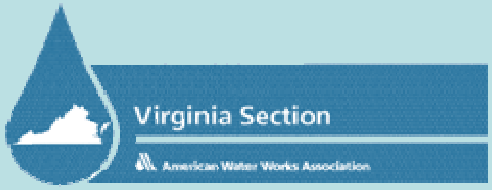
Risk Analysis with Multiple Sources



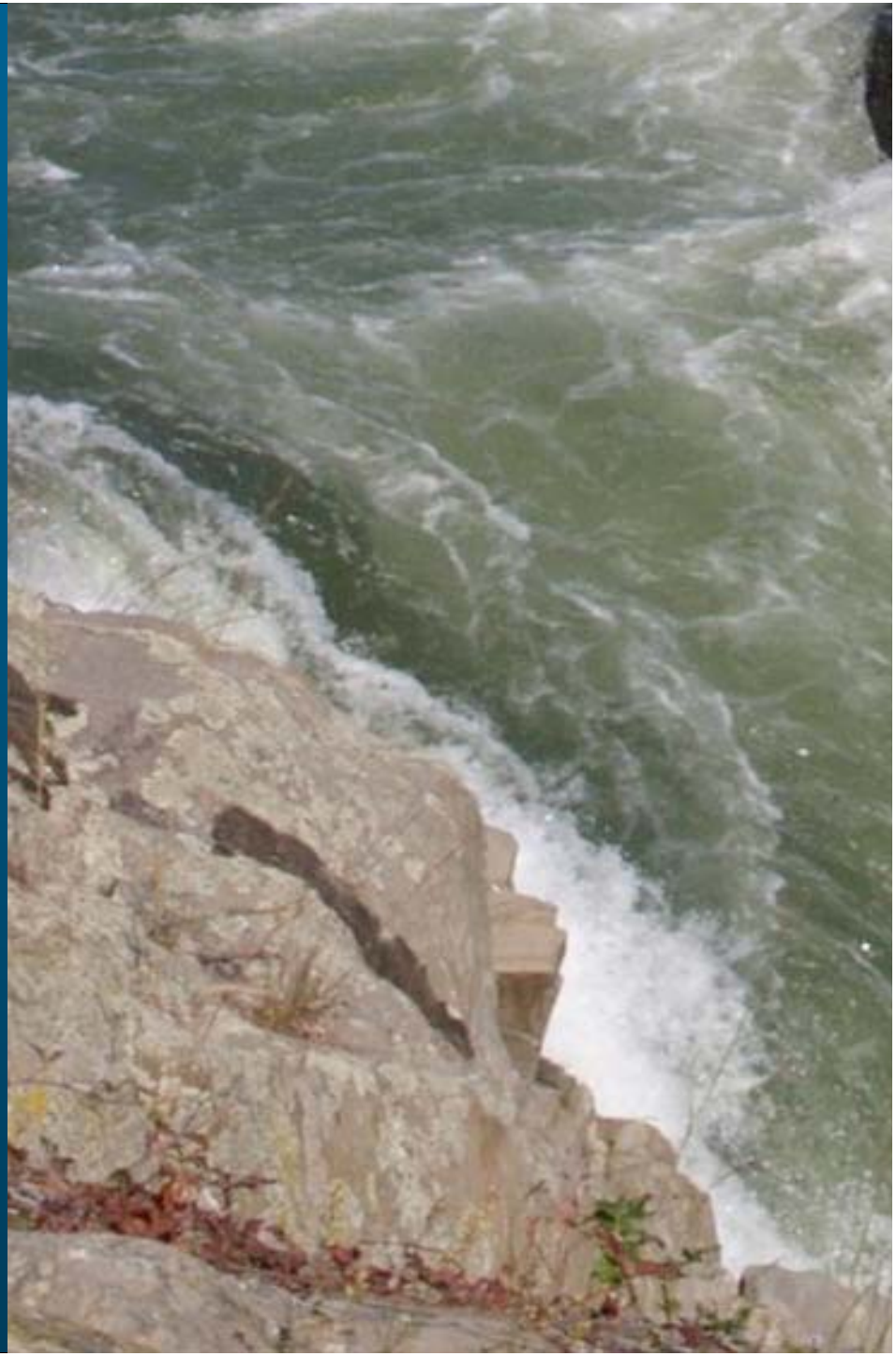
Presented By: Erik Hagen

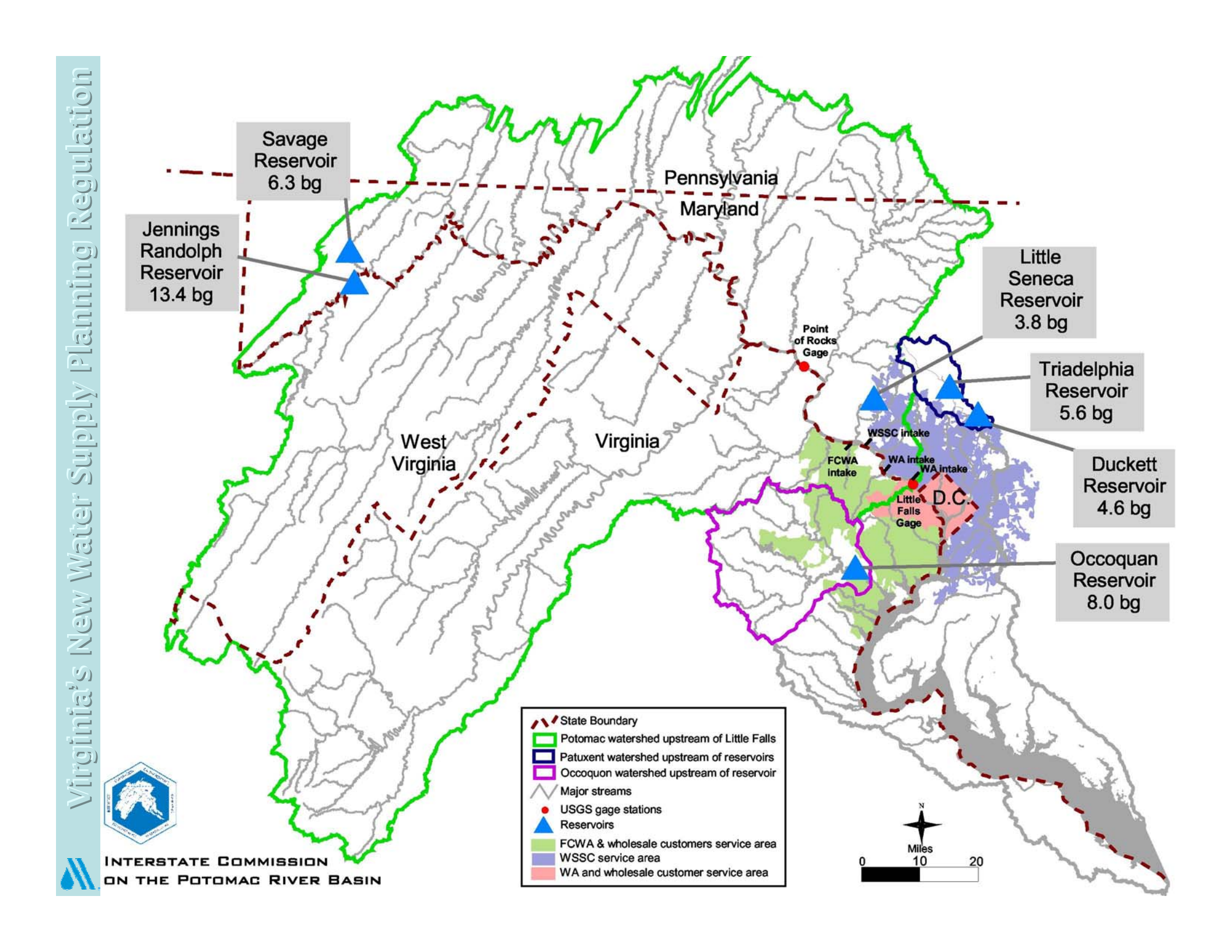
Interstate Commission on the Potomac River Basin
American Water Works Association - Virginia Section
Water Resources & Environment Committee

March 28, 2007

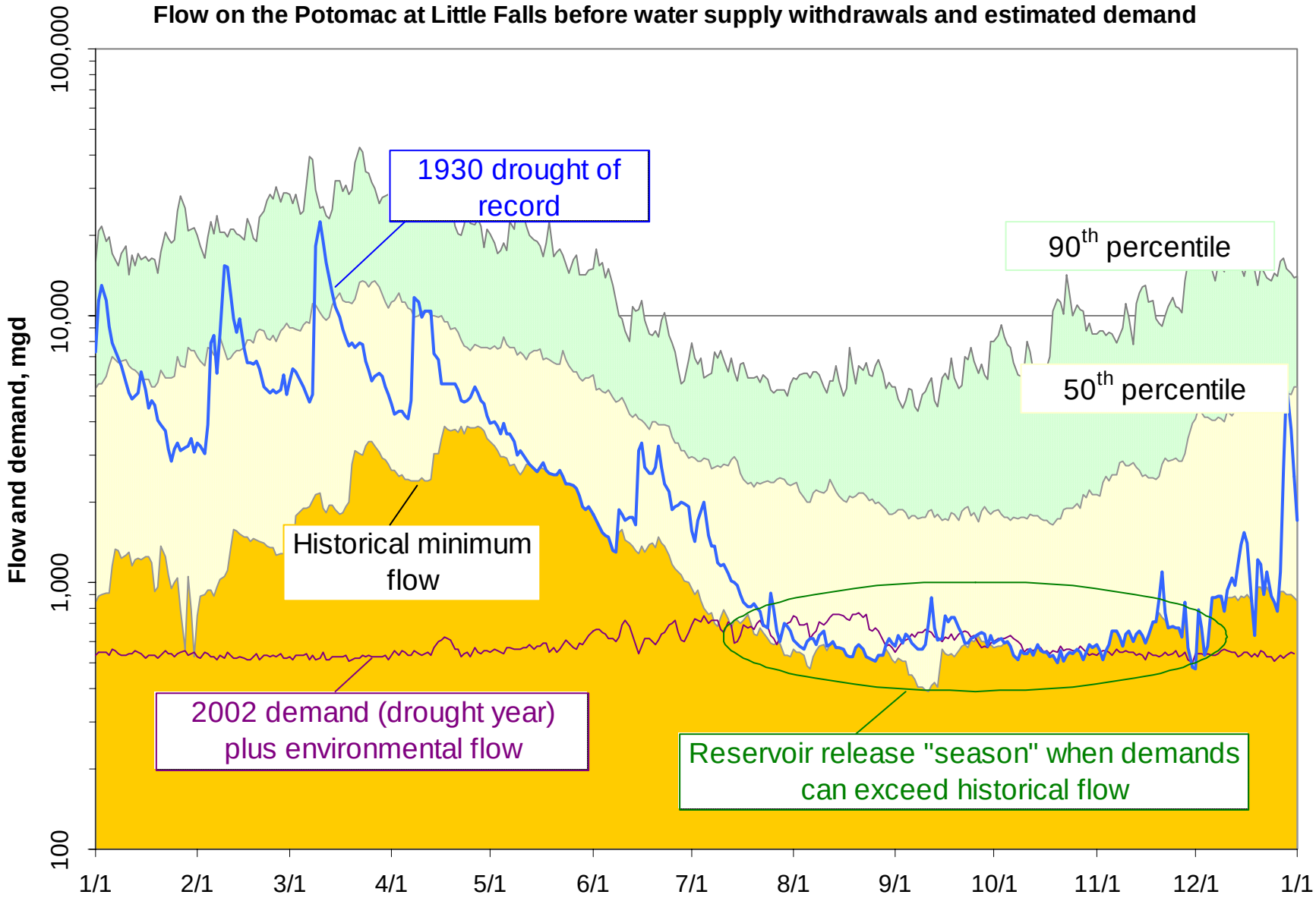
Outline

- Background on Washington D.C. water supply system
- 20-year demand forecast and resource reliability assessments
- Risk assessment on the supply and demand sides, where we have been and where we are going



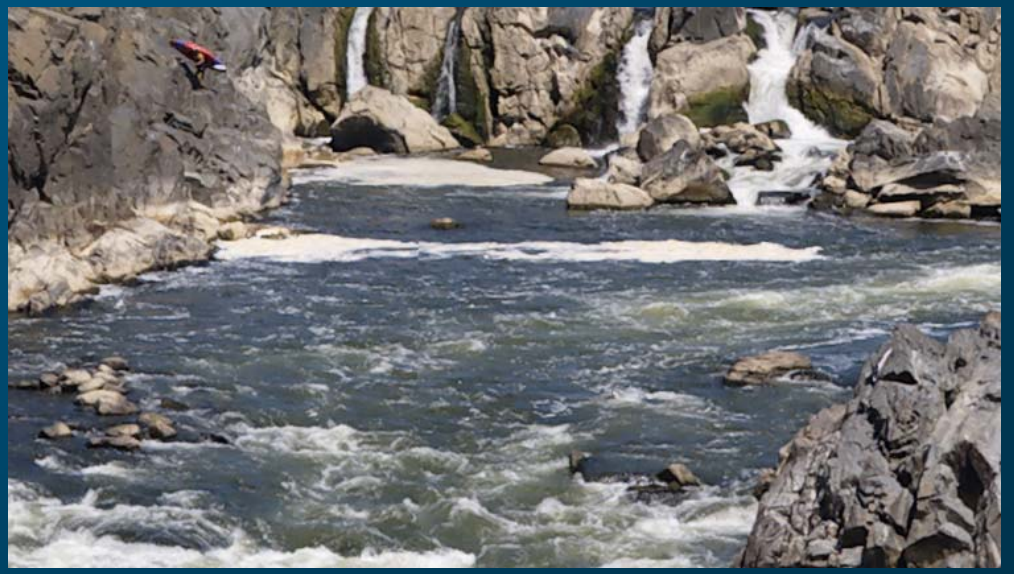

Virginia's New Water Supply Planning Regulation
Savage Reservoir 6.3 bg
Jennings Randolph Reservoir 13.4 bg
Pennsylvania
Maryland
West Virginia
Virginia
Point of Rocks Gage
Little Seneca Reservoir 3.8 bg
Triadelphia Reservoir 5.6 bg
Duckett Reservoir 4.6 bg
Occoquan Reservoir 8.0 bg
WSSC intake
FCWA intake
WA intake
WA intake
Little Falls Gage
D.C.
State Boundary
Potomac watershed upstream of Little Falls
Patuxent watershed upstream of reservoirs
Occoquon watershed upstream of reservoir
Major streams
USGS gage stations
Reservoirs
FCWA & wholesale customers service area
WSSC service area
WA and wholesale customer service area
N
Miles
0
10
20
Interstate Commission on the Potomac River Basin

Virginia's New Water Supply Planning Regulation



Washington area's demand forecast and resource assessments

- Every 5 years:
  - Conduct demand forecast
  - Assess system reliability for current and future demand levels by comparing demand with resource
  - Through 2000:
    - Historical streamflow
  - In 2005:
    - Historical streamflow
    - Synthetic streamflow

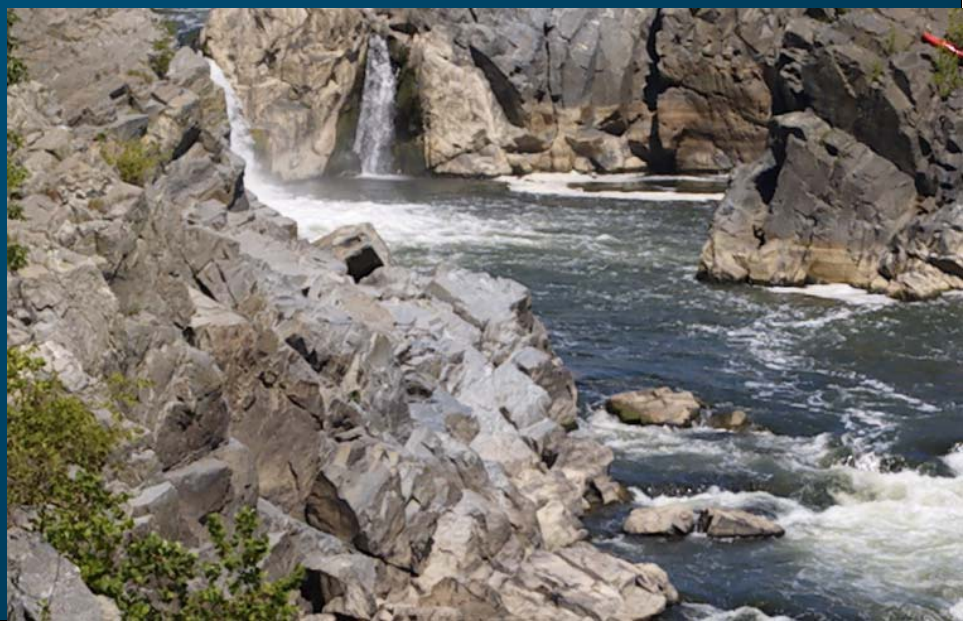


Going beyond the historical record – Why?

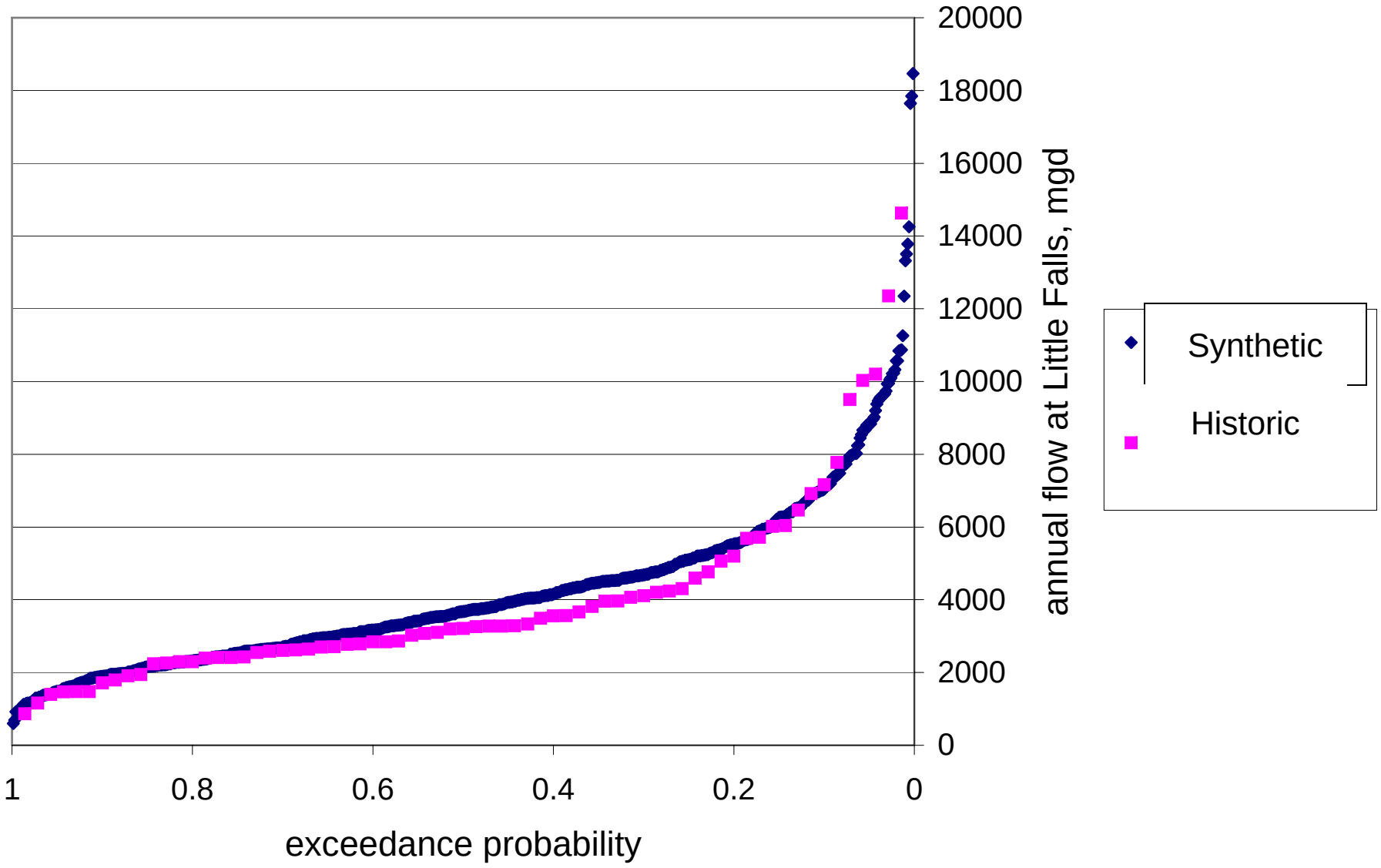
- 73-year historical record is limited
- Avoid being tied to specific characteristics and timing of historical events
- In Potomac basin, 2002 conditions heightened concerns

2005 Study – risk assessment supply side

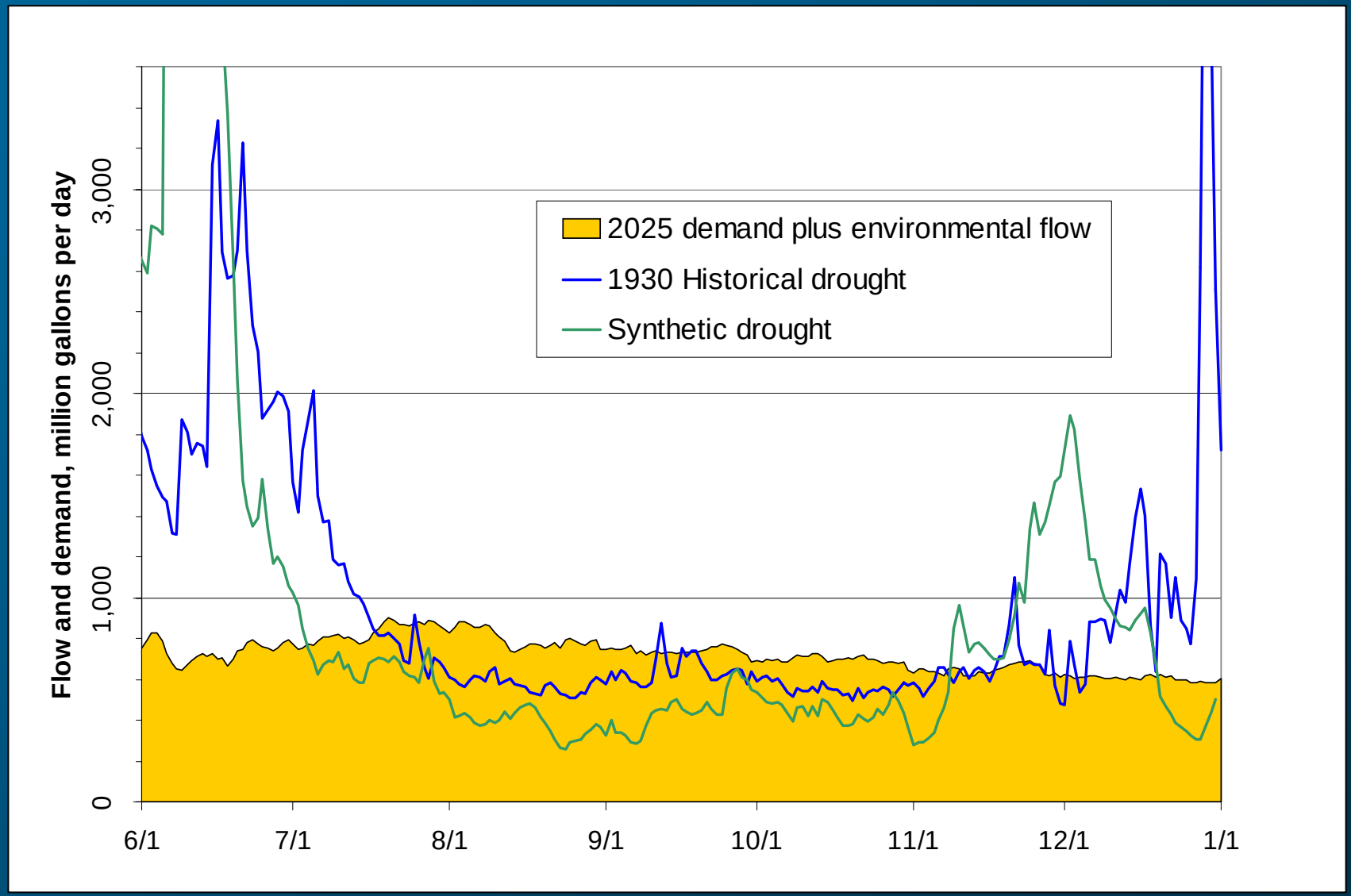
- Resources
  - Demands were assessed as compared to the drought of record (1930)
  - Synthetic streamflow records were developed to examine the reliability of the system over 540 years of simulated streamflow



Cumulative flow at Little Falls, historic vs. synthetic
June 1 – October 31



Synthetic drought vs. drought of record



Potomac Reservoir and River Simulation Model (PRRISM)

Traditional Inputs:

- **historic** streamflow and reservoir inflows (73 years)
- system demands f(forecast year)

Stochastic Inputs:

- **synthetic** streamflow and reservoir inflows (540 years)
- system demands f(forecast year)

Outputs:

- reservoir releases
- reservoir storage
- streamflow downstream of all intakes

Comparison of worst synthetic drought with worst historical drought

Minimum storage in reservoirs, Billion Gallons (% full)		
Reservoirs	2025 Demands	
	1930 drought Historical Flows	Synthetic Flows
Potomac augmentation reservoirs	7.4 (43%)	0.8 (5%)
Total system storage	12 BG (23%)	3.2 BG (6%)

2005 Study – risk assessment demand side

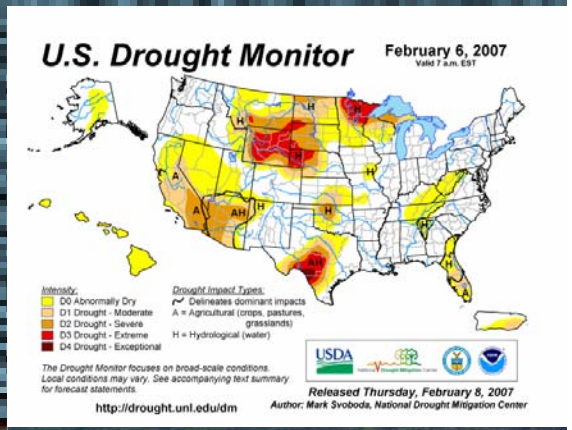
- Demands
  - Low and high forecasts were made based on low and high estimates of employment and households
  - Climate change scenario - Demands were linked to temperature and other meteorological inputs, and a climate change scenario was run to see how demands might change as a function of temperature increases, also decreased streamflow by 10 percent.

Synthetic streamflows

- Key Assumption: the near future (~25 years) will be a lot like the recent past (~70 years)
- The climate is changing and it has changed significantly before
- What does that mean for Potomac Basin hydrology?

Virginia's New Water Supply Planning Regulation

How Bad Can It Get?
Drought Risk in Context
Using Paleoclimatic Data



Future directions

1. **Place historical streamflow in larger context**

   Where are we now? Where have we been?

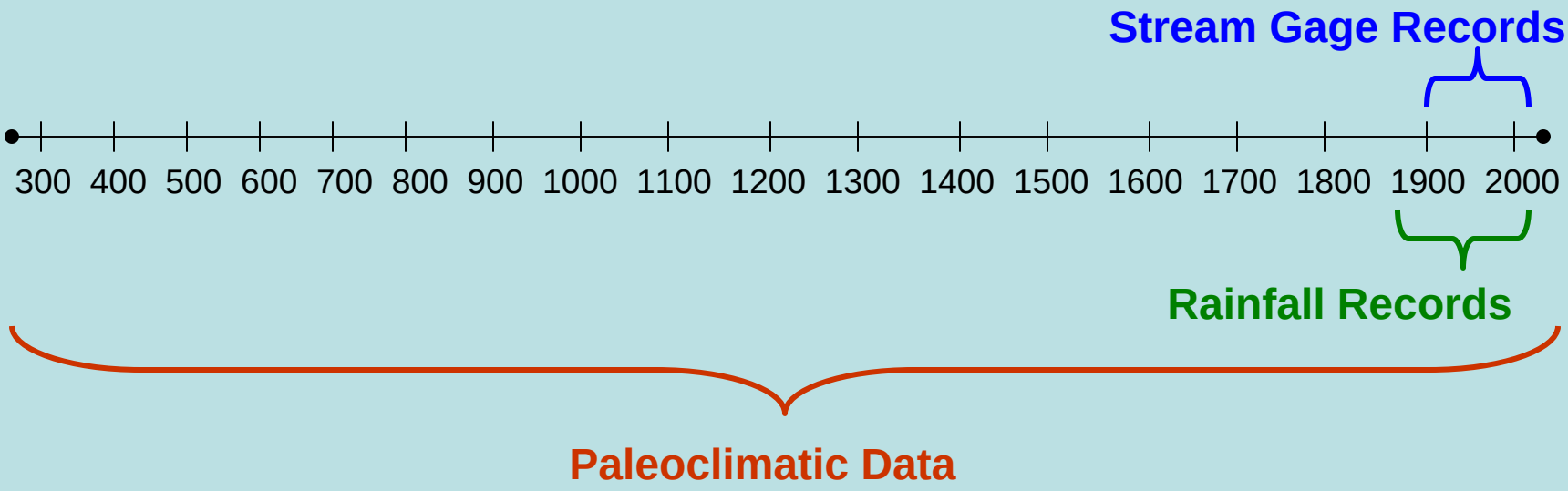
2. **Planning for the future**

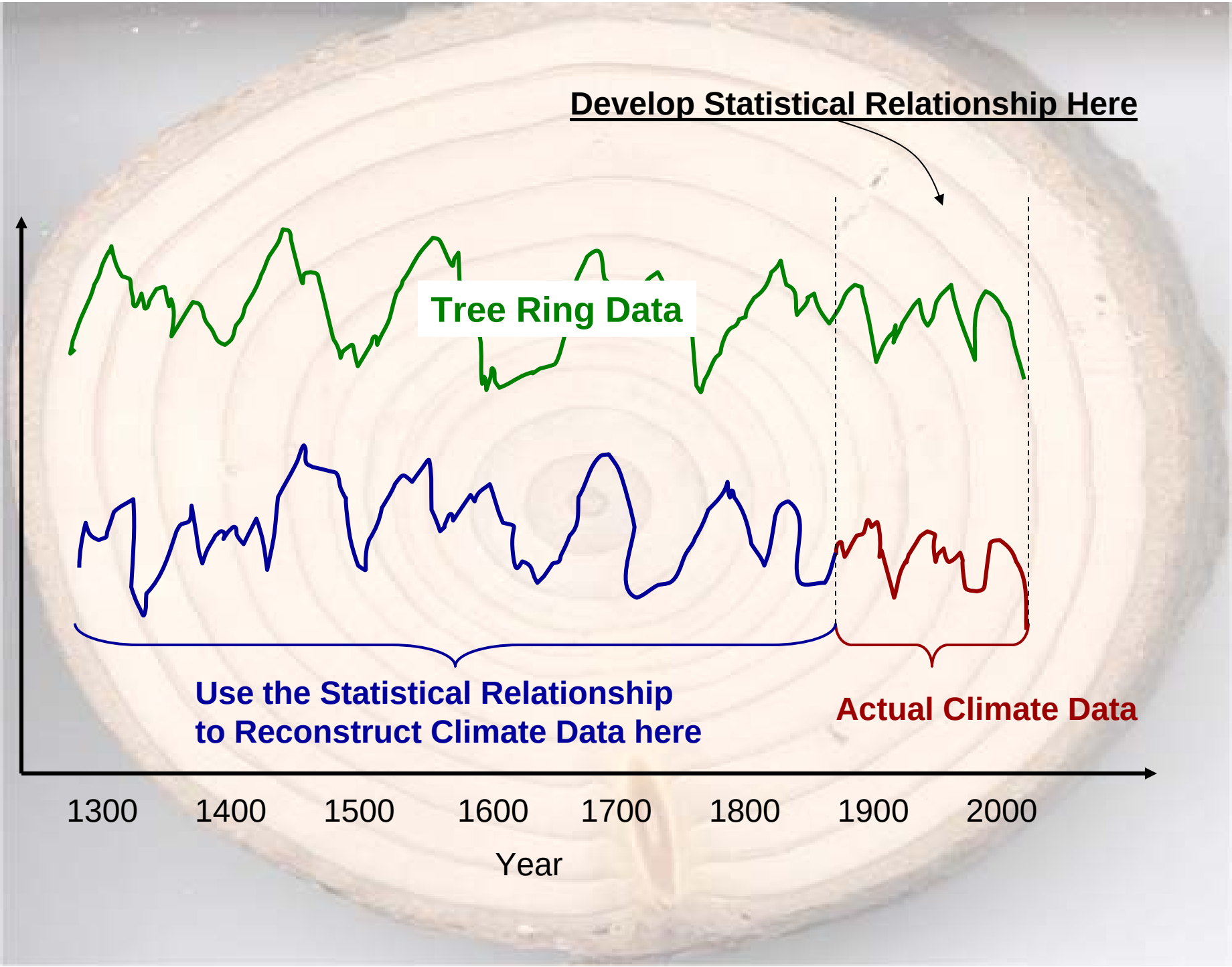
   Where might we be going? What can or should we do about it?

Paleoclimatology

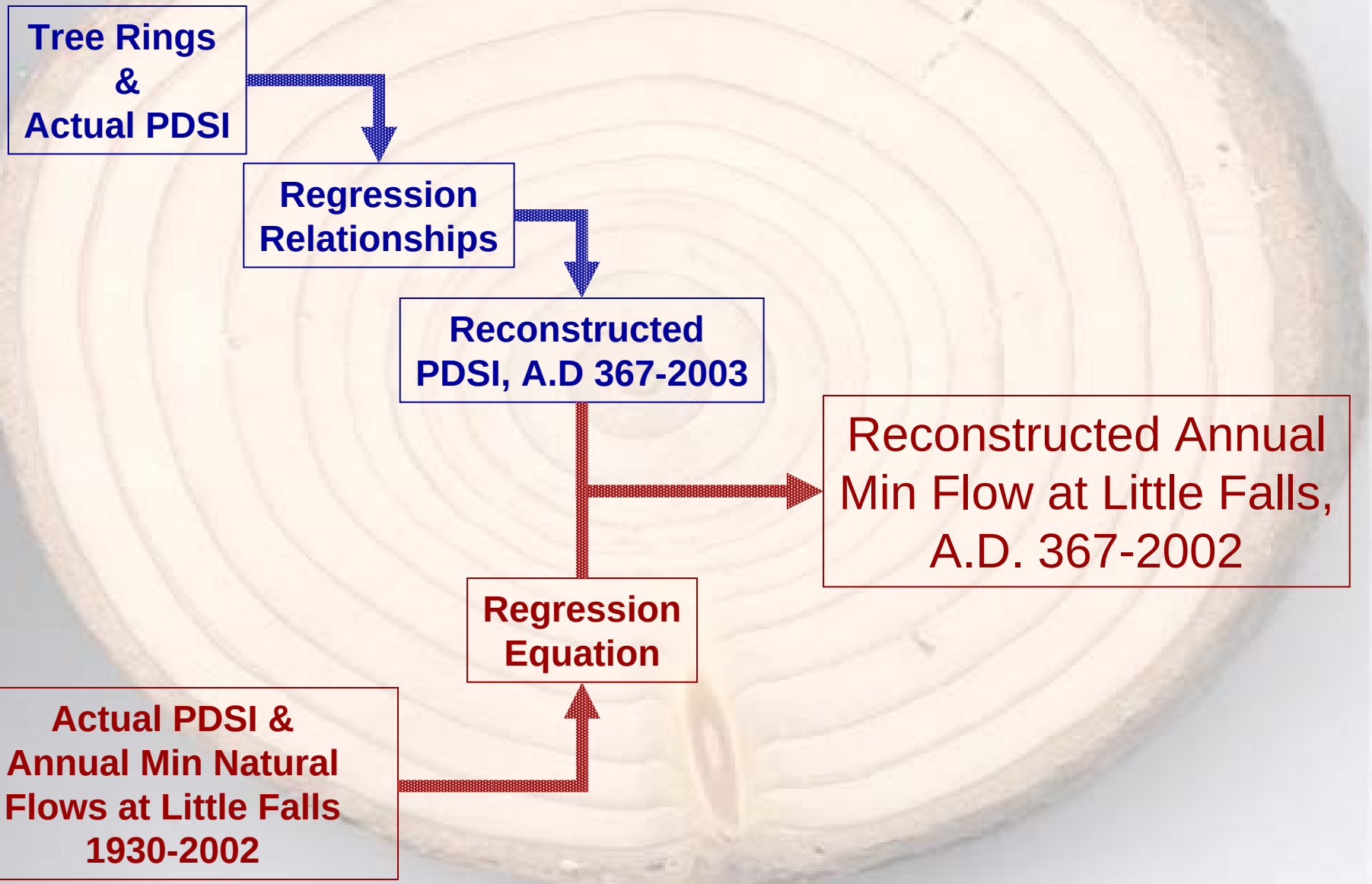
"the study of past climate for times prior to instrumental weather measurements"

-NOAA Paleoclimatology Program

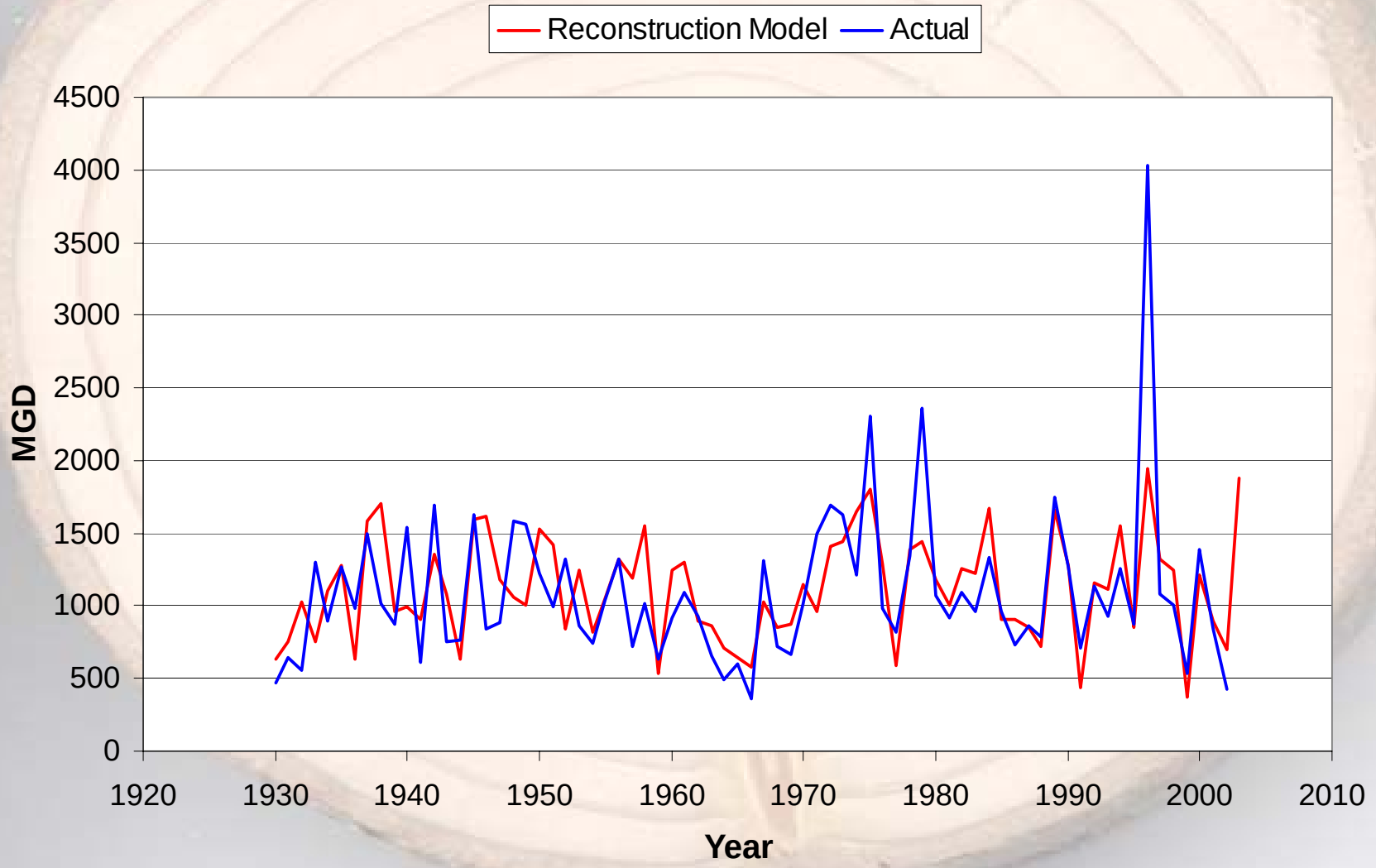



Develop Statistical Relationship Here
Tree Ring Data
Use the Statistical Relationship
to Reconstruct Climate Data here
Actual Climate Data
1300
1400
1500
1600
1700
1800
1900
2000
Year

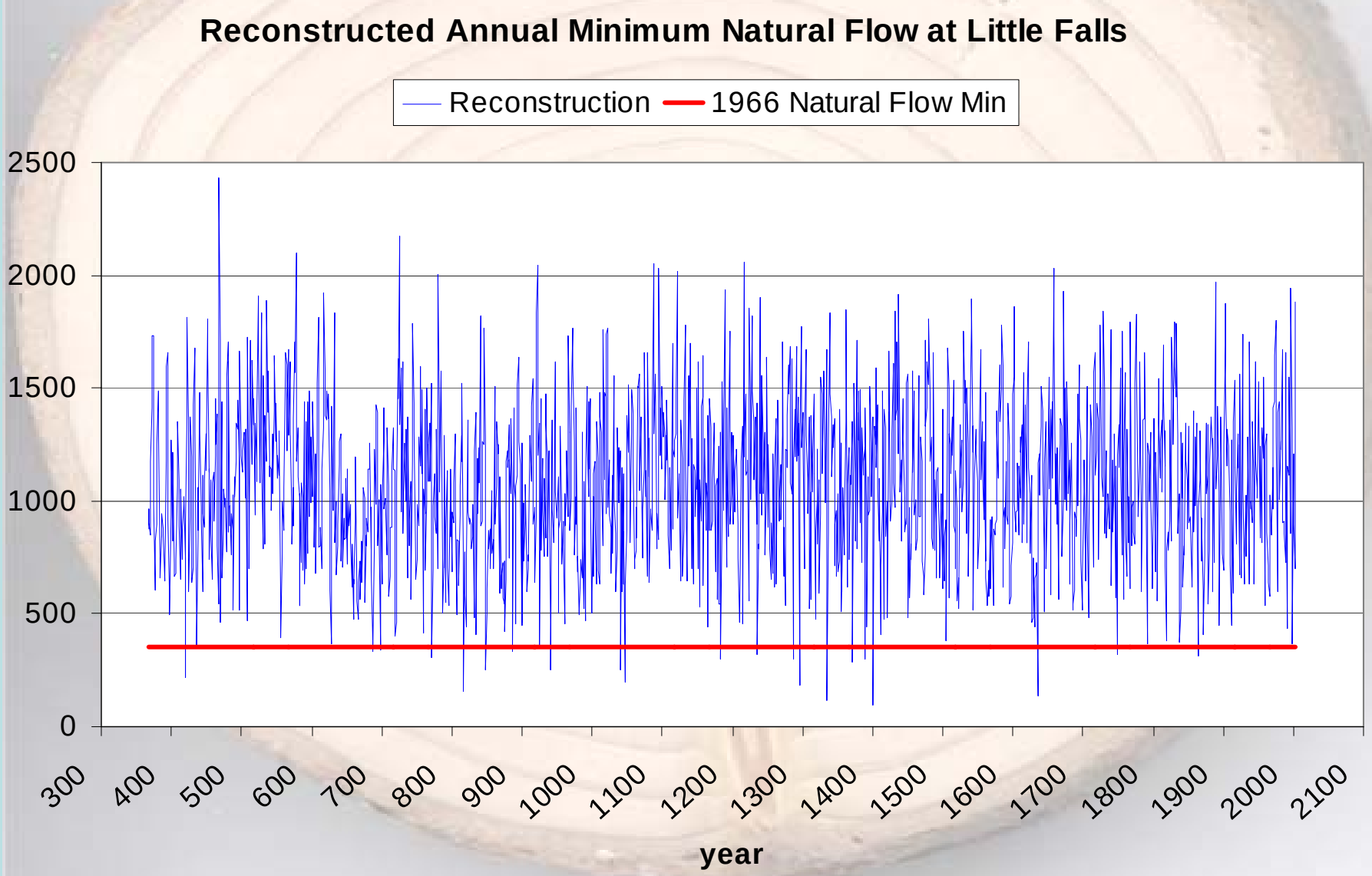
Two Reconstructions



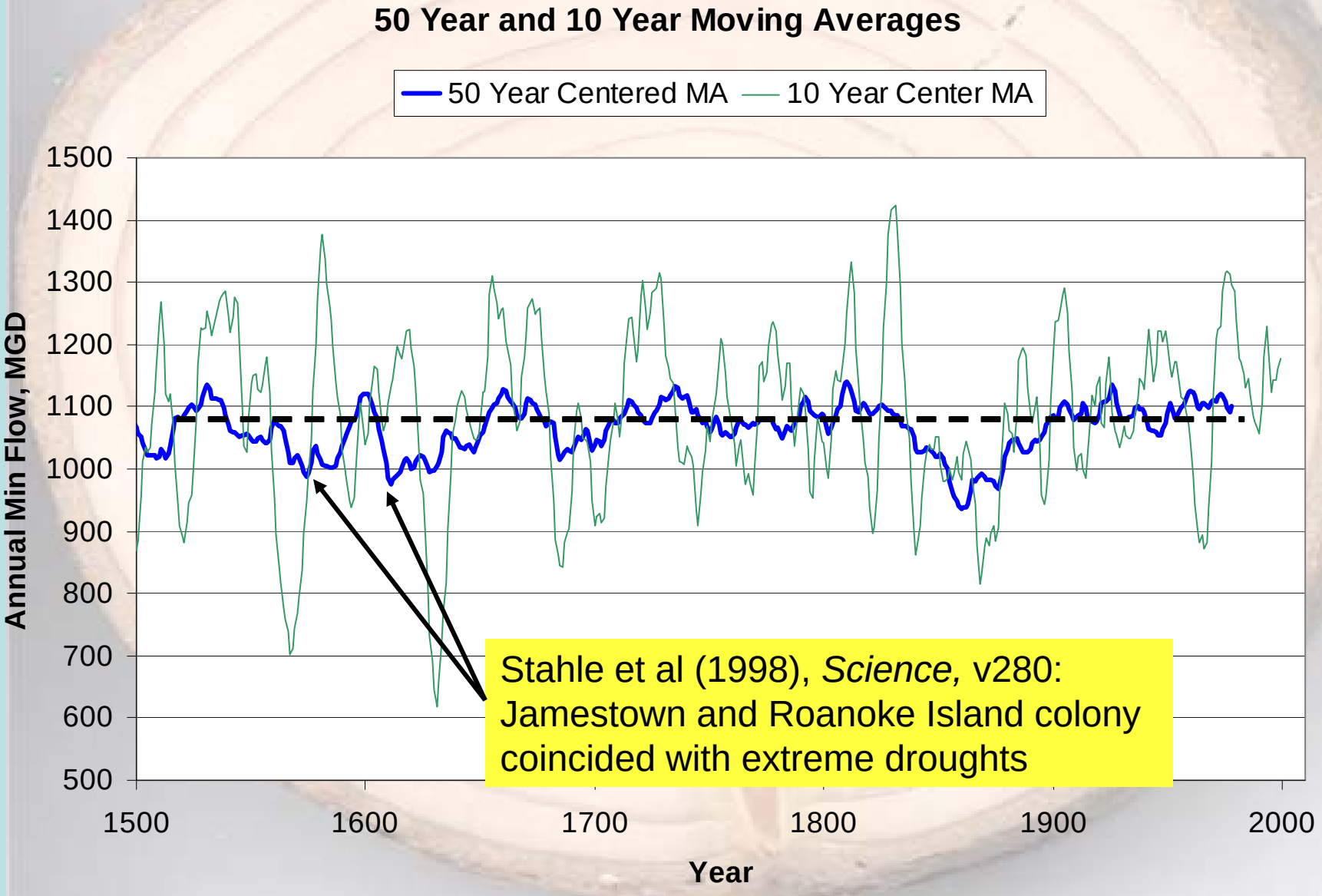
LF Natural Flow Reconstruction Validation



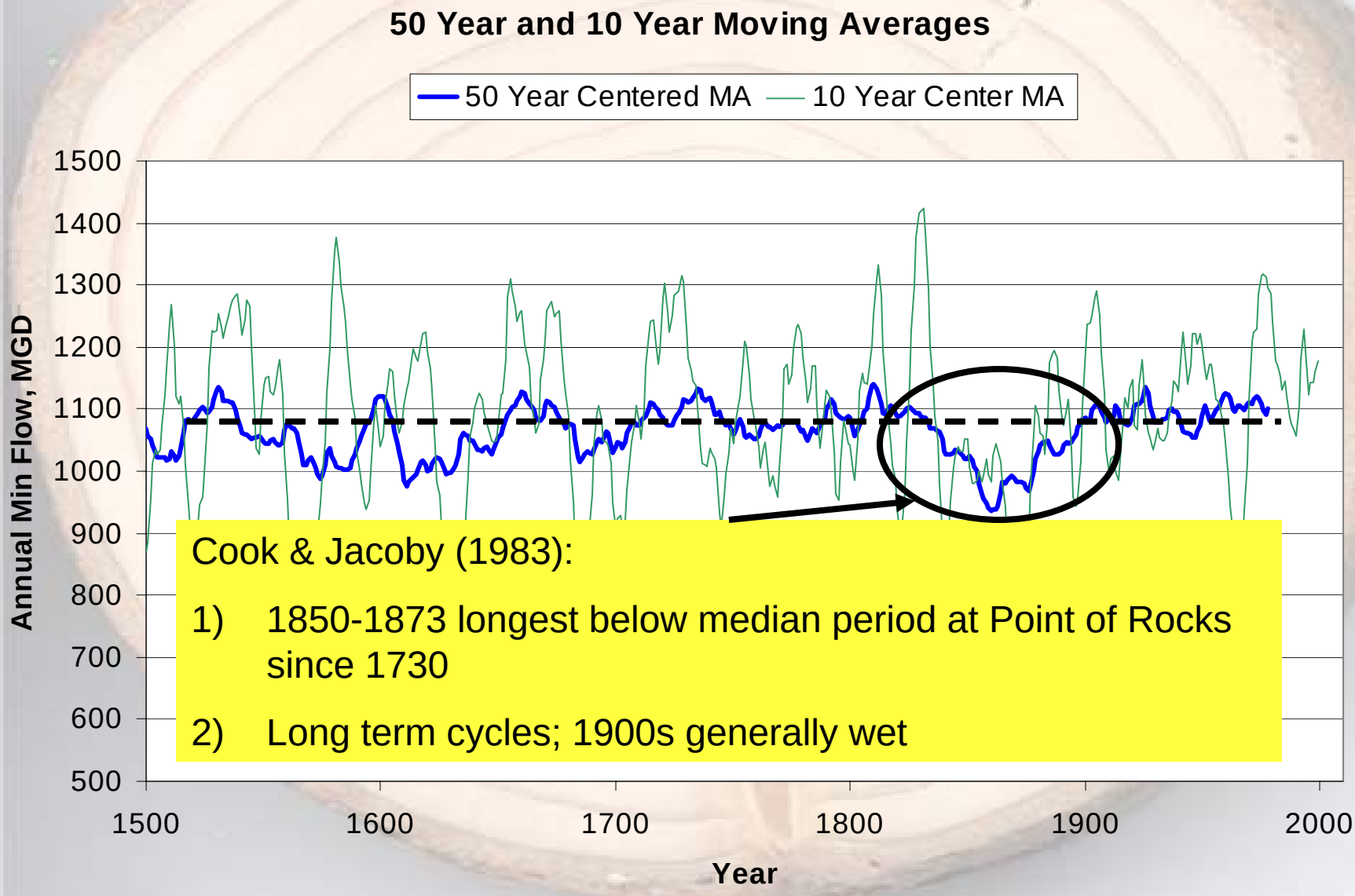
The Full Reconstruction



"Recent" Years



Verification of "Recent" Years



Cook & Jacoby (1983):

1) 1850-1873 longest below median period at Point of Rocks since 1730

2) Long term cycles; 1900s generally wet

Recap

- Where we've been
  - Drought of record
- Where we're going
  - Big picture overview of risks under climate variability