

# Urban Water Management Plans and Reconstructed Hydrology



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**Climate Change Adaptation Policy  
Workshop**

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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?
- How is this information being used in water resource planning?
- Tree-ring data and Urban Water Management Plans (UWMPs)

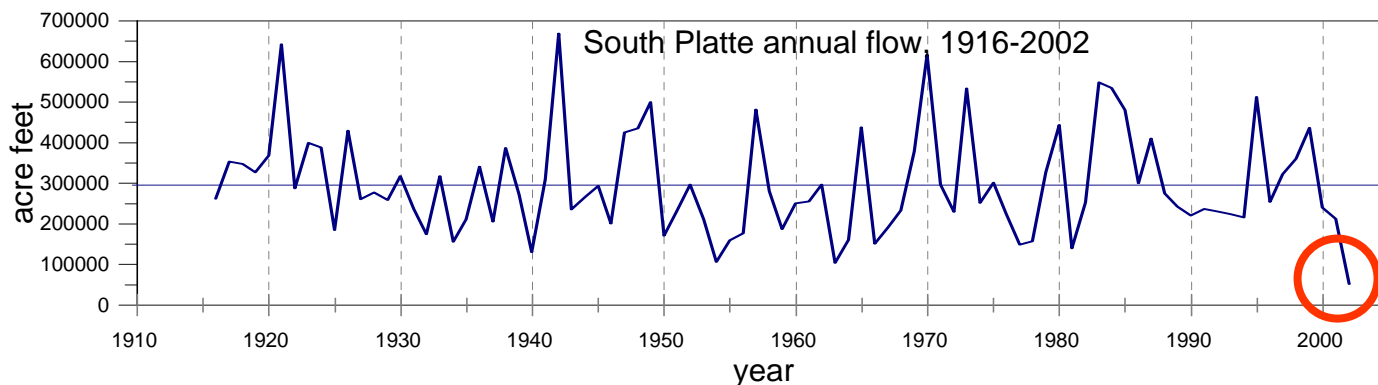
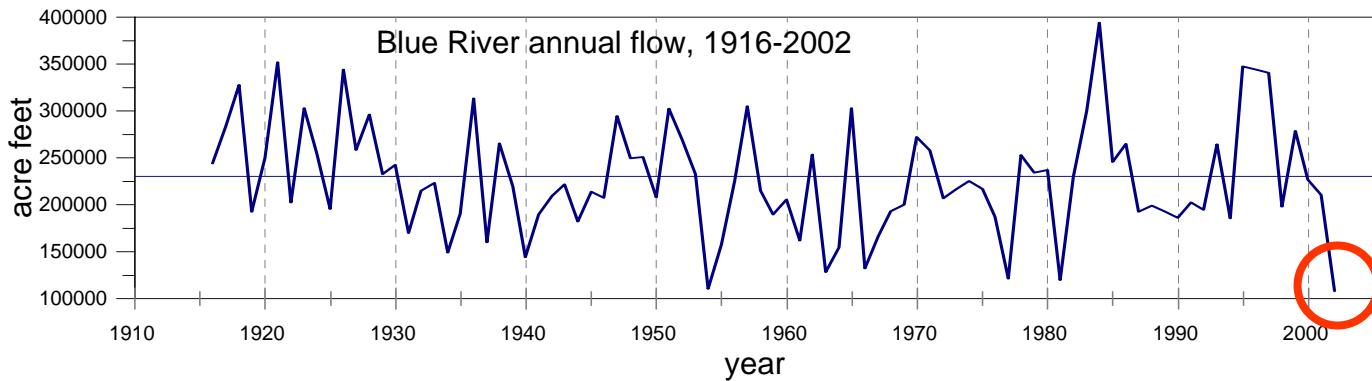
Why consider the past when planning for the future?

Streamflow values for water year 2002 were the lowest on record at many gages in Colorado.

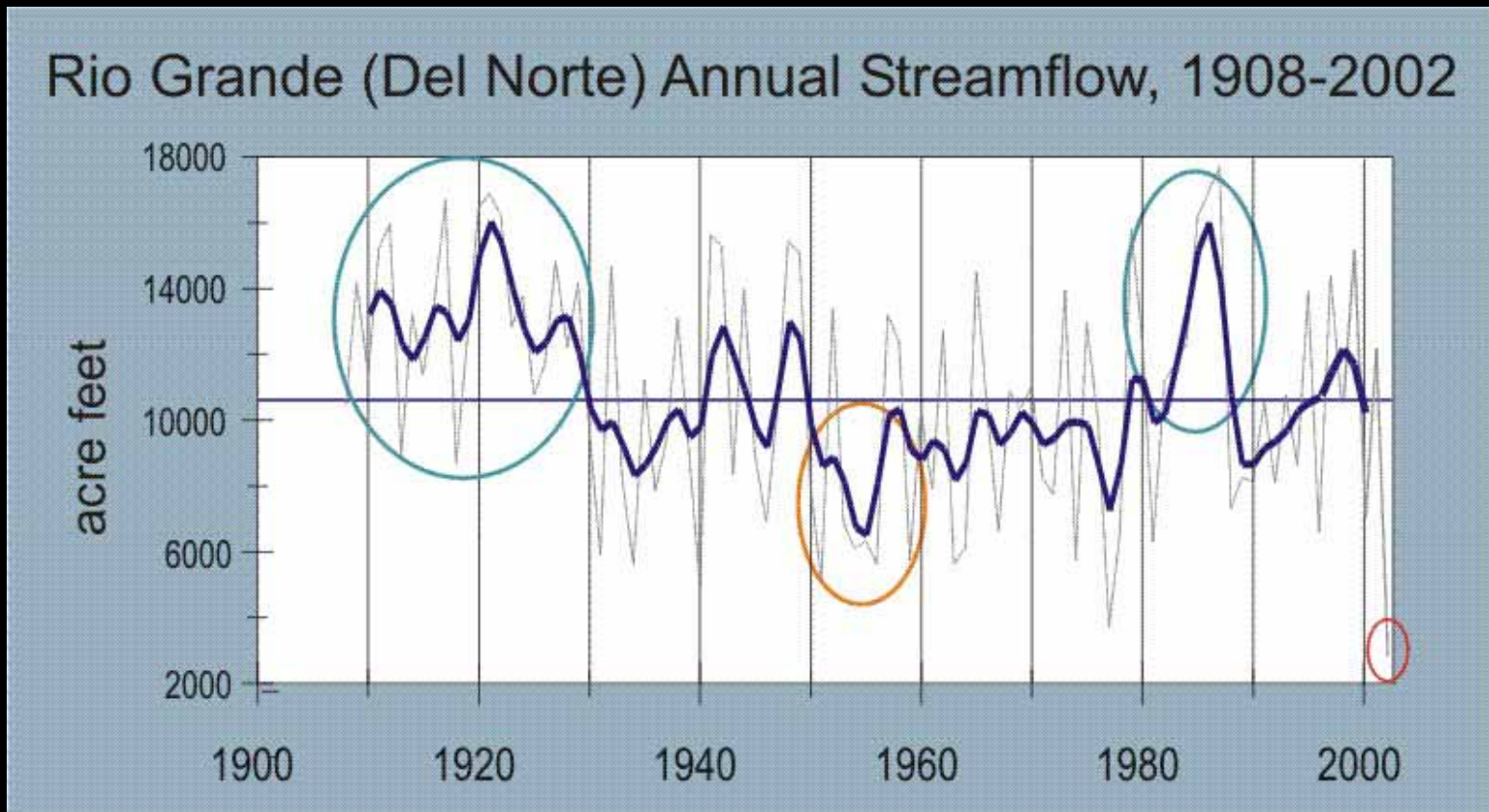
Water managers wondered....how low can flow values go?



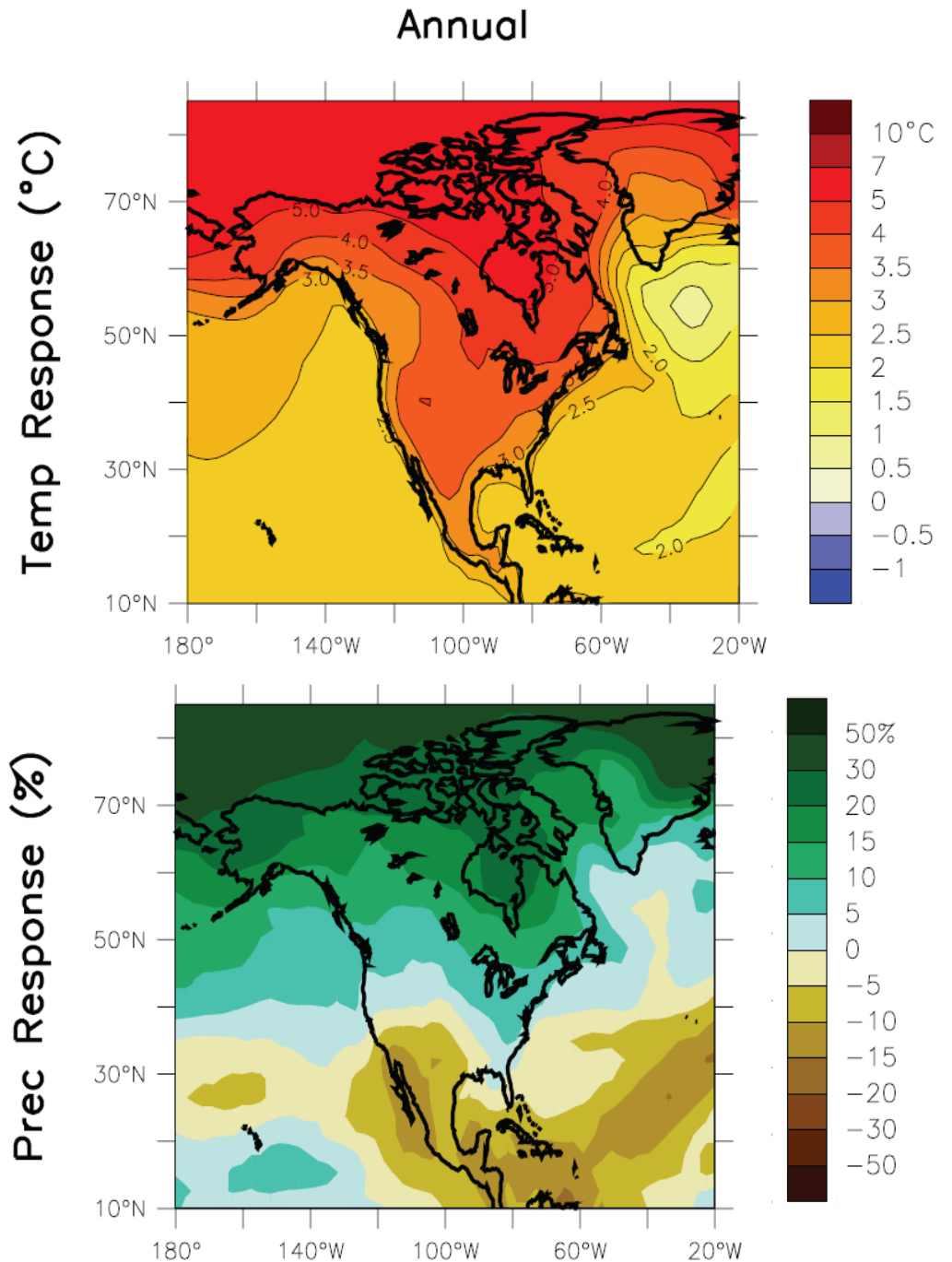
Photo: Denver Water



How typical are the wet and dry intervals in the modern gage record? Is the 1950s an adequate basis for planning?



What about the future? Could droughts be even worse due to climate change?



In the western U.S, water managers have become acutely interested in several key questions:

- Is the 20th century record of flow an adequate frame of reference for planning, with regard to extreme years, multi-year droughts, and sequences of drought years?
- What is the best way to plan for the future, given uncertainties in the climate projections?

Extended records from paleoclimatic data, such as tree rings, can provide a long-term context for assessing climate and drought events.

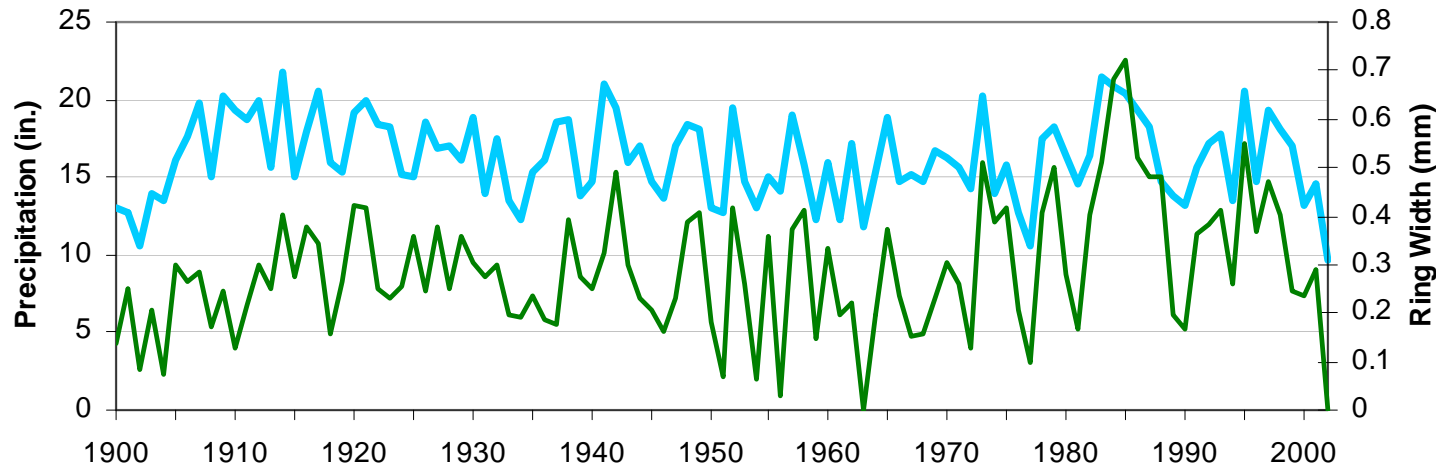
But will the climate of the past be a useful analogue for the future? While records from the past cannot be used to predict the future, the broader range of variability in the extended records can provide guidance for planning.

How do tree rings work?

Moisture-stressed trees closely track variations in precipitation



Western CO Annual Precip vs. Pinyon ring width (WIL731)

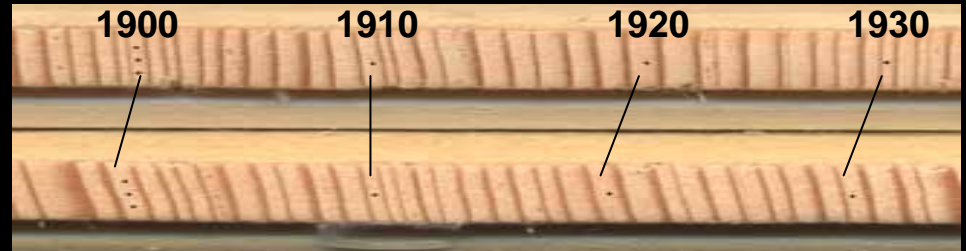


Ring widths from a single tree near Grand Junction are plotted with annual precipitation in the Colorado River basin. ( $r = 0.69$ ).

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



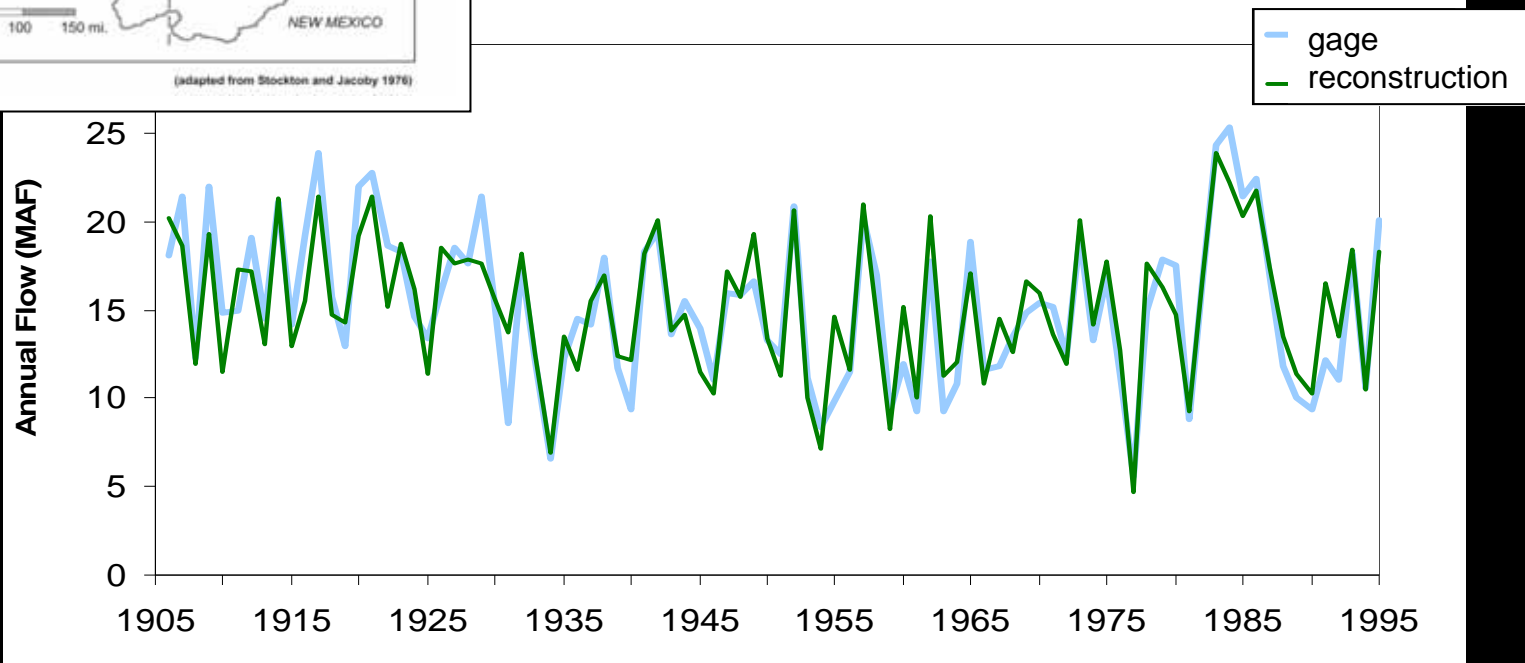
An increment borer is used to sample cores from about 20 trees at a site



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

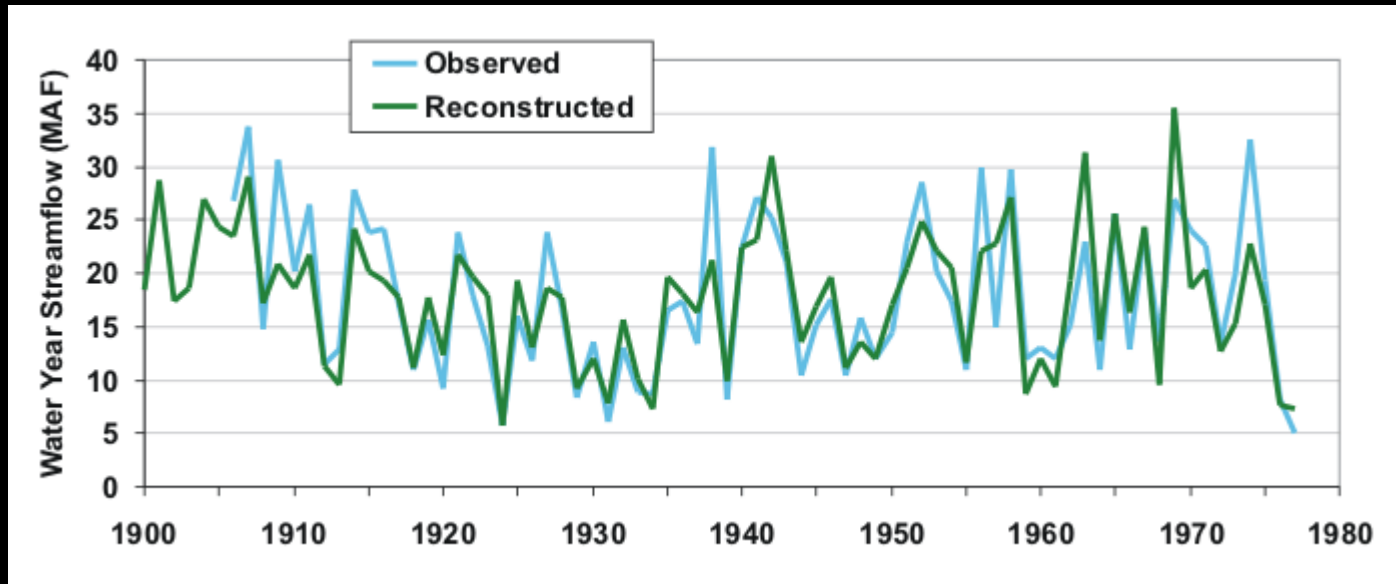


Tree-ring chronologies are calibrated with the gage record to generate a reconstruction model



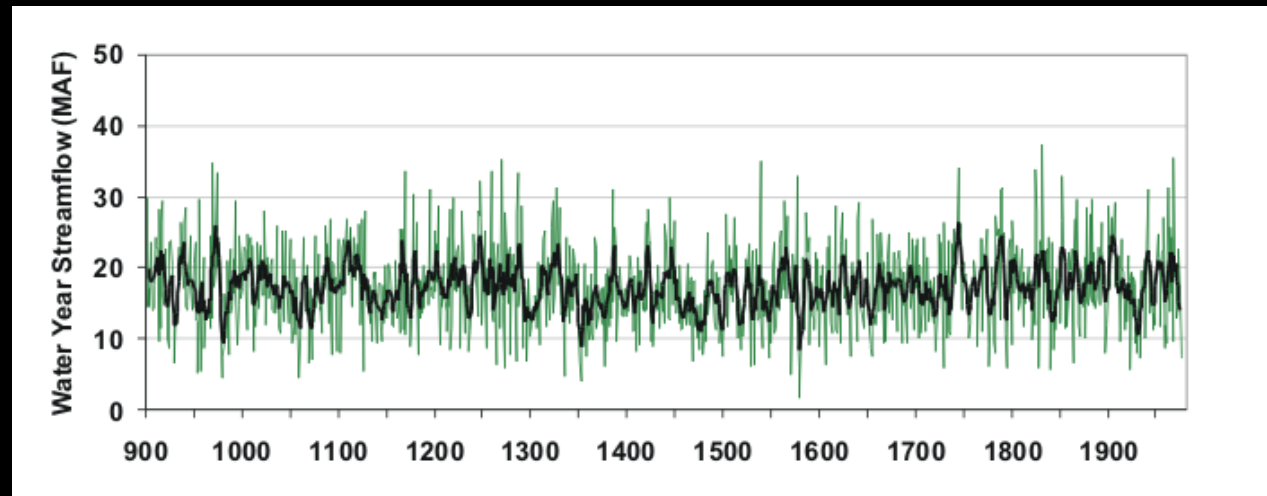
The reconstruction model for the Colorado River (Lees Ferry) explains 81% of the variance in the gage record.

## Sacramento River, CA (Four Rivers Index)



The reconstruction model explains 80% of the variance in the gage record.

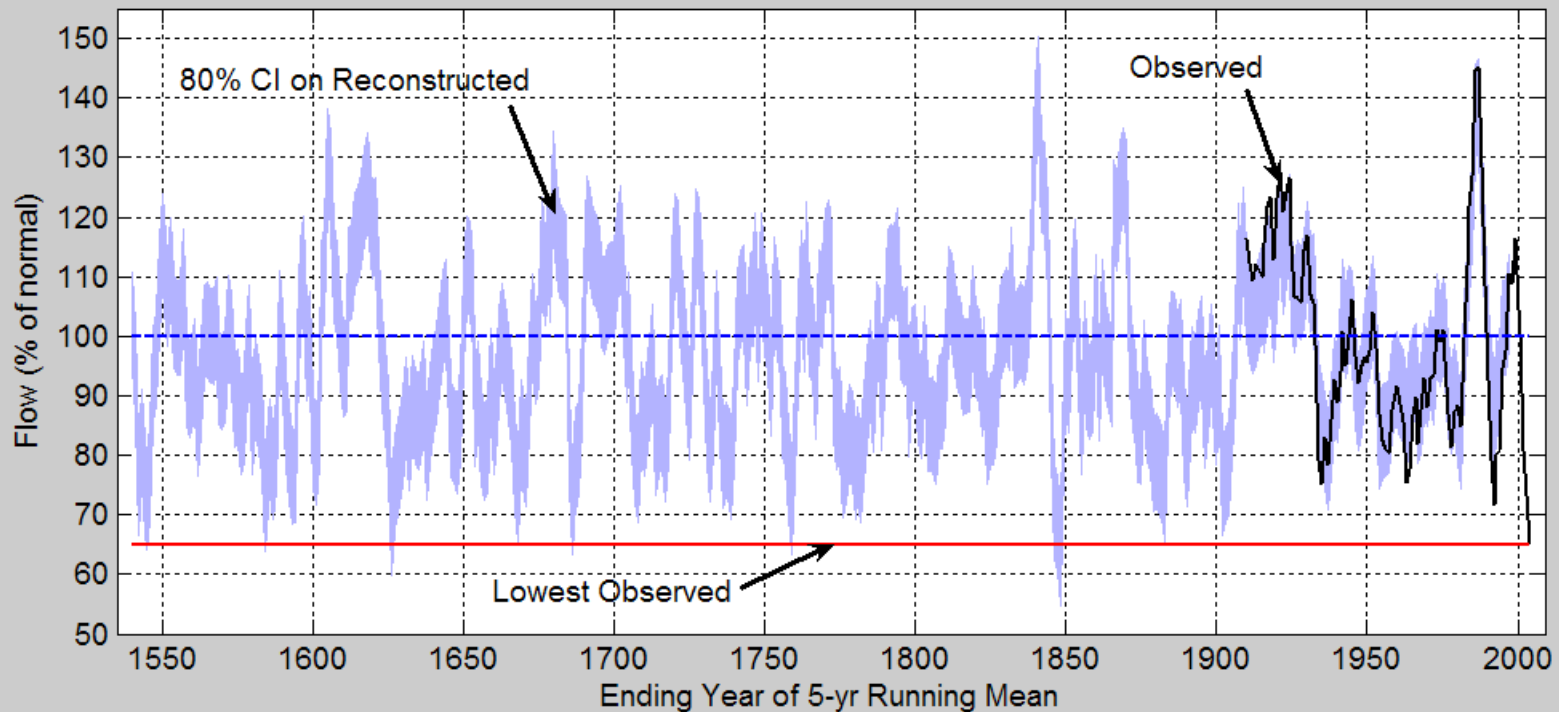
**Sacramento River  
full reconstruction,  
901-1977**



What do tree rings tell us about past droughts?

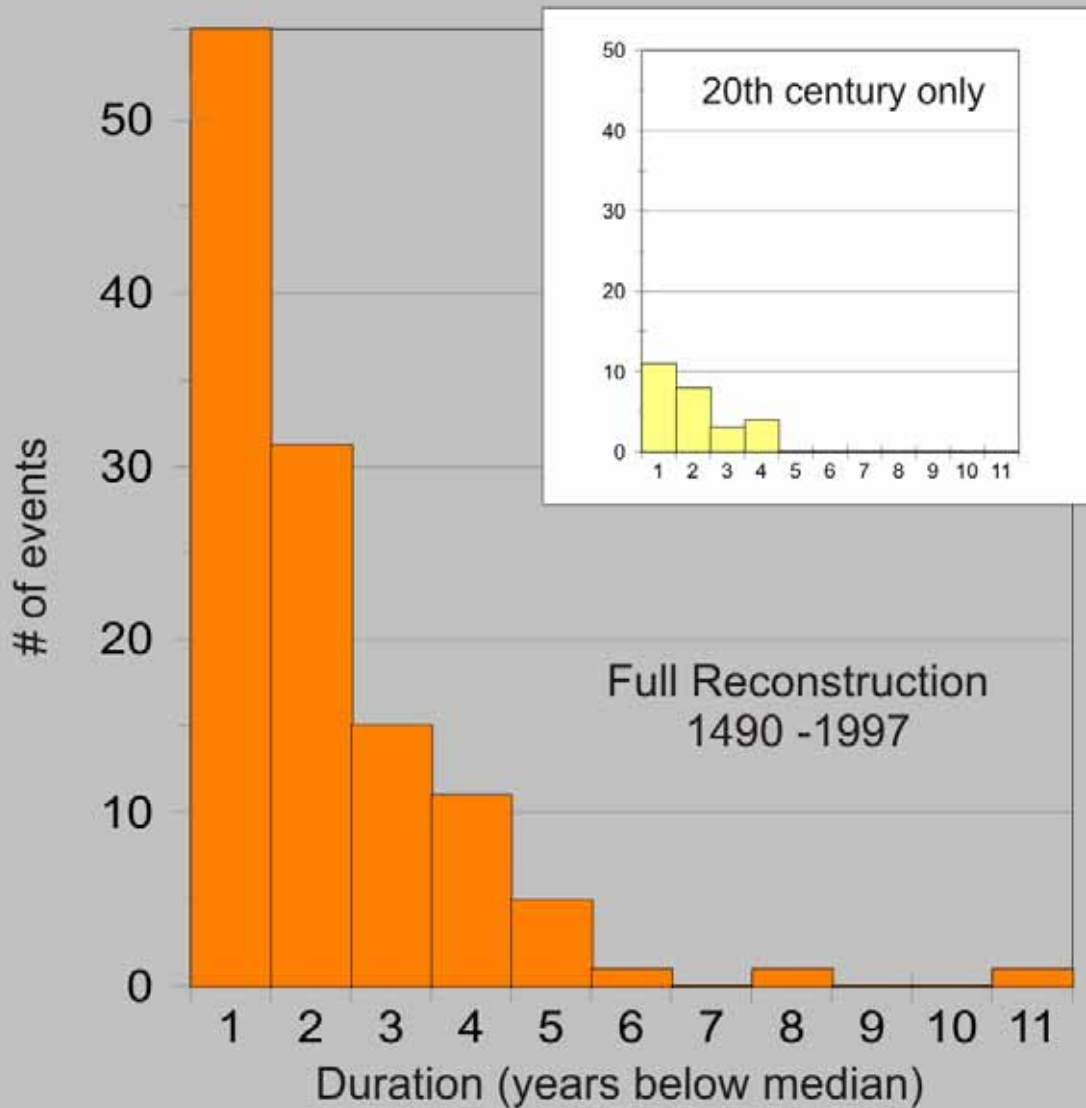
# Assessing the 2000-2004 drought in a multi-century context

## Lees Ferry Reconstruction, 1536-1997 (5-Year Running Mean)



# Reconstructed Lees Ferry Streamflow, 1490-1997

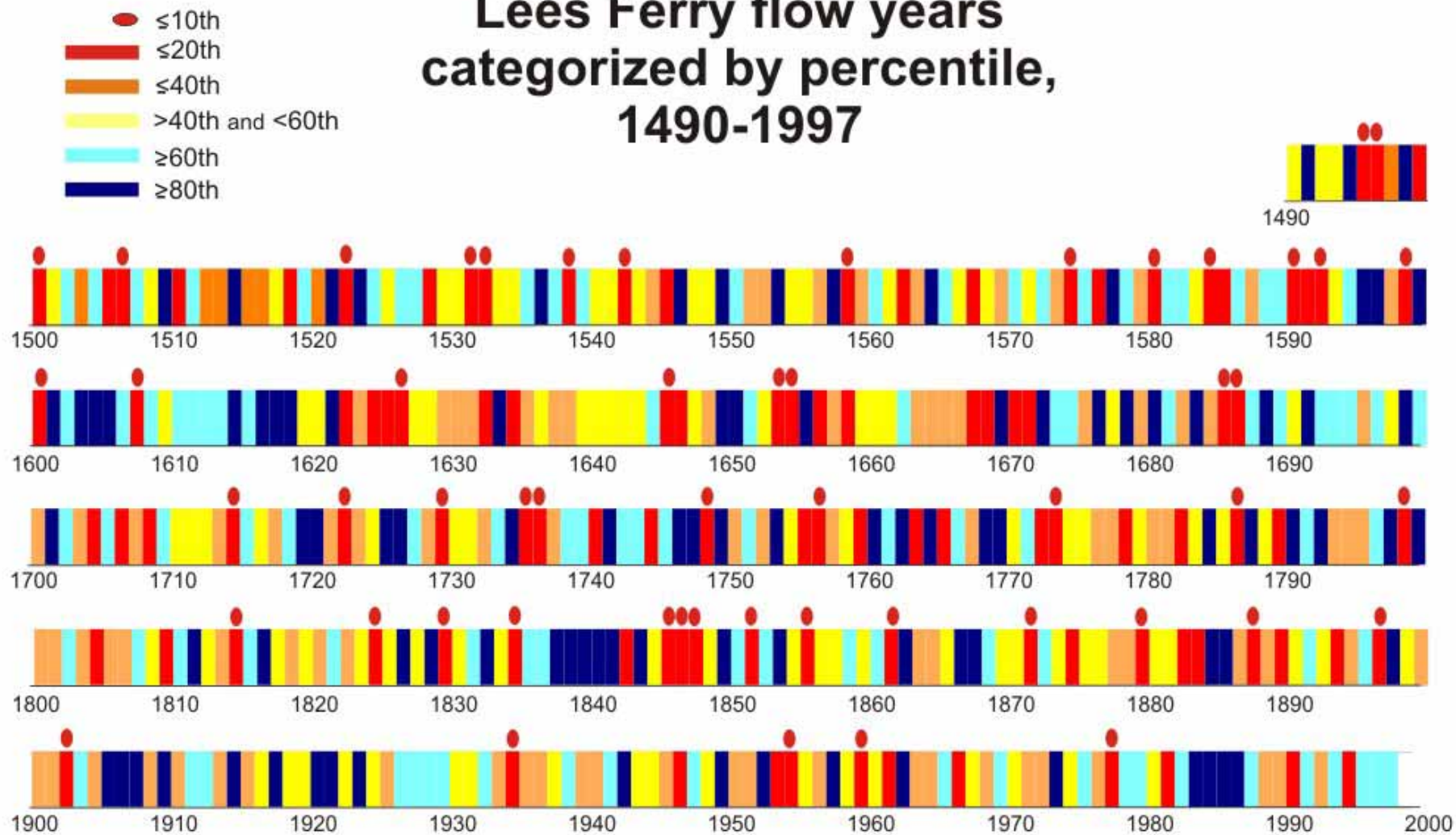
## Drought Frequency



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

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

# Lees Ferry flow years categorized by percentile, 1490-1997



The sequences of years and the distribution of extreme events or runs of wet or dry years is variable from century to century.

How is this information being used in water resource planning?

# Worst case scenarios for drought planning:

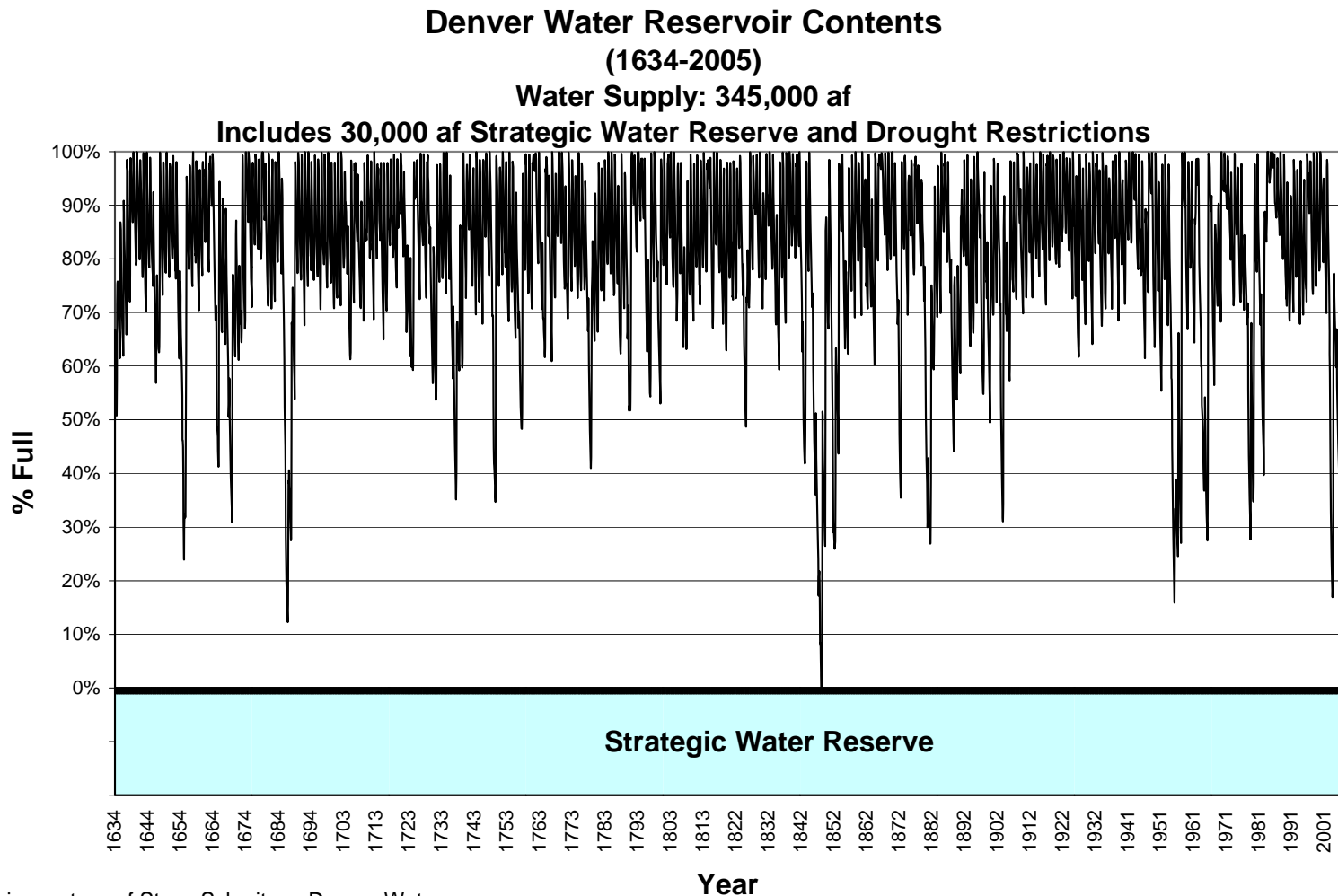
## An example from the City of Chandler (AZ)

- What should be the basis for a worst case scenario for drought?
- The driest year on record for 10 or 20 consecutive years?
- After considering reconstructions of Colorado River basin streamflow, this seemed improbable
- Instead, a scenario of 10 dry years out of 25 years was considered as being more realistic
- The City is now working on incorporating the streamflow reconstructions into a water supply model.



# Water Supply System Resilience: Denver Water

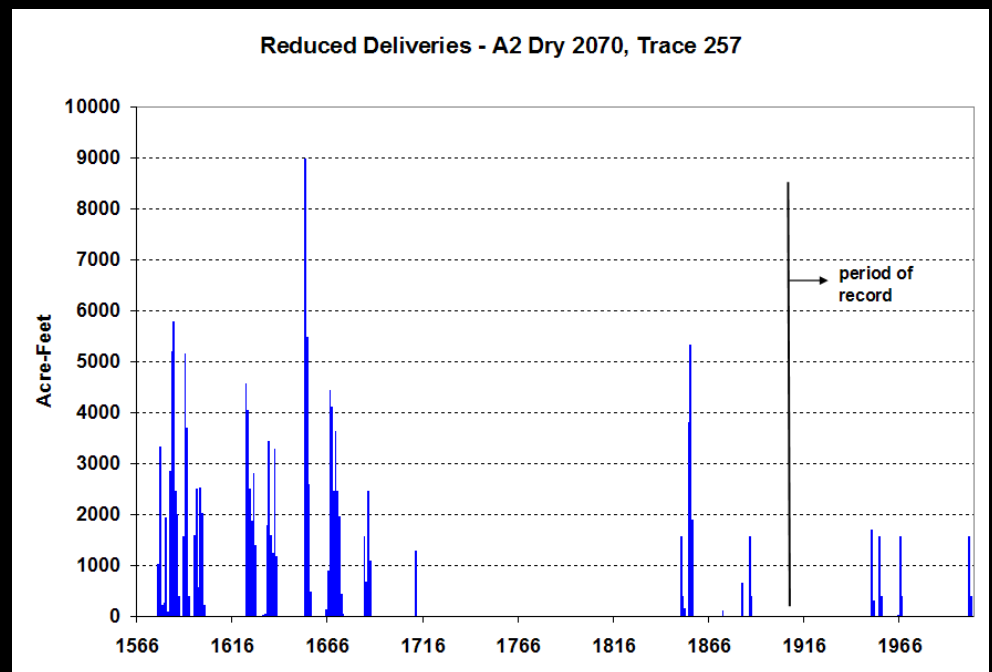
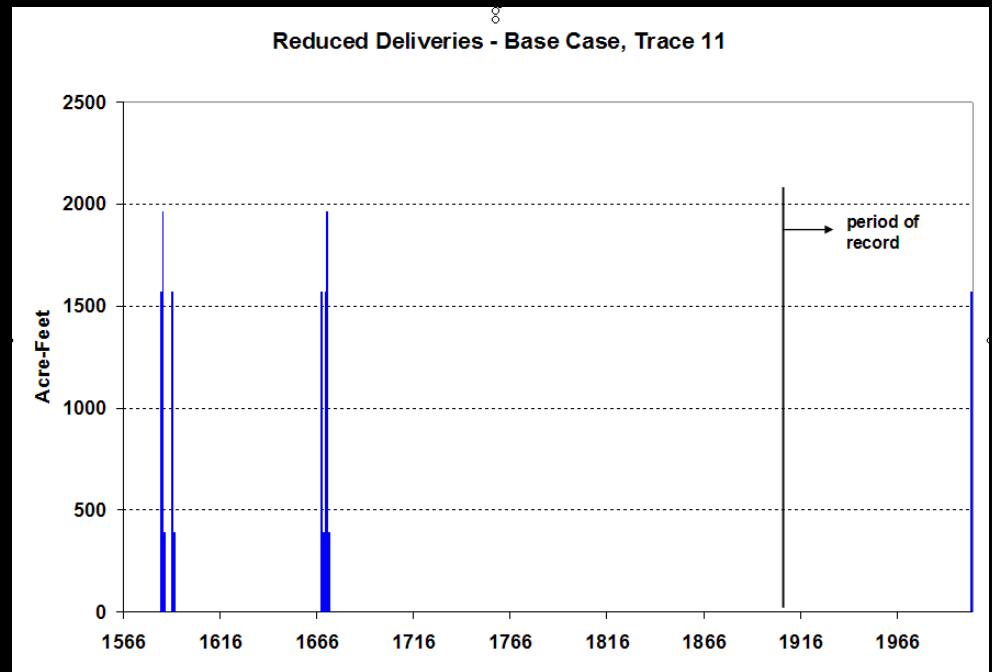
Streamflow reconstructions are being used to test water supply systems under a broader range of conditions than contained in the gage record.



# Blending Past and the Future:

## An example from the City of Boulder

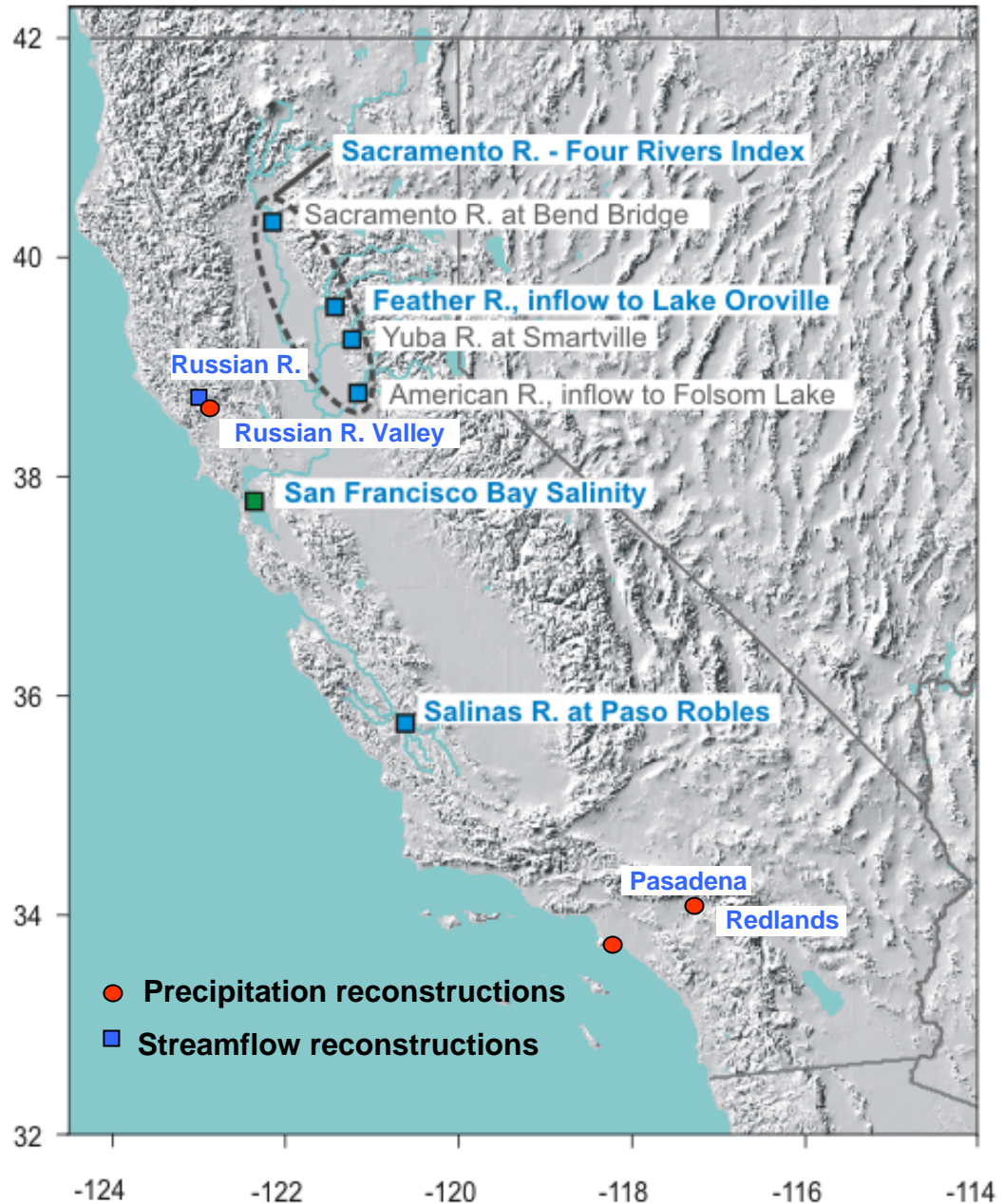
Long-term natural hydrologic variability from tree-ring reconstructed streamflow with projections for future climate yield planning scenarios



# Tree-ring data and Urban Water Management Plans (UWMPs)

- In California, municipalities and local agencies that serve more than 3000 customers, or 3,000 acre-feet, develop UWMPs to document adequate and reliable water supplies.
- UWMPs are submitted and reviewed every 5 years
- This project will evaluate the multiple-year dry periods that are being used as the basis for planning, compared to droughts documented in tree-ring based reconstructions of precipitation and runoff, in a subset of the plans.
- Evaluations will consider duration and cumulative deficits, taking precautions to account for the uncertainty in the reconstructions.

Tree-ring based reconstructions of streamflow and precipitation available for assessing California UWMP droughts.



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

Probably not, but tree-ring reconstructions can provide an understanding the range of conditions that may be expected under natural variability.

This information, used in conjunction with climate change projections, may provide realistic scenarios for planning.

