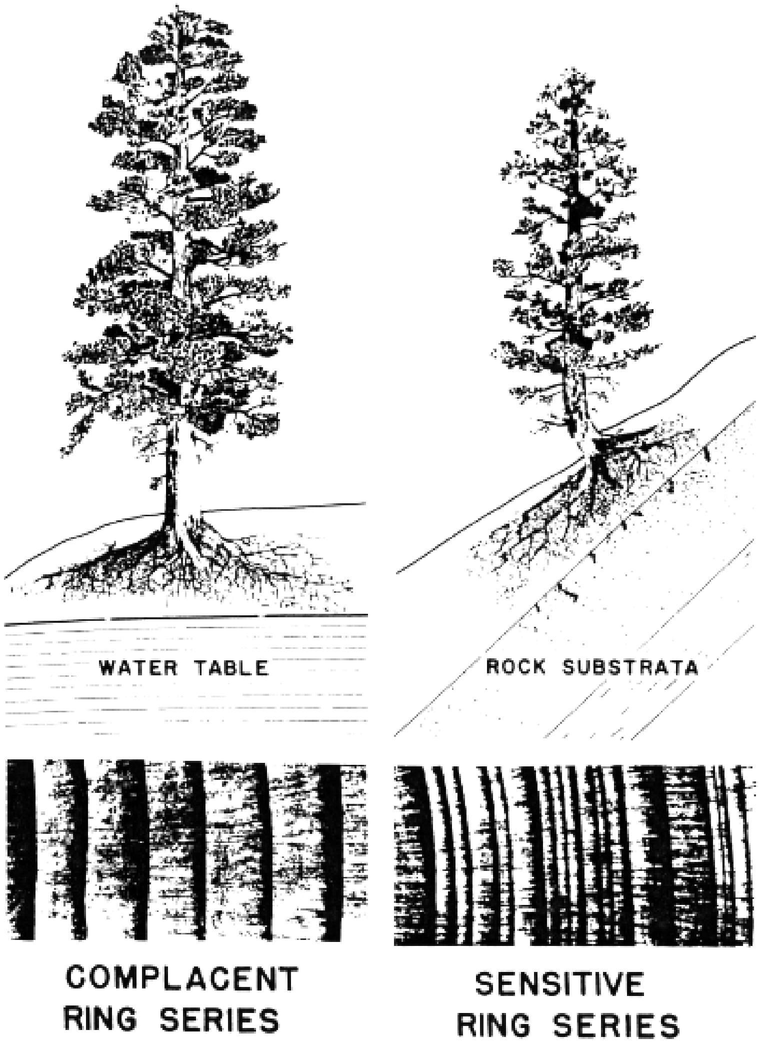




Source: Barnett, 2007

Site Selection

(Moisture Sensitive Species, Old, Stressed)



Site Selection

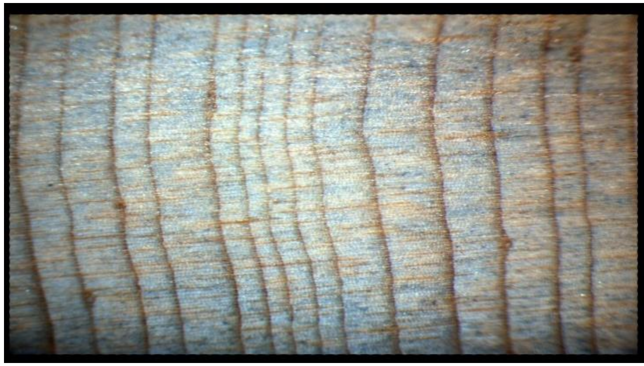
(Wind River Range, Wyoming)

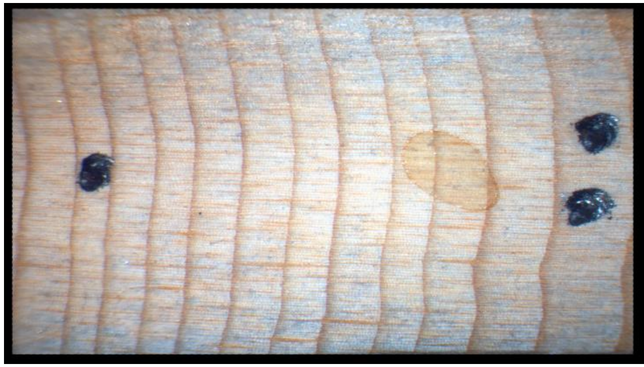
Site Selection

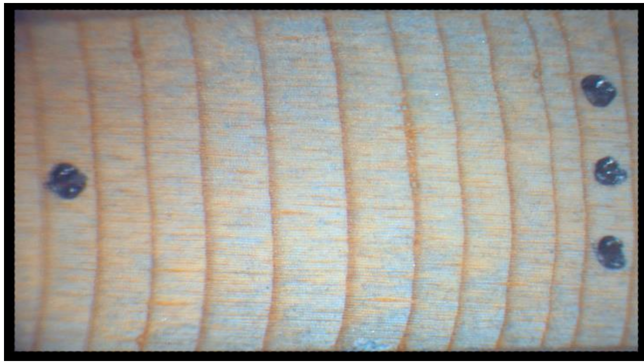
(near Grants, New Mexico)

Tree core sampling and core preservation

Tree Ring Lab







Many samples from a site are detrended and combined to create a single time series (chronology)

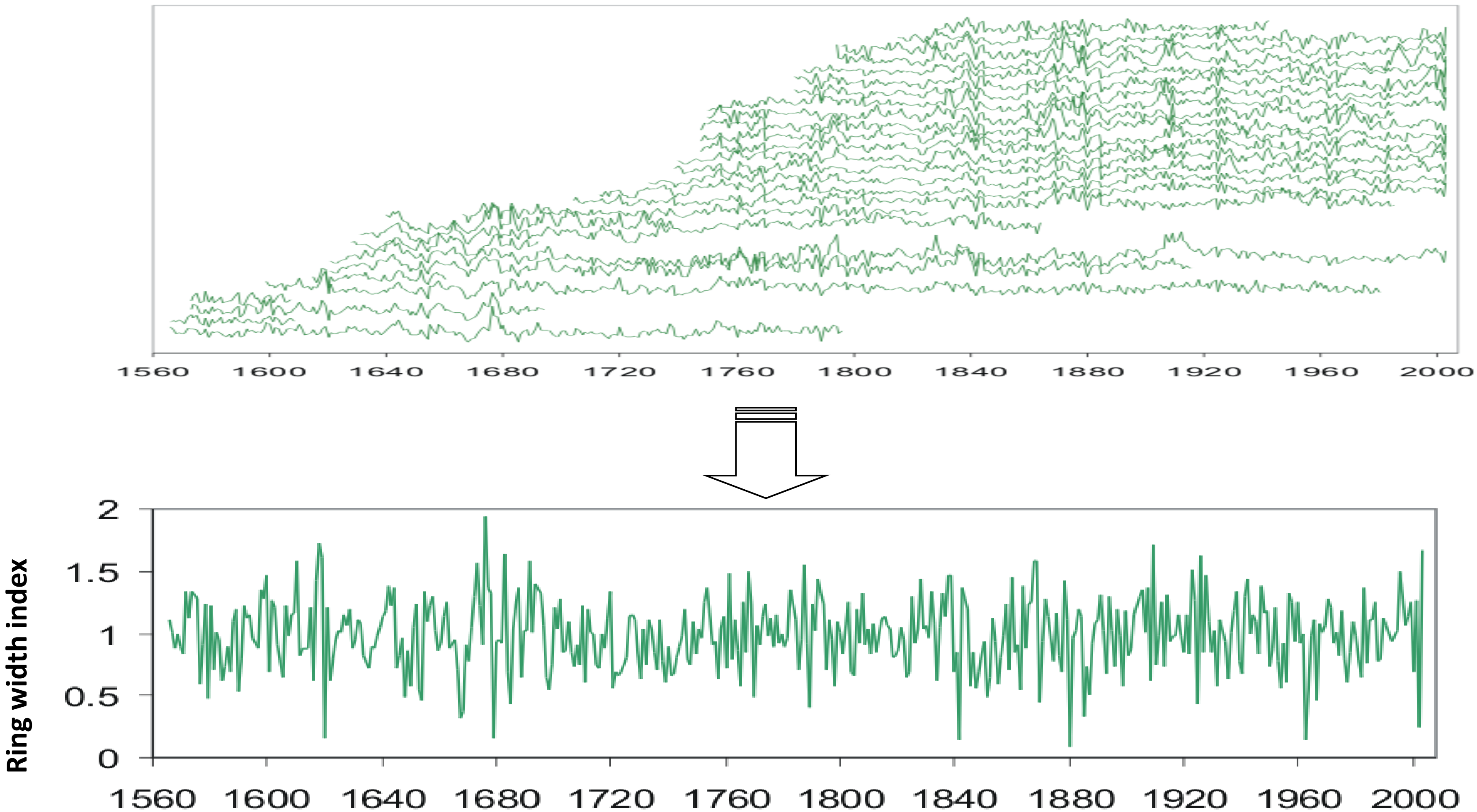
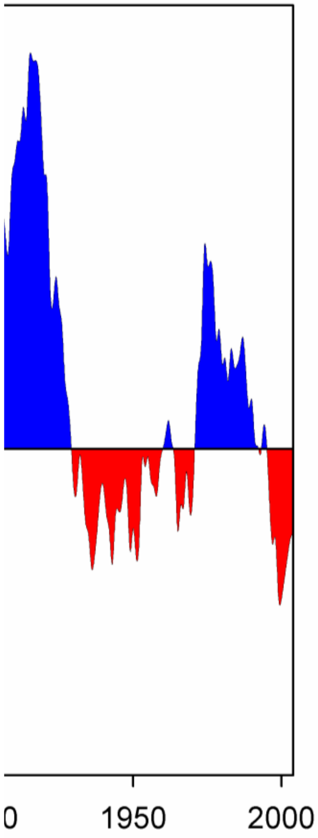


Image courtesy of J. Lukas (U. CO)

Statistical models (reconstructions) of streamflow, snowpack, precipitation, soil moisture can be developed going back in time 300 to 500 years identifying extreme events.

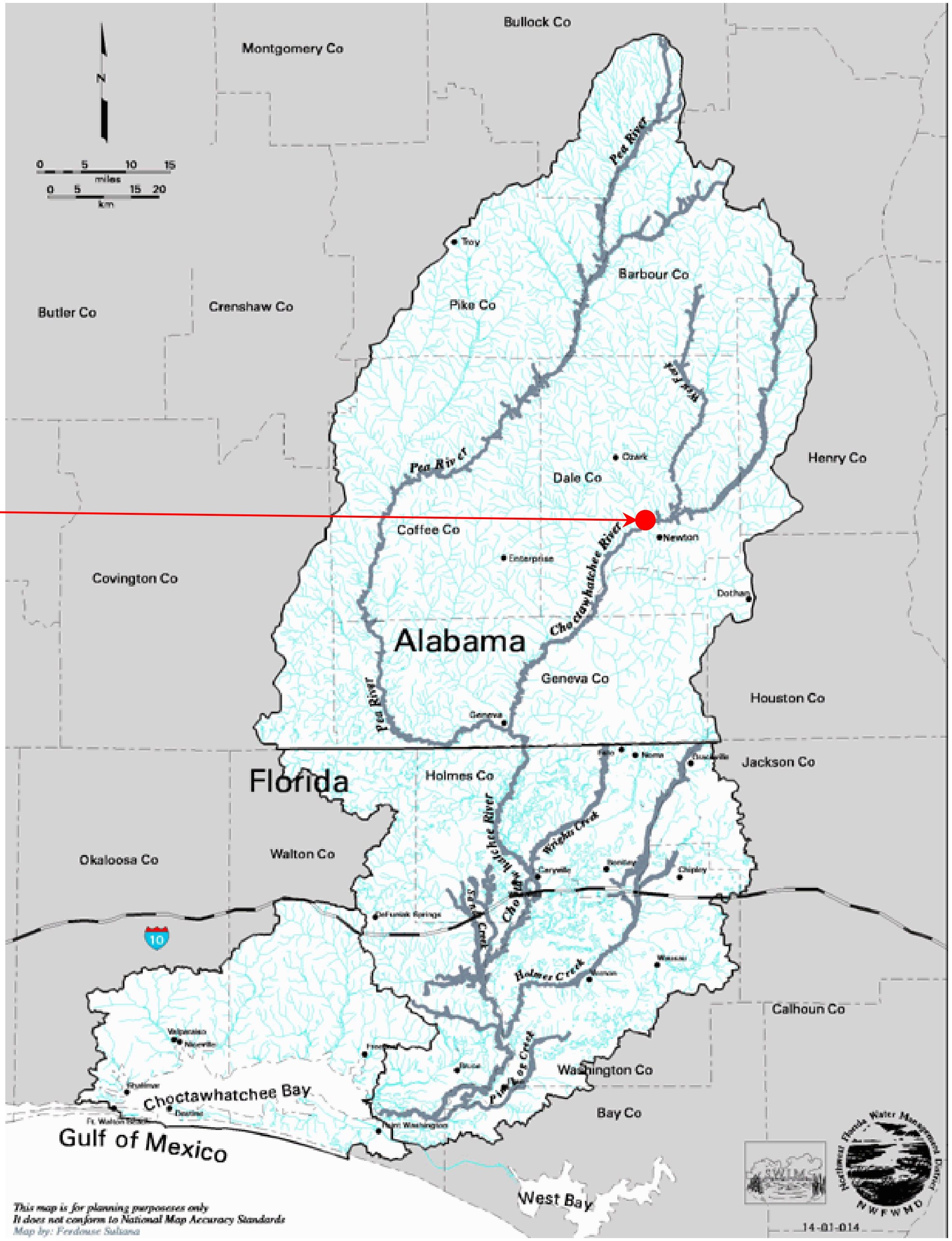


Source: Barnett et al., 2010

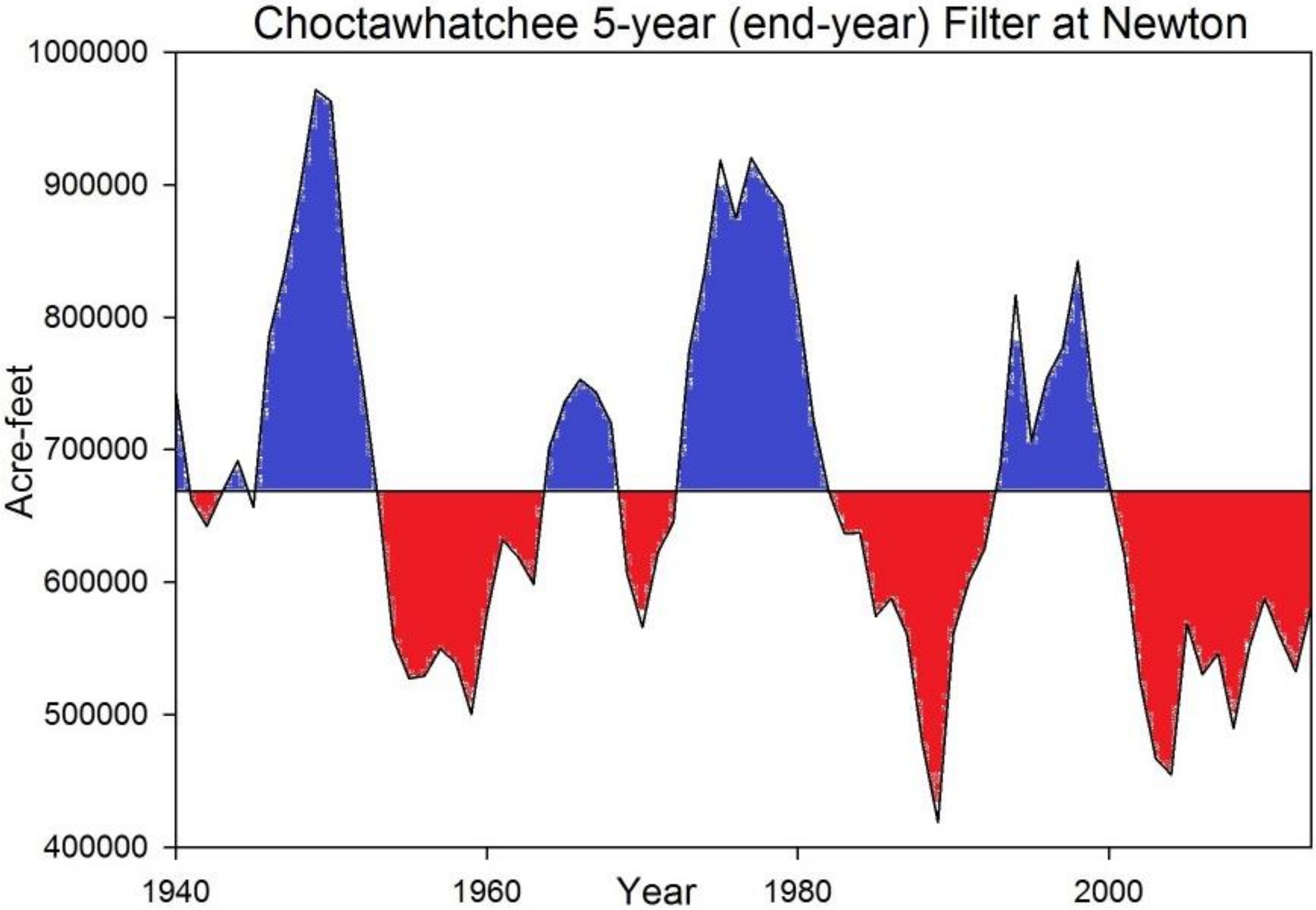
Choctawhatchee River Water-Year Droughts

Newton AL

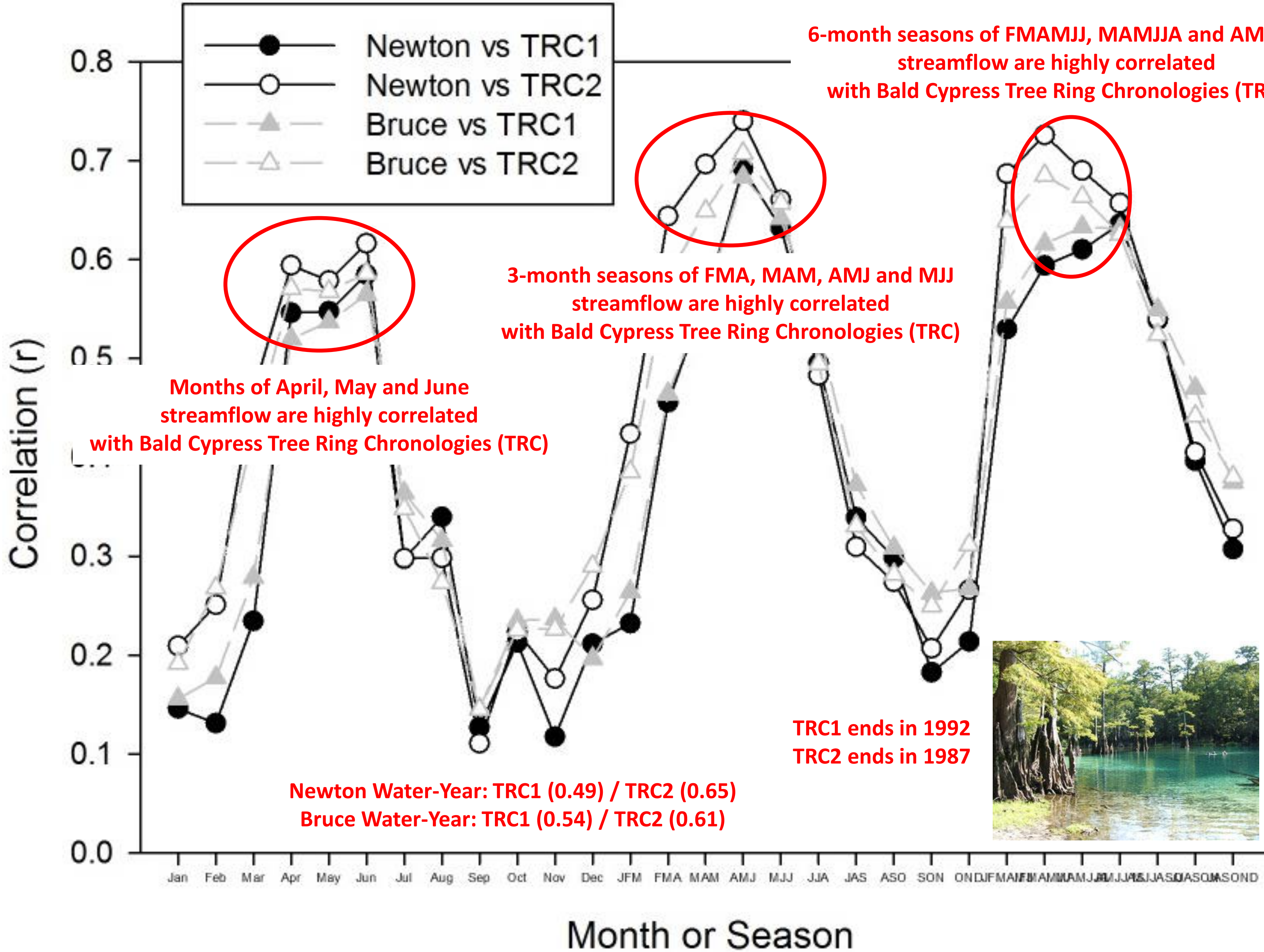
	Water-Year (1936 to 2013)		
Rank	1-year	5-year (end year)	10-year (end year)
1	**2012**	1989	**2008**
2	**2000**	**2004**	**2009**
3	**2011**	**2003**	1989
4	**2002**	1988	1959
5	1955	**2008**	**2007**
6	**2007**	1959	**2013**
7	1981	**2002**	**2012**
8	1951	1955	**2011**
9	1956	1956	1960
10	**2006**	**2006**	1988



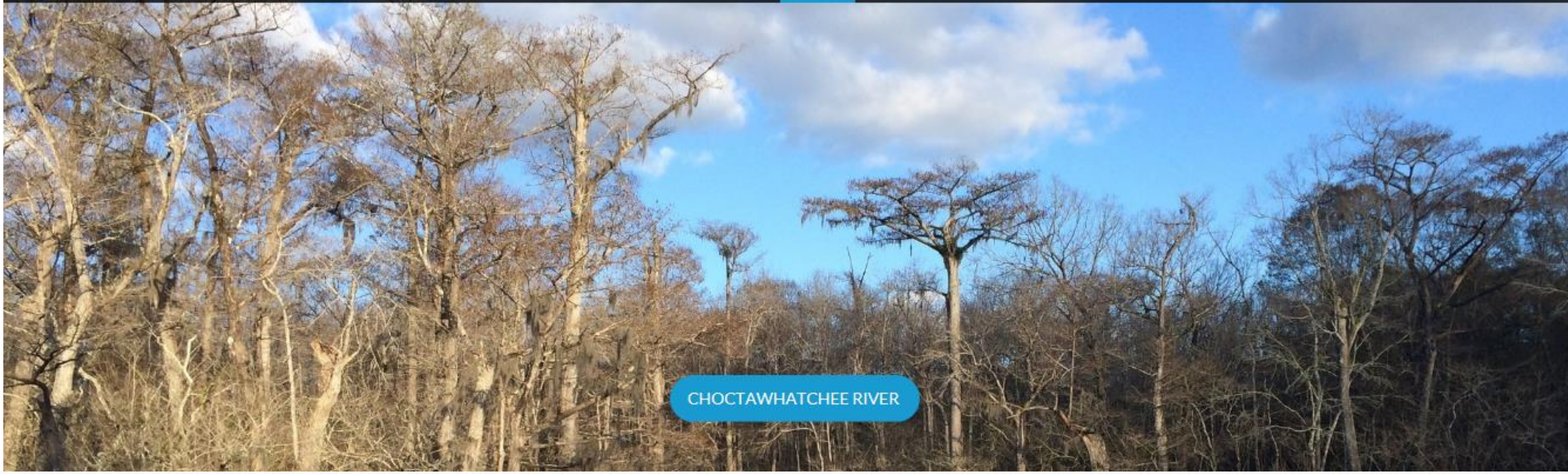
Choctawhatchee River Water-Year Streamflow



Choctawhatchee River Reconstruction Potential



CHOCTAWHATCHEE RIVER TREE RING STUDY | HOME | DATA COLLECTION | LAB ANALYSIS | LAB RESULTS



ABOUT THE STUDY

Dr. Matt Therrell (UA Department of Geography) and Dr. Glenn Tootle (UA Department of Civil, Construction and Environmental Engineering) and a team of two graduate (Ashton Greer and Matt Meko) and seven undergraduate (Siera Jann, Caitlin Koranda, Natalie Leder, Aubrey Loria, Mallory Mitchell, Thomas Moat, Sam Spector) researchers traveled from The University of Alabama to the Choctawhatchee River in the Florida panhandle to collect tree ring data from Bald Cypress trees in order to conduct research on reconstructing streamflow. The study is funded by the Geological Survey of Alabama and the Mississippi-Alabama Sea Grant Consortium.

Special thanks to Mr. Bruner for access to the tree sampling sites and to the Geological Survey of Alabama and the Mississippi-Alabama Sea Grant Consortium for their support.

GEOLOGICAL SURVEY OF ALABAMA Founded 1848

Sea Grant Mississippi-Alabama

http://choctawhatcheerivertreeringstudy.weebly.com/

Thanks and Questions?

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Matt Therrell (therrell@ua.edu)