

Dendrohydrology: The Use of Tree Ring Data in Paleo Reconstructions

Glenn Tootle¹ and Matt Therrell²

¹University of Alabama, Department of Civil, Const. and Env. Engineering

²University of Alabama, Department of Geography



Lake Mead above Hoover Dam – early 2000's



Lake Lanier – late 2000's



Outline

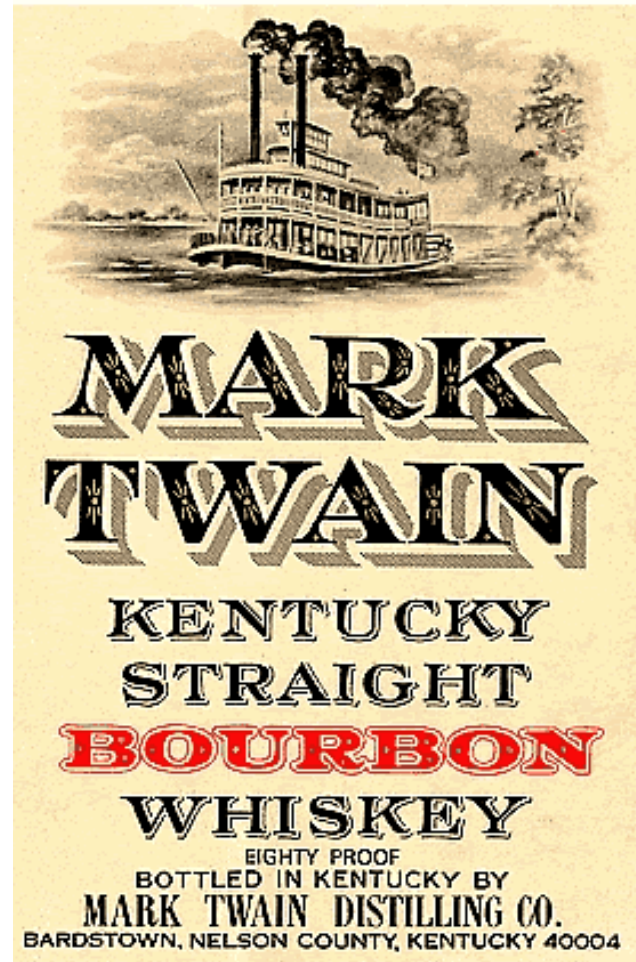
- Western US Water & Colorado River Compact
- Paleohydrology
 - Past Research in the Upper Colorado River Basin
- Developing a Tree Ring Chronology (TRC)
- Developing a Streamflow Reconstruction
- Reconstruction Potential in the SE US
- Questions



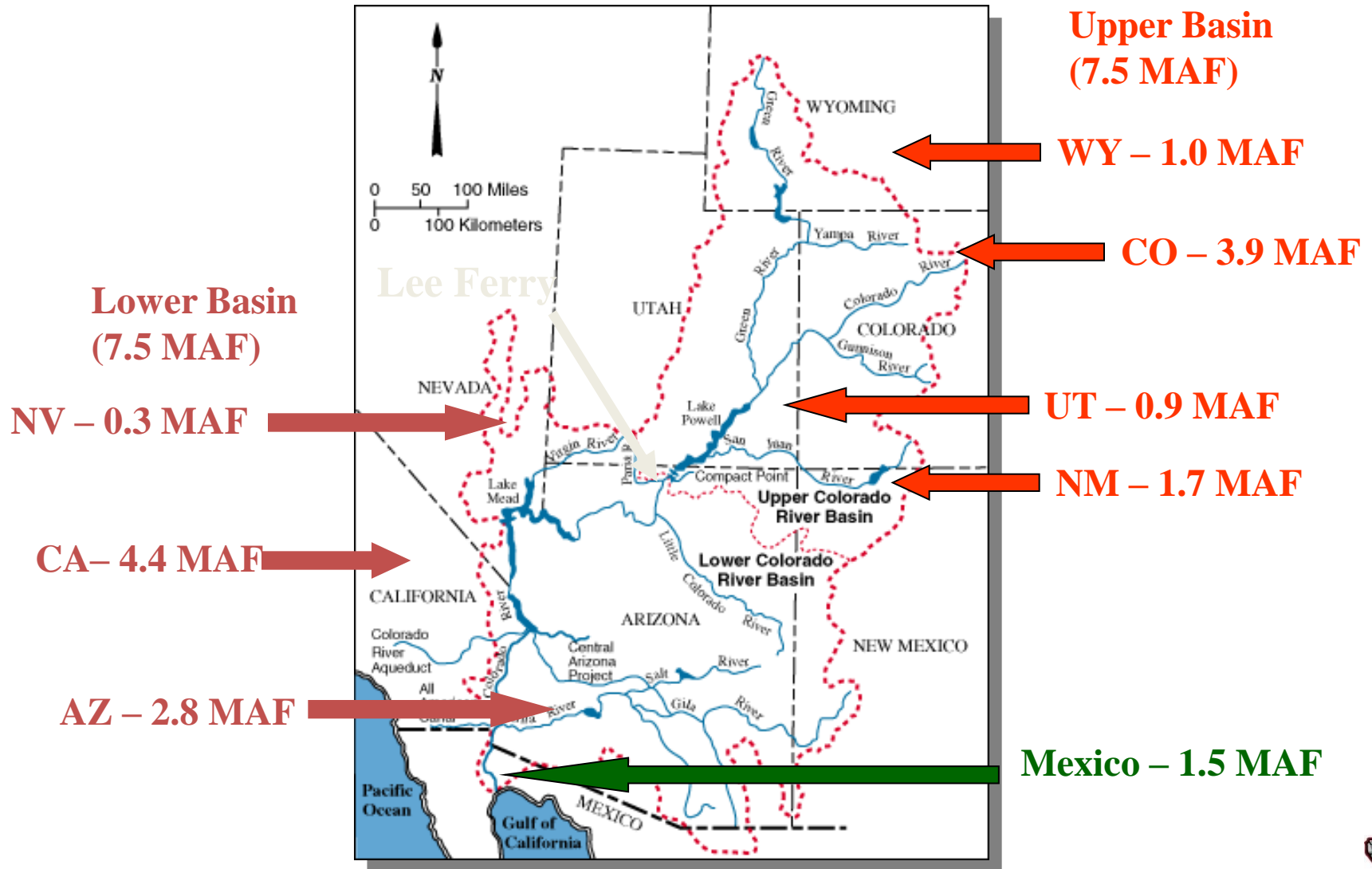
Mark Twain's View

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

"Water, taken in moderation, cannot hurt anybody"



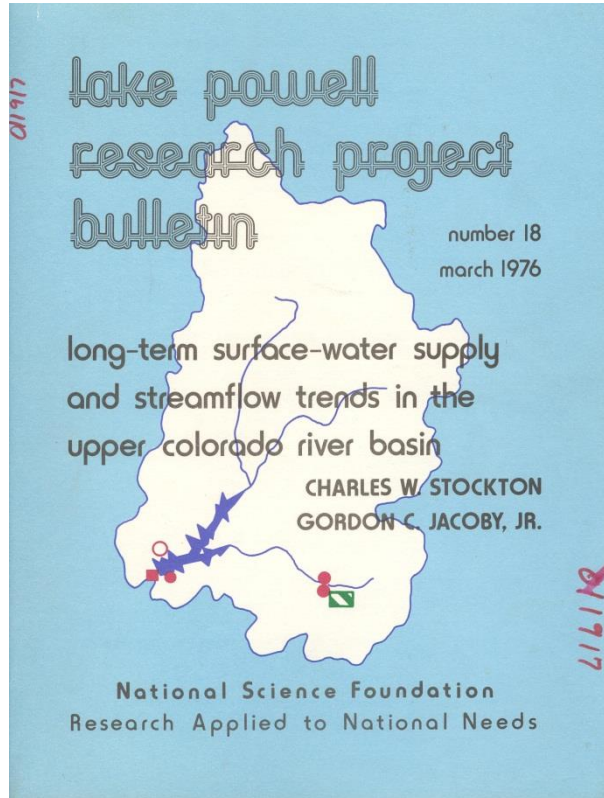
Allocation of Colorado River Water [16.5 million acre-ft (MAF)]



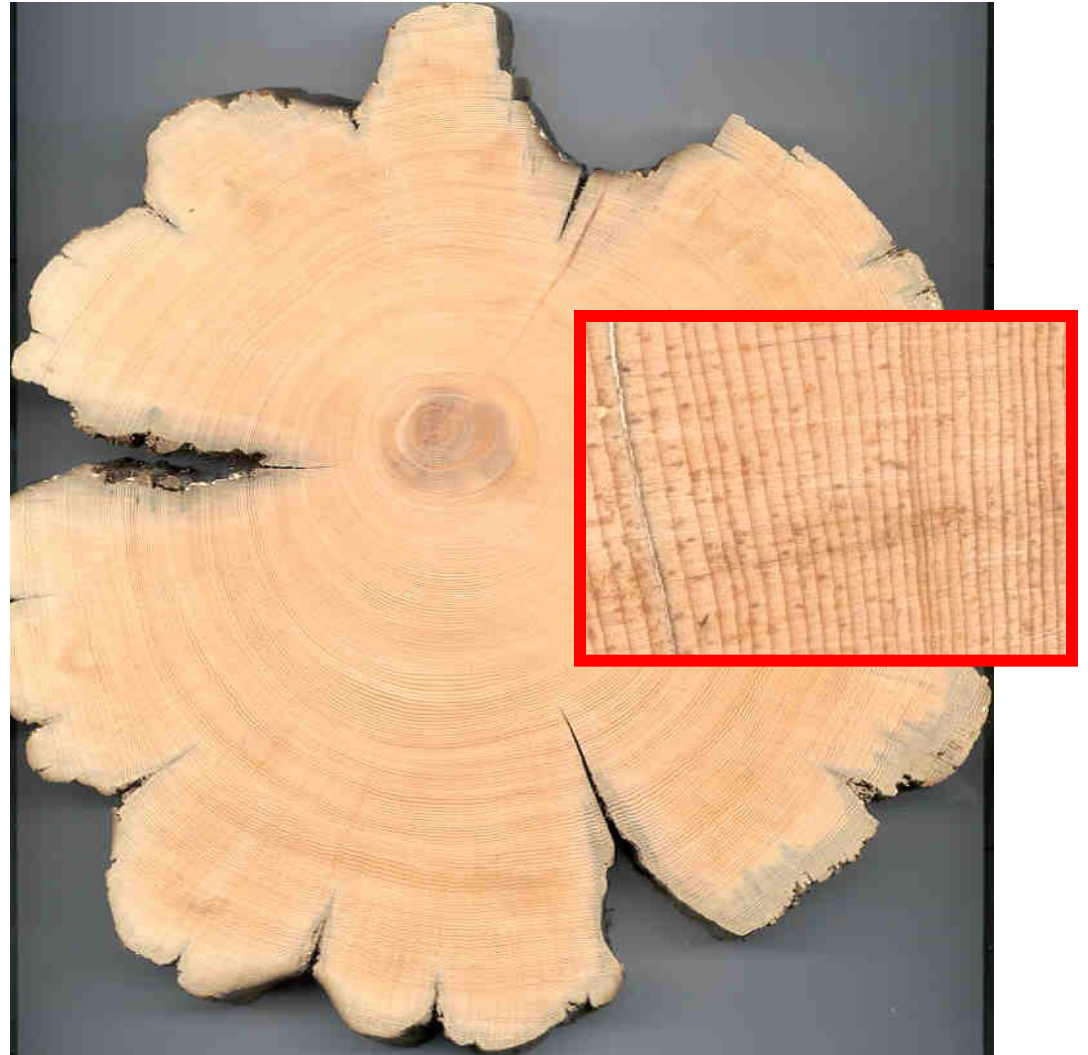
Water Education Foundation, 1999



Stockton and Jacoby (1976)



First statistical reconstruction of streamflow from tree rings





RECONSTRUCTED STREAMFLOWS FOR THE HEADWATERS OF THE WIND RIVER, WYOMING, UNITED STATES¹

Thomas A. Watson, F. Anthony Barnett, Stephen T. Gray, and Glenn A. Tootle²

Upper Green River Basin (United States) Streamflow Reconstructions

F. Anthony Barnett, M.ASCE¹; Stephen T. Gray²; and Glenn A. Tootle, M.ASCE³

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.ASCE¹; Glenn Tootle²; Snehalata Huzurbazar³; Larry Pochop⁴; and Anthony Barnett⁵

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 those 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. © 2013 American Society of Civil Engineers.

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

Author keywords: Drought; Paleo; Streamflow.



Adapted from ADWR, 1997





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. MOSER¹, GLENN A. TOOTLE¹, HENRI D. GRISSINO-MAYER², JANAK TIMILSENA³, and THOMAS PIECHOTA⁴

¹University of Tennessee, Department of Civil and Environmental Engineering, 67 Perkins Hall, Knoxville, TN 37996 USA

²Laboratory of Tree-Ring Science, University of Tennessee, Department of Geography, Knoxville, TN 37996 USA

³Idaho Power Company, Boise, ID 83707 USA

⁴University of Nevada, Las Vegas, Office of Sustainability and Multidisciplinary Research, Las Vegas, NV 89054 USA



Contents lists available at SciVerse ScienceDirect

Journal of Hydrology

journal homepage: www.elsevier.com/locate/jhydrol



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

^aUniversity of Tennessee, Department of Civil and Environmental Engineering, 67 Perkins Hall, Knoxville, TN 37996, USA

^bUniversity of Tennessee, Department of Geography, 417 Burchfiel Geography Building, Knoxville, TN 37996, USA

^cUniversity of Wyoming, Department of Civil and Architectural Engineering, 1000 E. University Ave., Laramie, WY 82071, USA



Vol. 48, No. 4

JOURNAL OF THE AMERICAN WATER RESOURCES ASSOCIATION

AMERICAN WATER RESOURCES ASSOCIATION

August 2012

RECONSTRUCTIONS OF SOIL MOISTURE FOR THE UPPER COLORADO RIVER BASIN USING TREE-RING CHRONOLOGIES¹

SallyRose Anderson, Glenn Tootle, and Henri Grissino-Mayer²



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

Adapted from ADWR, 1997



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

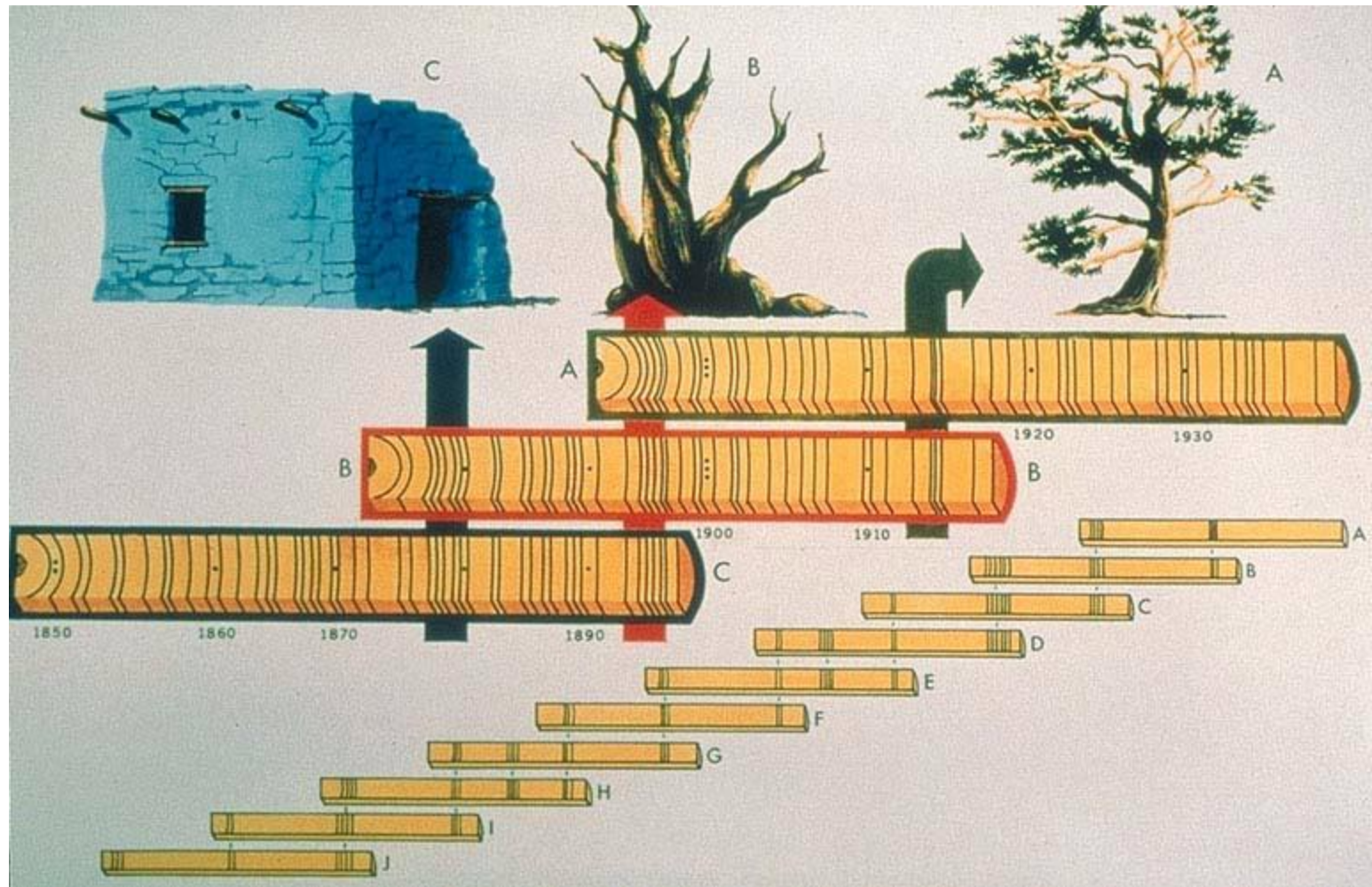
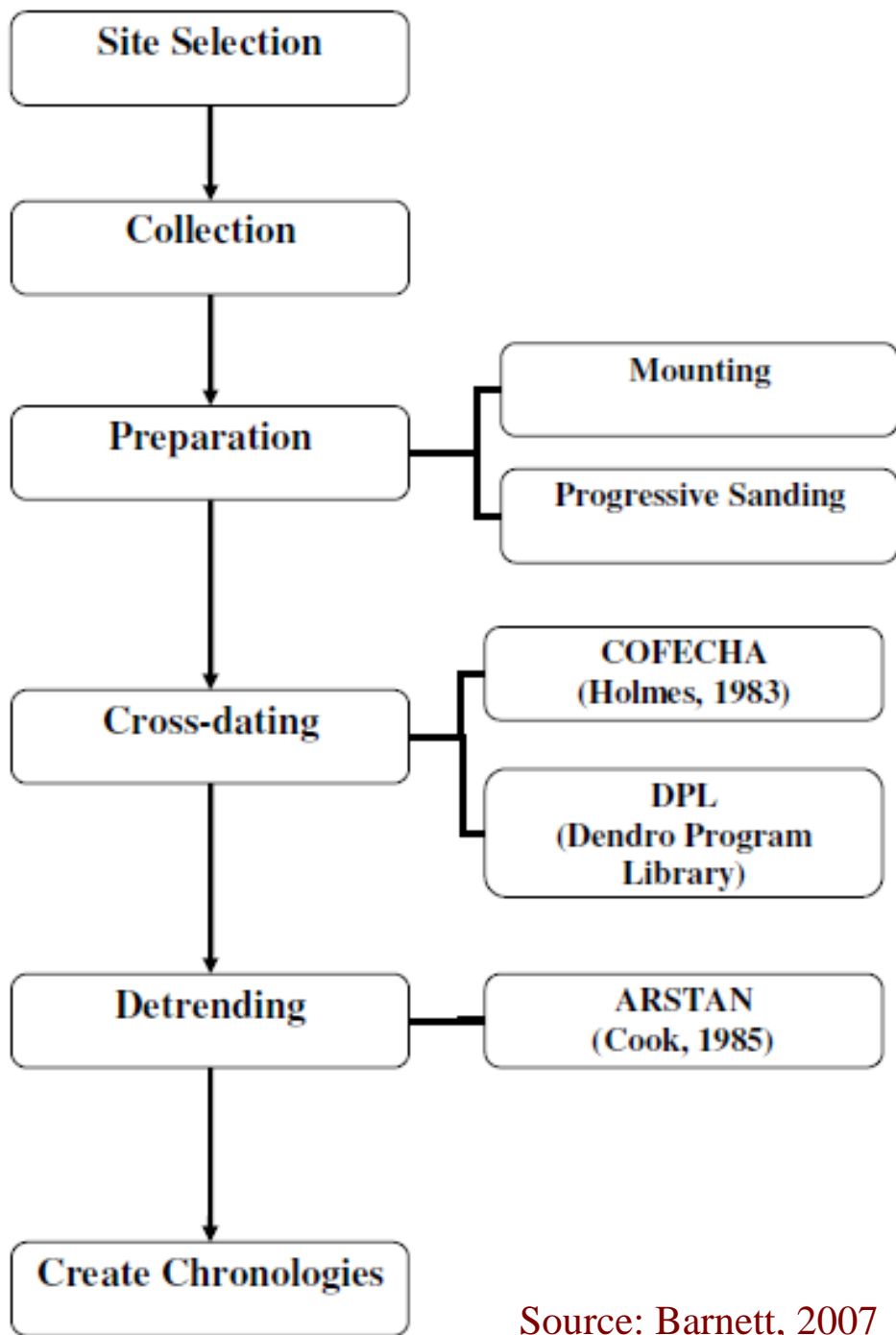


Image courtesy of LTRR (U. AZ)





Source: Barnett, 2007

NOAA NATIONAL CLIMATIC DATA CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Home Climate Information Data Access Customer Support Contact About NCDC Search NCDC

Home > Data Access > Paleoclimatology > Datasets > Tree Ring

Quick Links
 Land-Based Station
 Satellite
 Radar
 Model
 Weather Balloon
 Marine / Ocean
 Paleoclimatology

Tree Ring

The International Tree-Ring Data Bank (ITRDB) is the world's largest archive of tree ring data, managed by NCDC's Paleoclimatology Branch and the World Data Center for Paleoclimatology. The ITRDB includes raw ring width, wood density, isotope measurements, and site growth index chronologies. Over 3,000 sites on six continents are included. Reconstructed climate parameters are also available for some areas.

Obtaining Data at the World Data Center
Search Datasets

NOAA NATIONAL CLIMATIC DATA CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Home Climate Information Data Access Customer Support About NCDC Search NCDC

Home > Data Access > Paleoclimate Pale Home | Datasets | Search | Contribute | Products | Perspectives | Outreach | About

Your search returned 4 match(es).

Back to [Data Search...](#) (Note: Please avoid using the browser "Refresh" and "Back" buttons as they may cause unexpected results.)

Display 15 Go

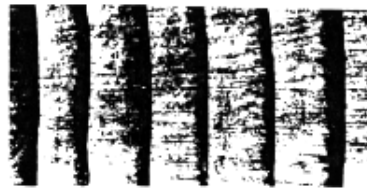
Search Results

- Gray, S.T.; Anderson Ridge East - PIFL - ITRDB WY042
 Gray, S.T.; Pederson, G.T.; Watson, T.; Barnett, A. *Earliest Year: 750 cal yr BP (1200 AD) * Most Recent Year: -56 cal yr BP (2006 AD) * Location Bounds - North: 42.45 * South: 42.45 * East: -108.8667 * West: -108.8667 **
 In western North America snowpack has declined in recent decades, and further losses are projected through the 21st century. Here we evaluate the uniqueness of recent declines using snowpack reconstructions from 66 tree-ring chronologies in key runoff generating areas of the Colorado, Columbia and Missouri River drainages. Over the past millennium, late-20th century snowpack reductions are almost unprecedented in magnitude across the northern Rocky Mountains, and in their north-south synchrony across the cordillera. Both the snowpack declines and their synchrony result from unparalleled springtime warming due to positive reinforcement of the anthropogenic warming by decadal variability. The increasing role of warming on large-scale snowpack variability and trends foreshadows fundamental impacts on streamflow and water supplies across the western USA. ...
- Gray, S.T.; Pederson, G.T.; Watson, T.; Barnett, A. *Earliest Year: 750 cal yr BP (1200 AD) * Most Recent Year: -37 cal yr BP (1987 AD) * Location Bounds - North: 42.45 * South: 42.45 * East: -108.8667 * West: -108.8667 **
 In western North America snowpack has declined in recent decades, and further losses are projected through the 21st century. Here we evaluate the uniqueness of recent declines using snowpack reconstructions from 66 tree-ring chronologies in key runoff generating areas of the Colorado, Columbia and Missouri River drainages. Over the past millennium, late-20th century snowpack reductions are almost unprecedented in magnitude across the northern Rocky Mountains, and in their north-south synchrony across the cordillera. Both the snowpack declines and their synchrony result from unparalleled springtime warming due to positive reinforcement of the anthropogenic warming by decadal variability. The increasing role of warming on large-scale snowpack variability and trends foreshadows fundamental impacts on streamflow and water supplies across the western USA. ...



Site Selection

(Moisture Sensitive Species, Old, Stressed)



COMPLACENT
RING SERIES



SENSITIVE
RING SERIES



Site Selection

(Wind River Range, Wyoming)



Site Selection

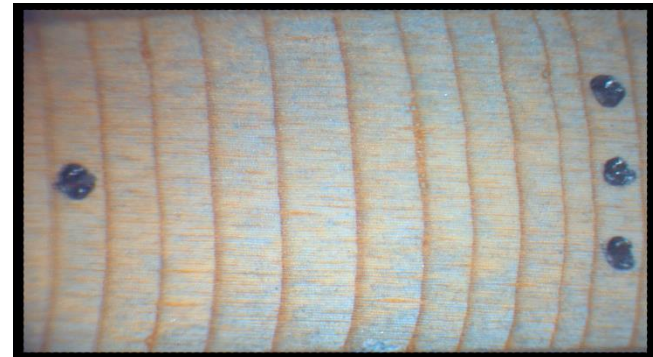
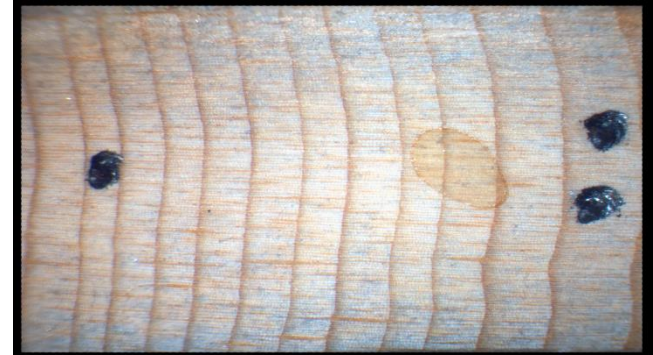
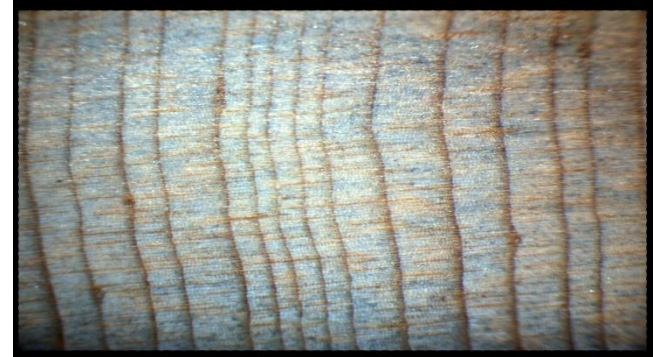
(near Grants, New Mexico)



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)

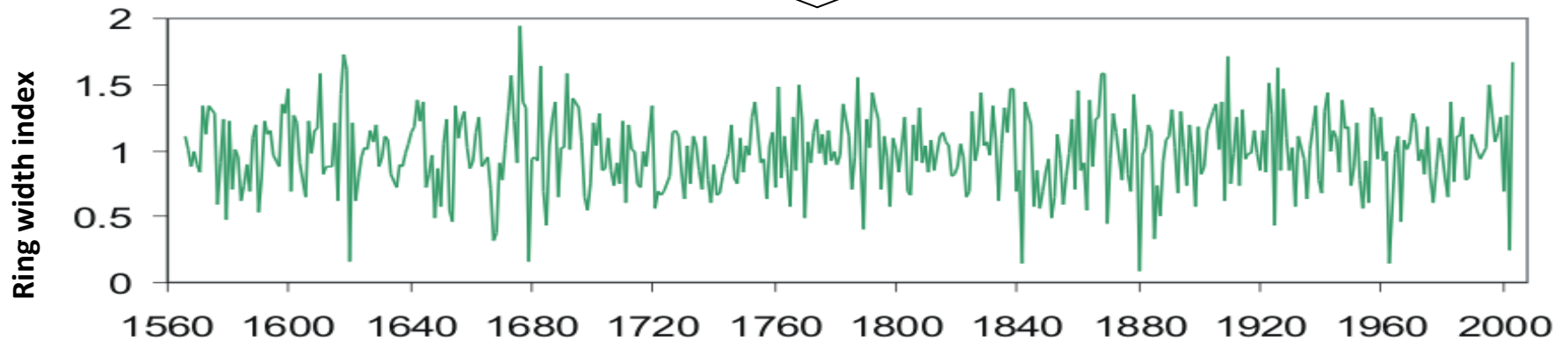
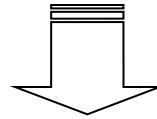
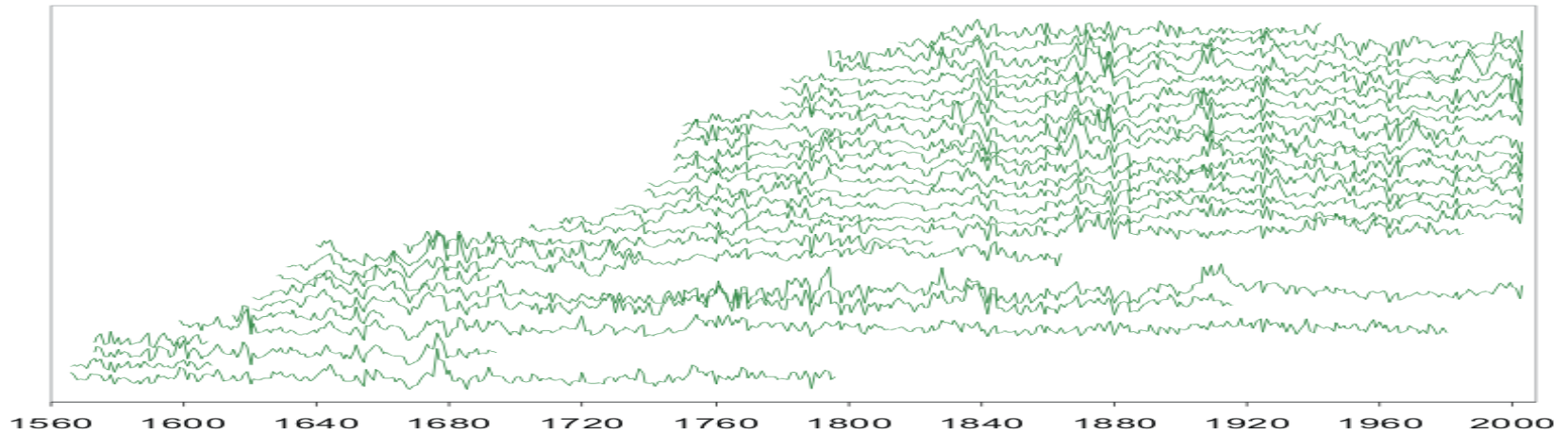
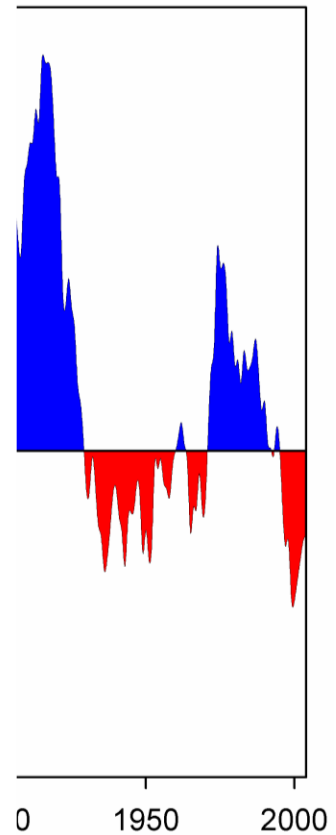


Image courtesy of J. Lukas (U. CO)



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



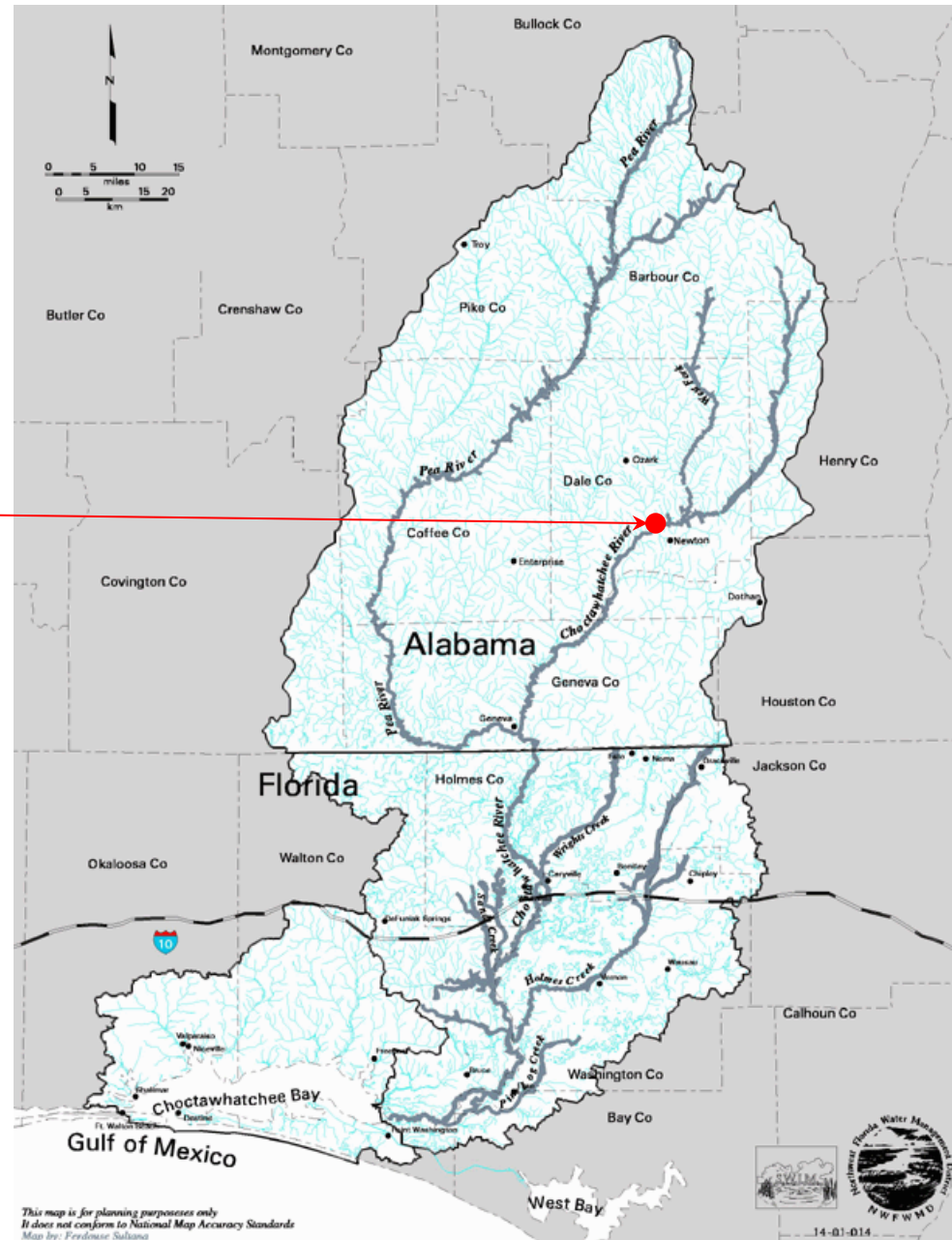
Source: Barnett et al., 2010



Choctawhatchee River Water-Year Droughts

Newton AL

Rank	Water-Year (1936 to 2013)		
	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



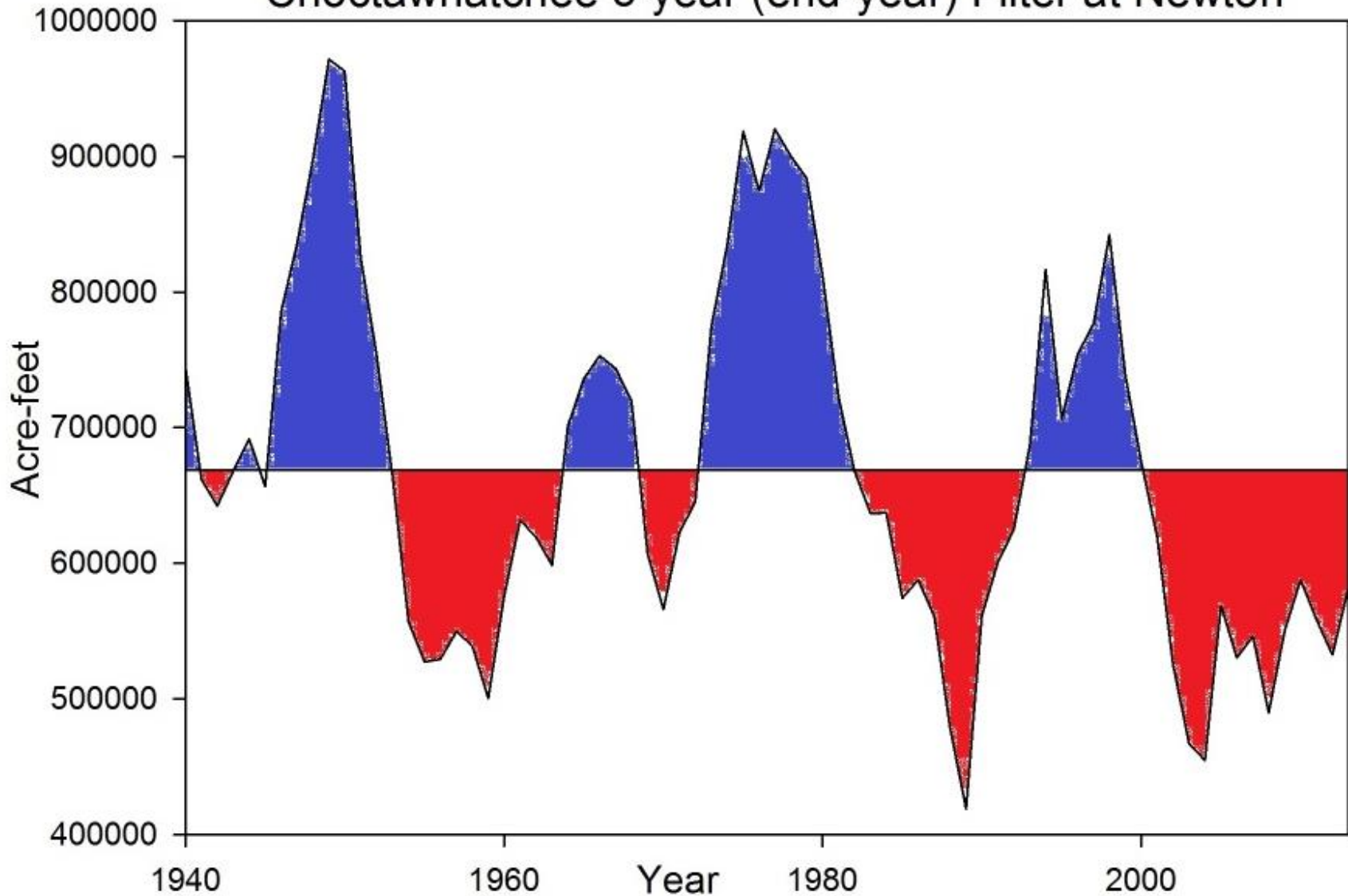
*This map is for planning purposes only
It does not conform to National Map Accuracy Standards
Map by: Ferdouse Sultana*

14-01-014

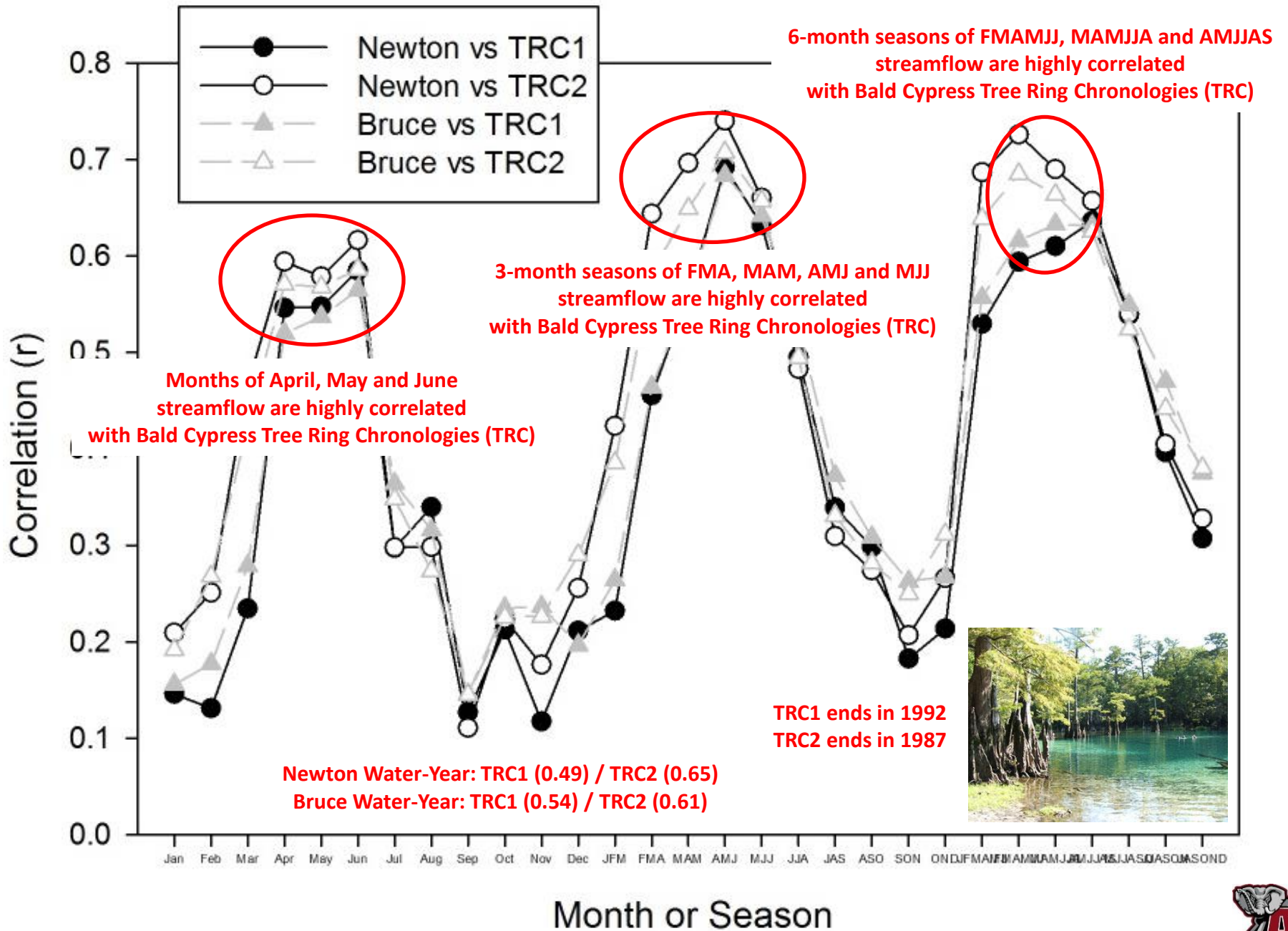


Choctawhatchee River Water-Year Streamflow

Choctawhatchee 5-year (end-year) Filter at Newton



Choctawhatchee River Reconstruction Potential





CHOCTAWHATCHEE RIVER

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.



<http://choctawhatcheerivertreeringstudy.weebly.com/>

Thanks and Questions?

Glenn Tootle (gatootle@eng.ua.edu)

Matt Therrell (therrell@ua.edu)

