Tarrant Regional Water District

Water Supply Reliability Study

John Carron, Hydrosphere Resource Consultants, Inc.

Laura Blaylock, David Marshall, Tarrant Regional Water District

Steve Setzer, Kevin Wheeler, Subhrendu Gangopadhyay,
Hydrosphere Resource Consultants, Inc.

HYDROSPHERE
Resource Consultants

RiverWare Users Group Meeting
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TARRANT REGIONAL WATER DISTRICT

Outline

- Motivation and Objectives
- Modeling Approach
- Synthetic Hydrology and Statistics
- RiverWare Simulations
- Preliminary Results
- PDSI Template

Motivation and Objectives

- **How reliable is TRWD's water supply?**
- Limitations / Constraints:
  - Infrastructure (pipeline capacity, reservoir elevations)
  - Hydrologic (e.g., drought)
  - Water Rights
- How do these limitations and constraints manifest themselves as demands increase?
  - Forecast demands (2010, 2020, … , 2060)
  - How effective is the current drought response plan?
  - What are appropriate conservation / drought response measures?

Modeling Approach

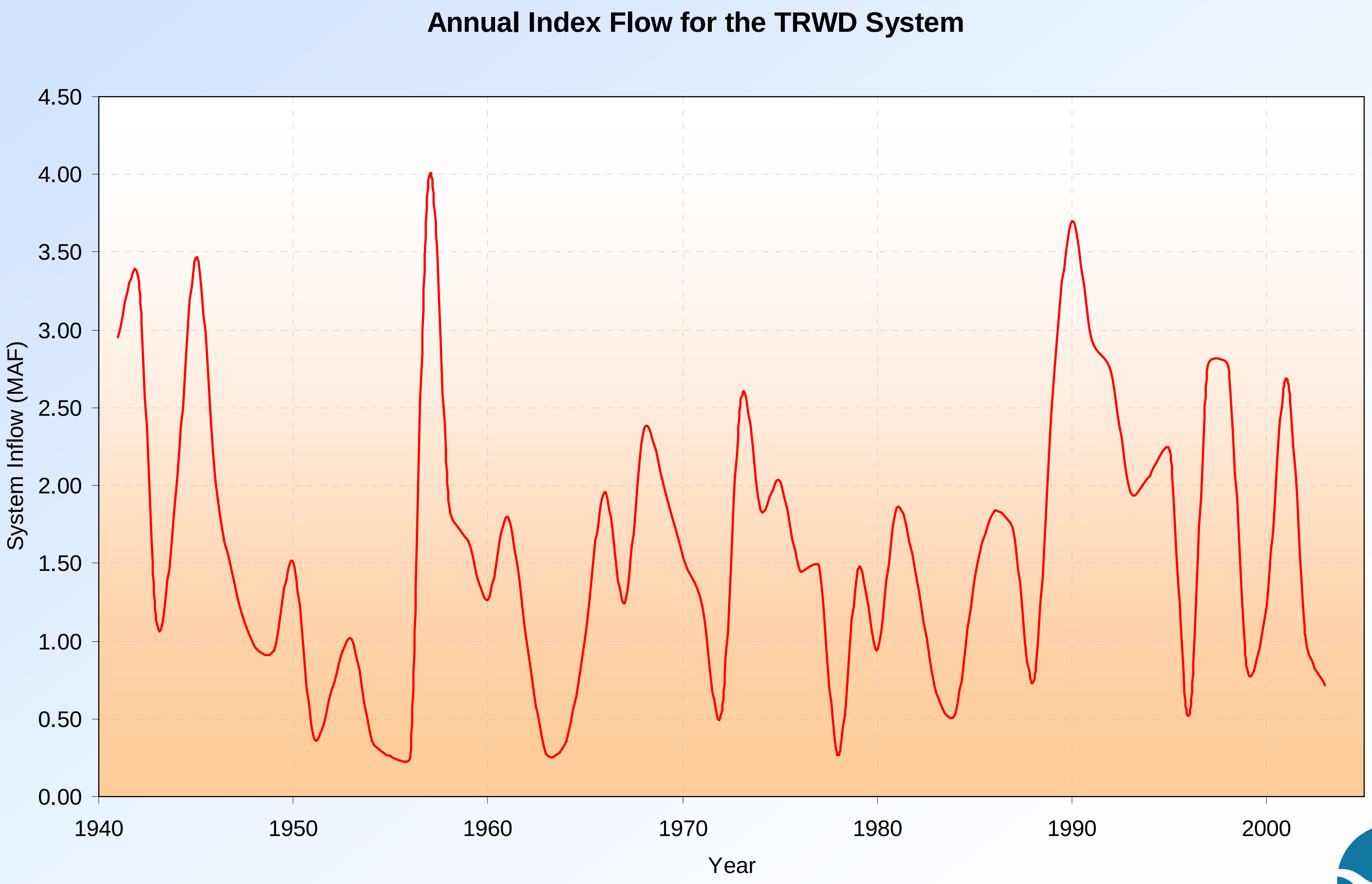
- TRWD RiverWare Model (1941-2003)
- Monte-Carlo type simulation using synthetic hydrologies
- Scenarios:
  - Simulate system at various demand levels
  - Simulate system with 2 different pipeline configurations
  - Simulate system with and without drought management plan in place

How to Evaluate Reliability without a Crystal Ball?

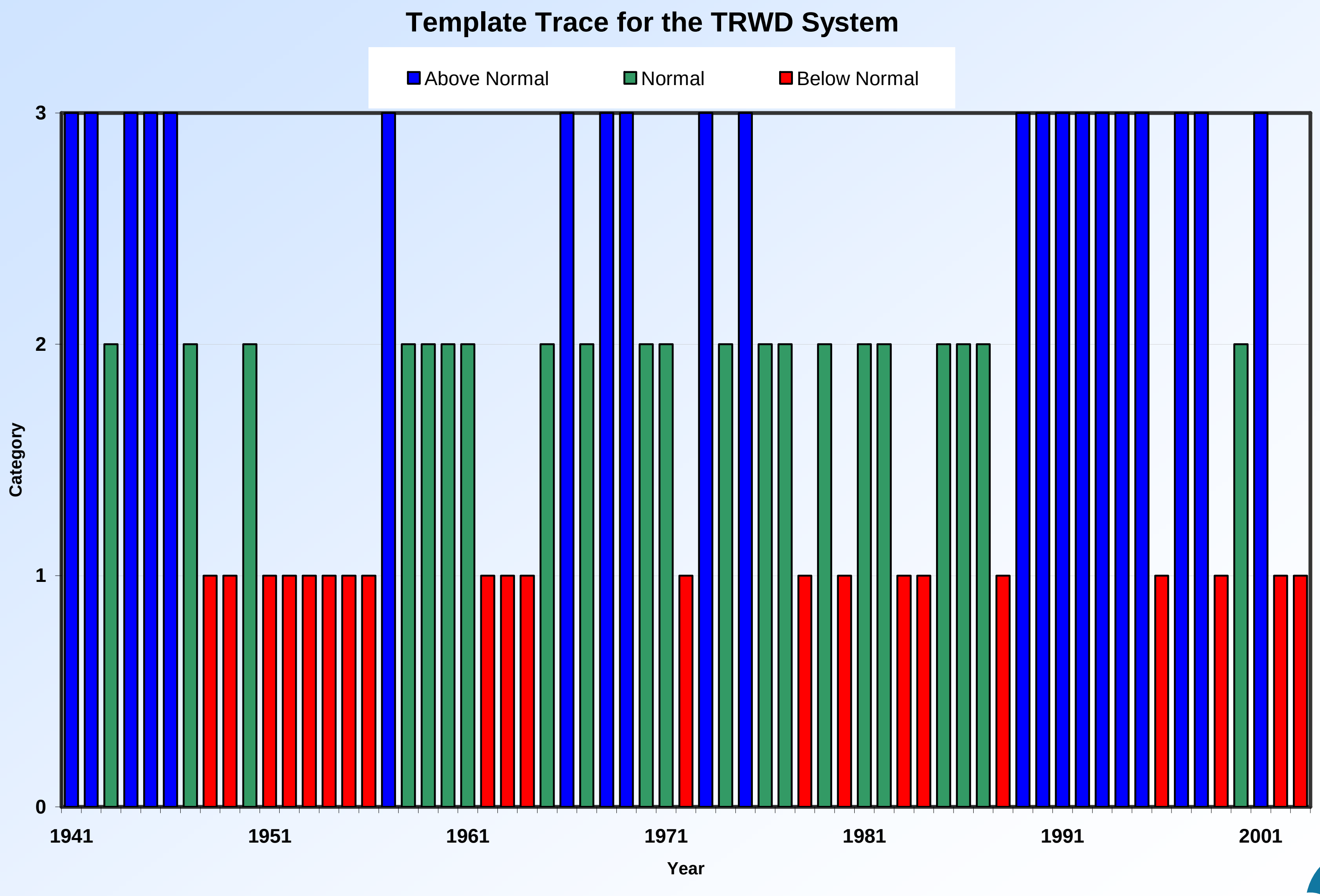
- **Use Historical Data Set?**
  - Good: Known events / statistically “tractable”
  - Good: Maintain multi-year correlations
  - Bad: Recorded History <> Future
- **Non-Parametric Reconstructions**
  - Based on Historical Data
  - Maintains multi-year correlations (e.g., patterns of drought events)
  - Uses actual historical hydrologic data
  - Sampling from “similar years” creates multiple synthetic traces

TRWD System Index Flow

(Annual Sum of Reservoir Inflows)



Index Flow Template



Categorical Resampling

Template Trace

low
mid
upper
mid
low
low
low
upper
mid
low
….

Resampling Trace

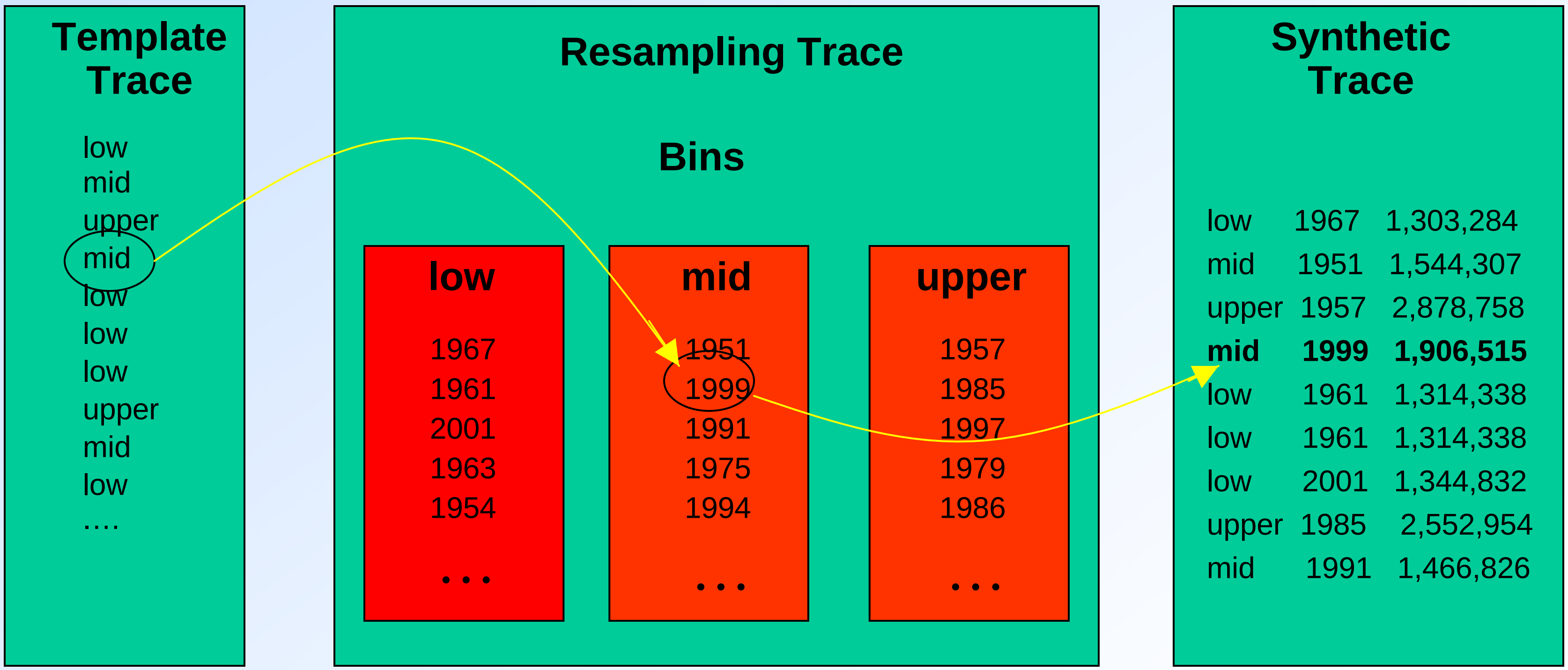
Bins

low	mid	upper
1967	1951	1957
1961	1999	1985
2001	1991	1997
1963	1975	1979
1954	1994	1986
. . .	. . .	. . .

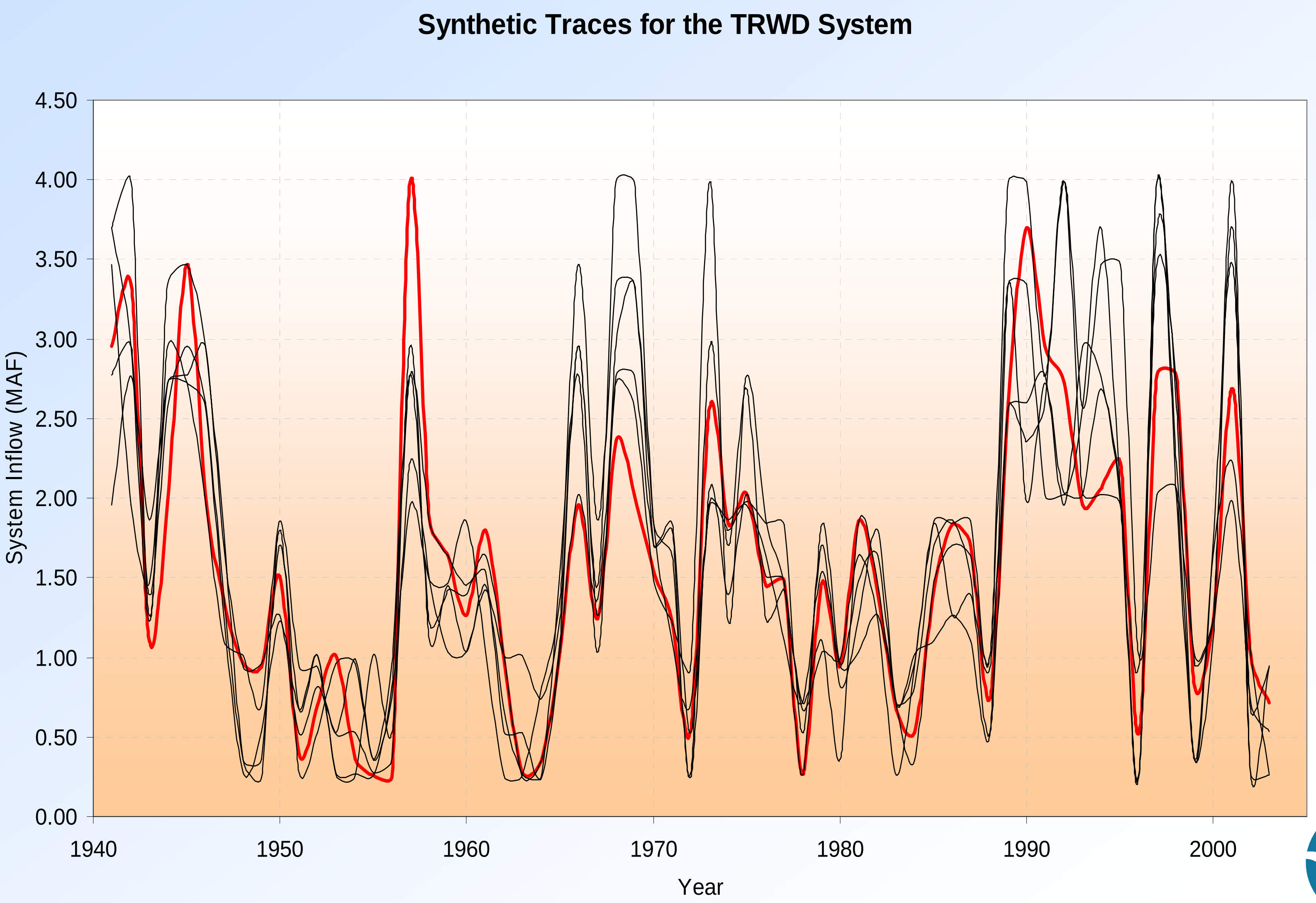
Synthetic Trace

low	1967	1,303,284
mid	1951	1,544,307
upper	1957	2,878,758
mid	1999	1,906,515
low	1961	1,314,338
low	1961	1,314,338
low	2001	1,344,832
upper	1985	2,552,954
mid	1991	1,466,826

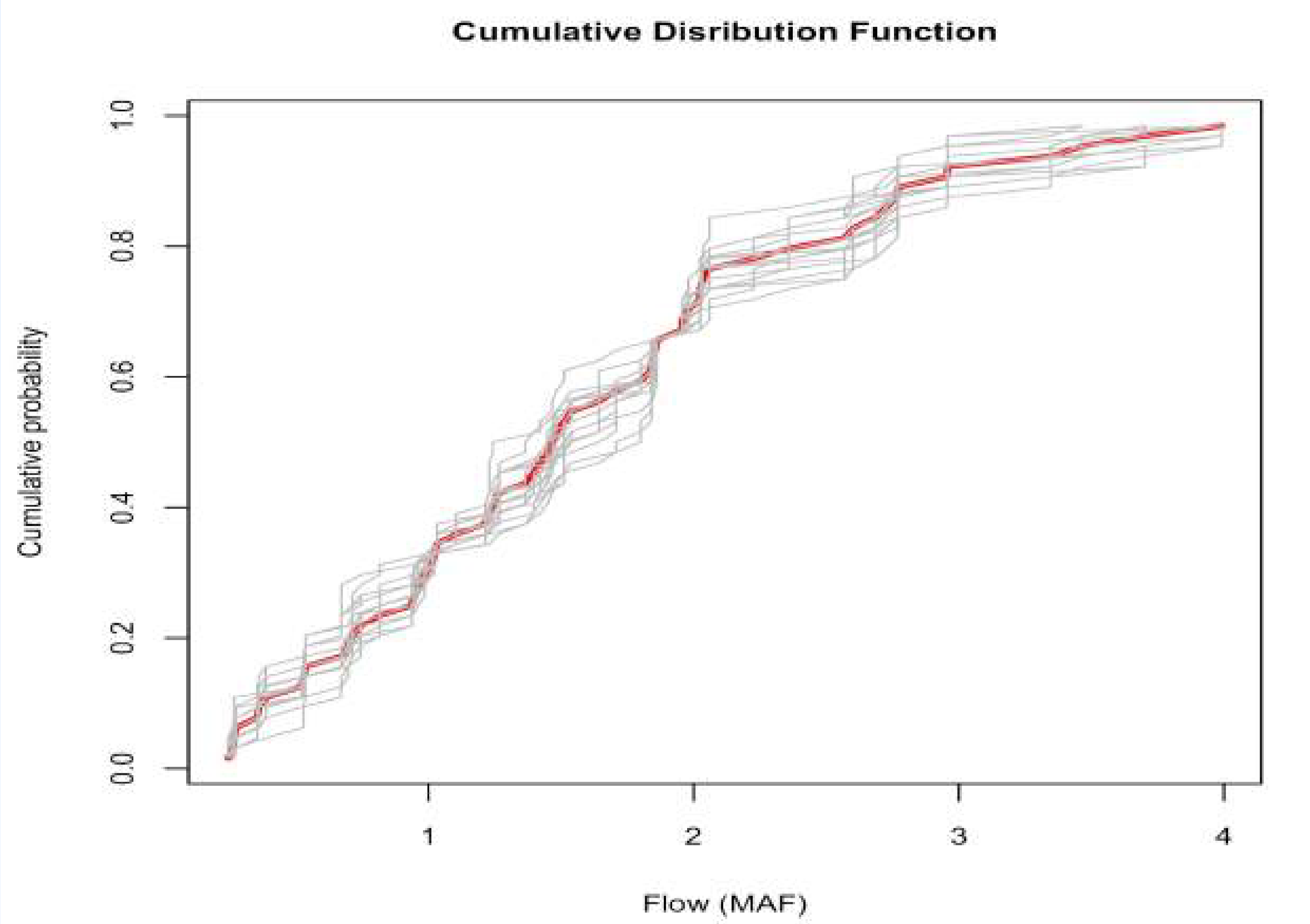
Trace Generation Process



Synthetic Hydrologies



Synthetic Trace Statistics



RiverWare Simulation

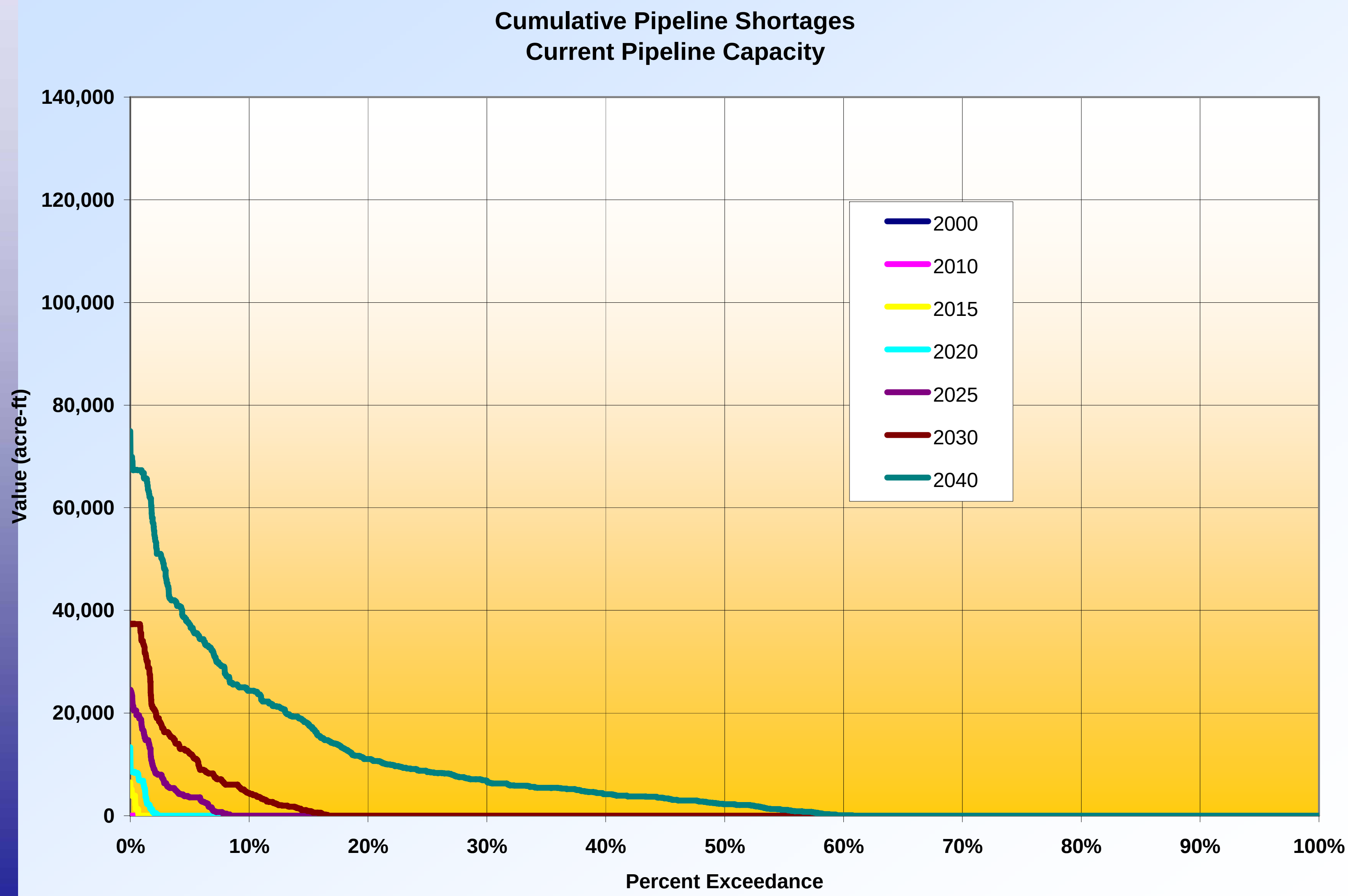
- **Multiple Run Manager (MRM)**
  - 100 synthetic hydrology traces
  - 9 demand levels (2000, 2010, 2015, 2020, 2025, 2030, 2040, 2050, 2060)
  - Pipeline configuration (current and unlimited
  - Drought Management Plan (Triggers / Stages)
  - 100 x 9 x 2 x 2 = 3600 63-year simulations (36 MRM runs)
- **Graphical Policy Analysis Tool (GPAT)**

Results (Preliminary)

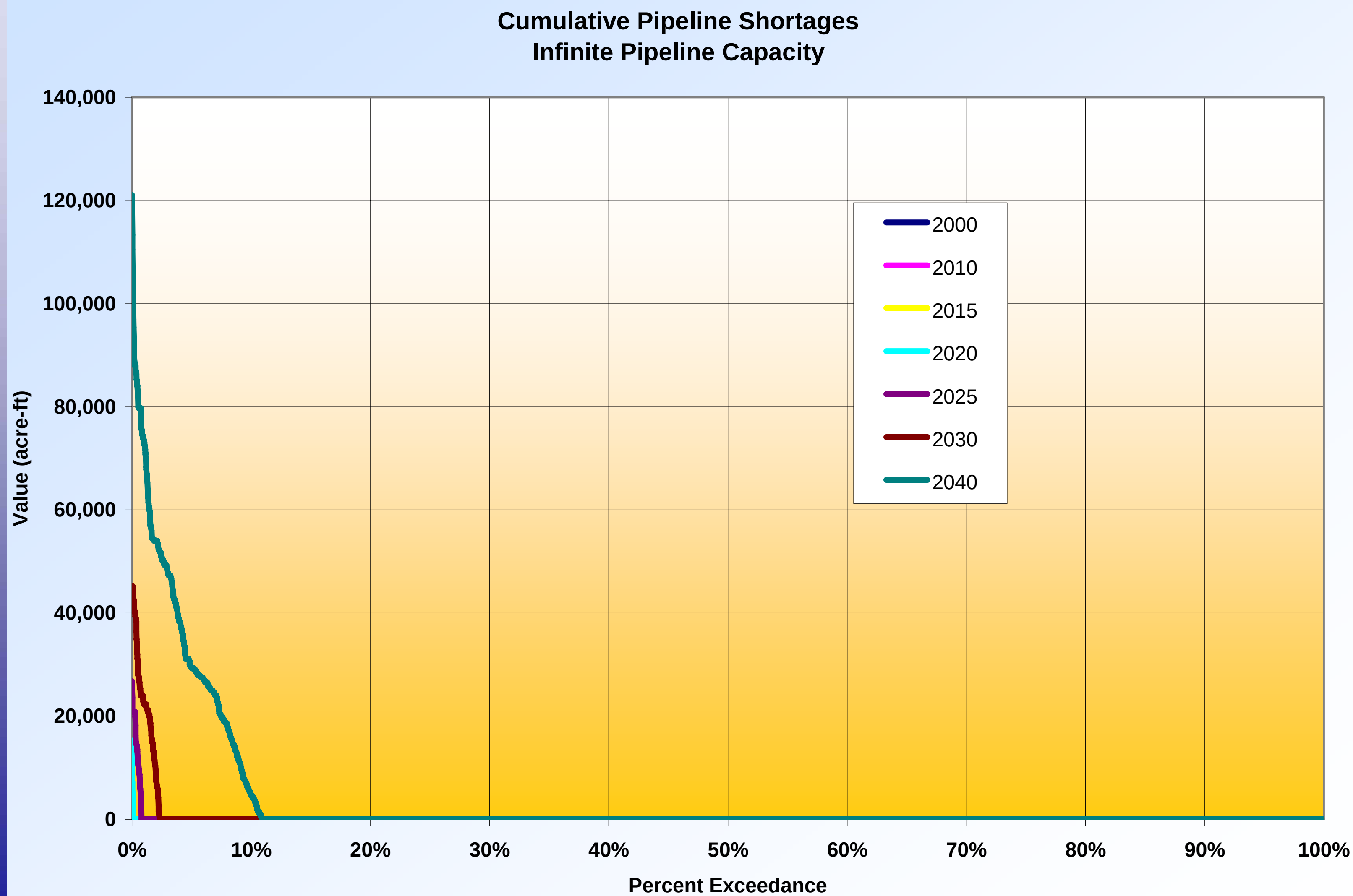
Pipeline demand shortages
(percentage of years in which a shortage occurs)

Demand Level	Current Pipeline Capacity	Infinite Pipeline Capacity
2000	0%	0%
2010	0%	0%
2015	0.67%	0%
2020	2.3%	0.08%
2025	8.4%	0.79%
2030	16.6%	2.3%
2040	60.9%	10.9%

Results (Preliminary)



Results (Preliminary)



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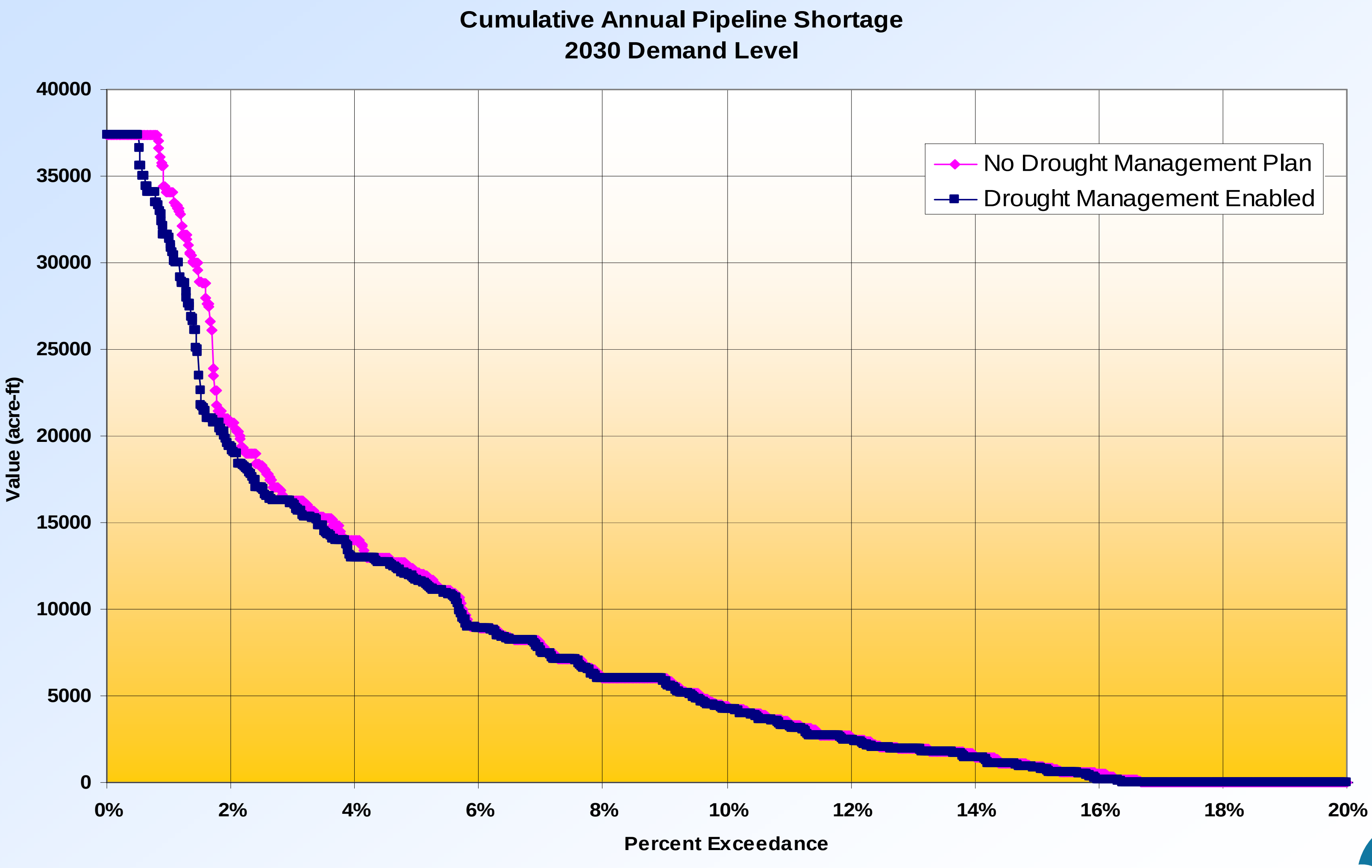
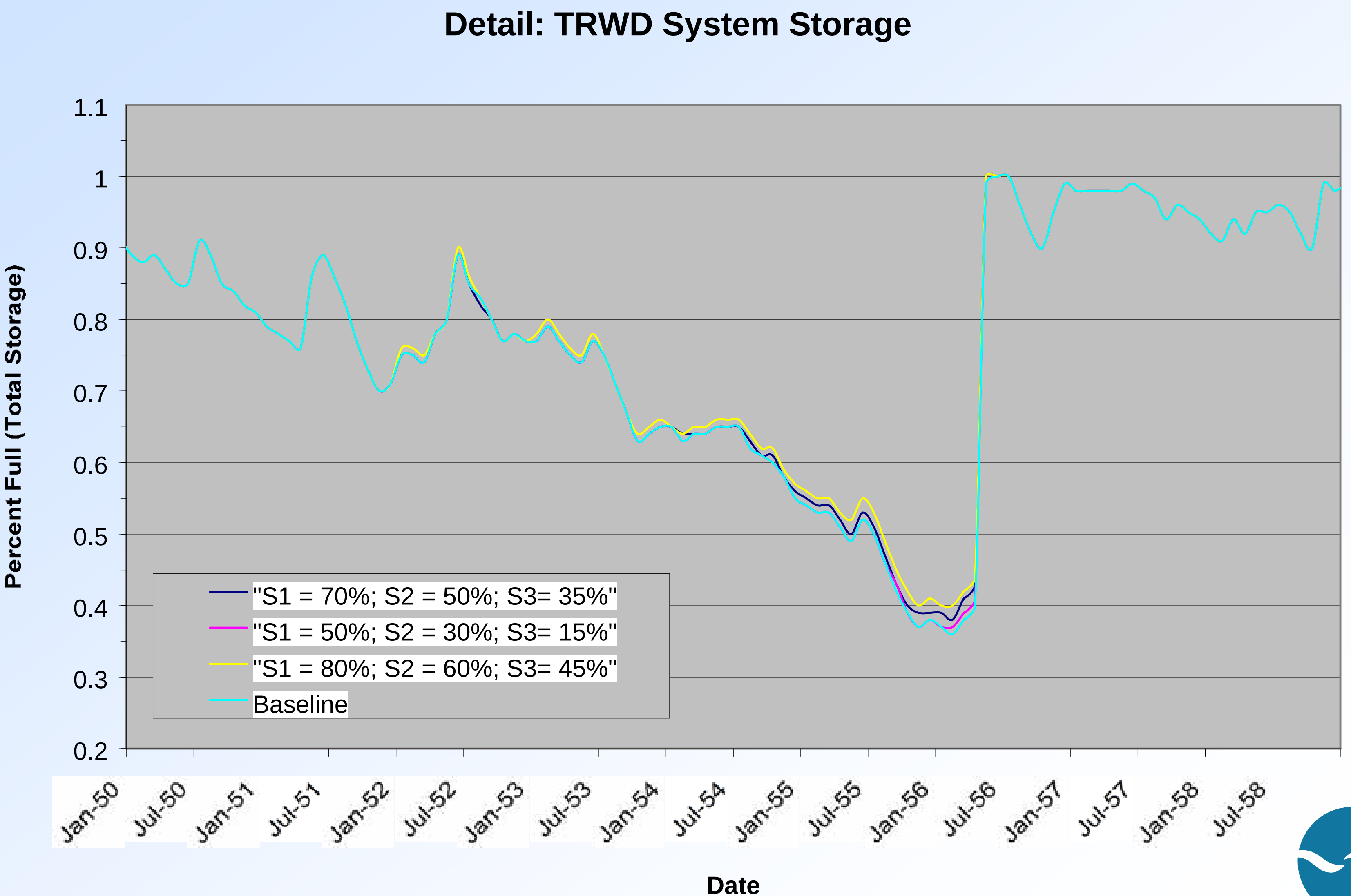


Results (Preliminary)



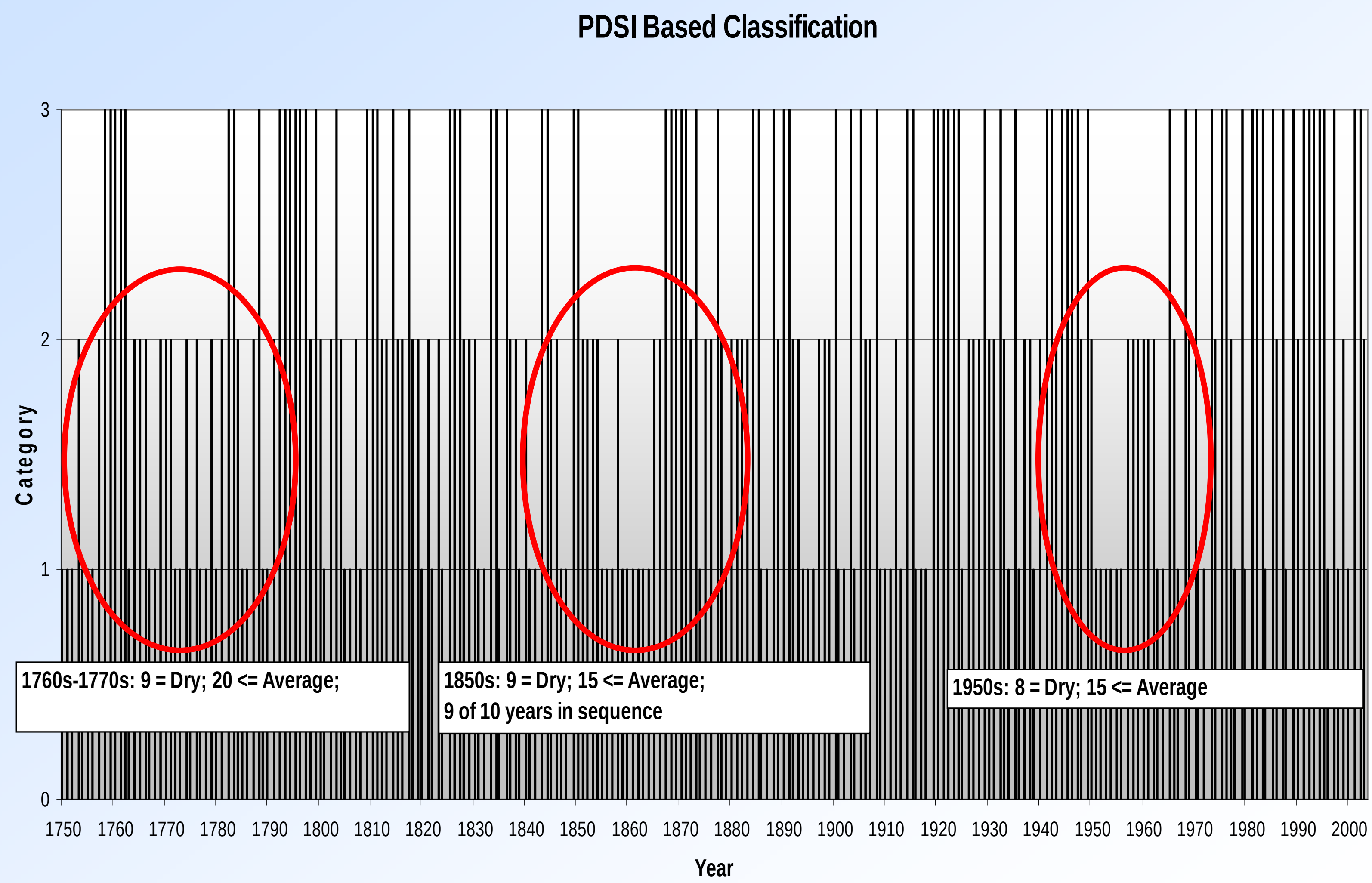
Conclusions (Preliminary)

- **Pipeline capacity <u>is</u> a limitation to meeting future demand**
- **Drought Management Plan as it is currently defined is not particularly effective in reducing the frequency of shortages**
- **Synthetic hydrology / Monte-Carlo approach is an effective method for addressing question of water supply reliability**

What's Next?

- **PDSI-Based hydrologic traces (NOAA/NCDC)**
  - 250 years (1750-2003)
  - Extended drought periods (1760s - 1770s; 1850s - 1860s)
  - Same demand, pipeline configuration scenarios
- **Drought Management Plan refinement**
  - Supply thresholds for triggering action
  - Demand reduction targets

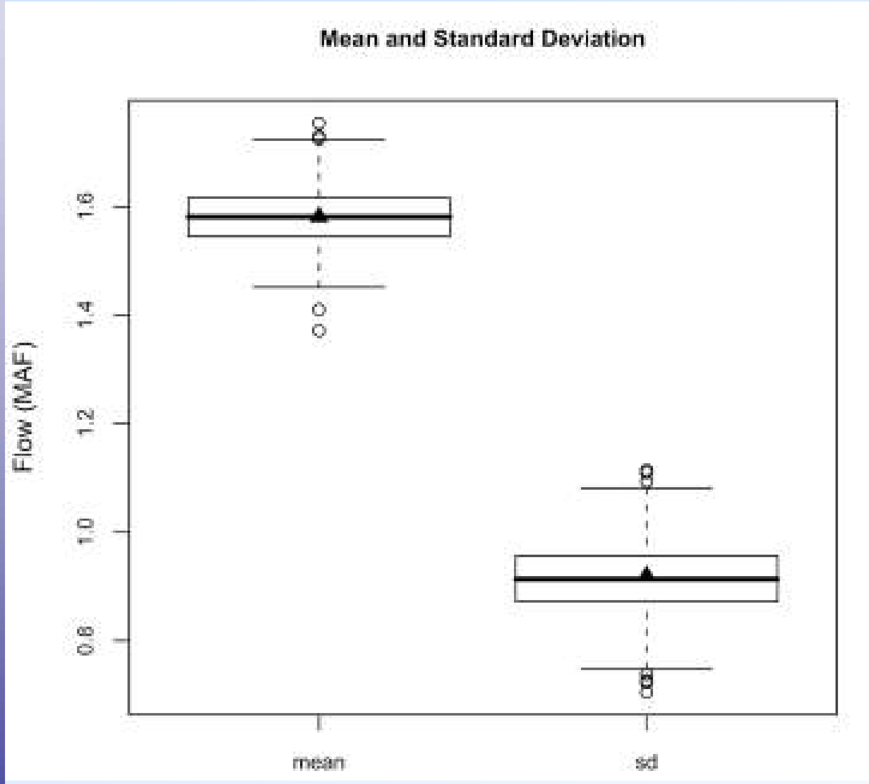
What's Next?

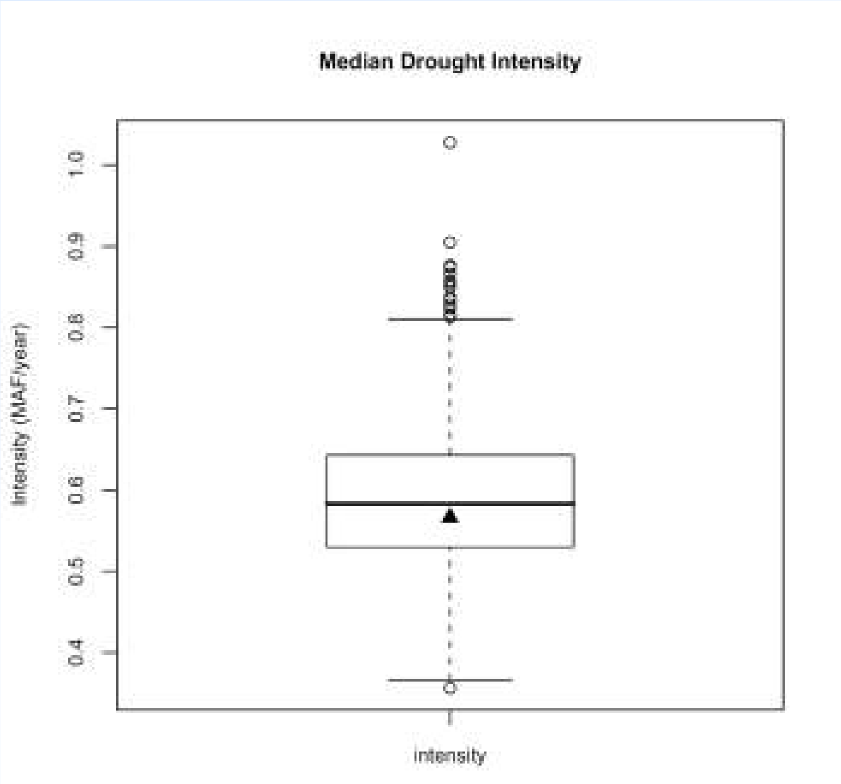


PDSI Based Classification
Category
Year
3
2
1
0
1750 1760 1770 1780 1790 1800 1810 1820 1830 1840 1850 1860 1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000
1760s-1770s: 9 = Dry; 20 <= Average;
1850s: 9 = Dry; 15 <= Average;
9 of 10 years in sequence
1950s: 8 = Dry; 15 <= Average

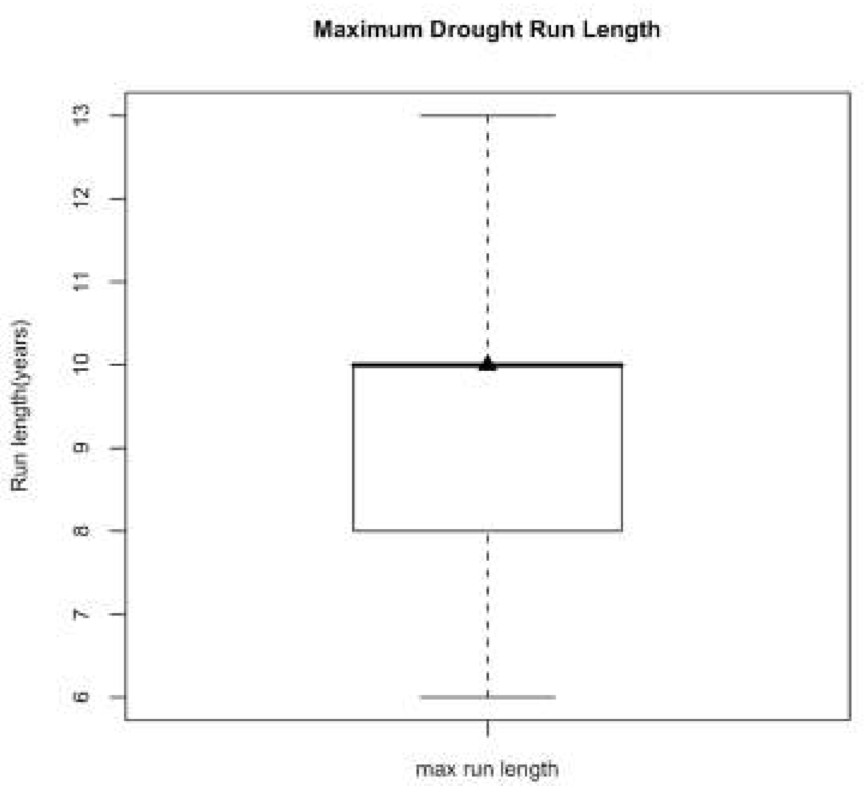
Questions?

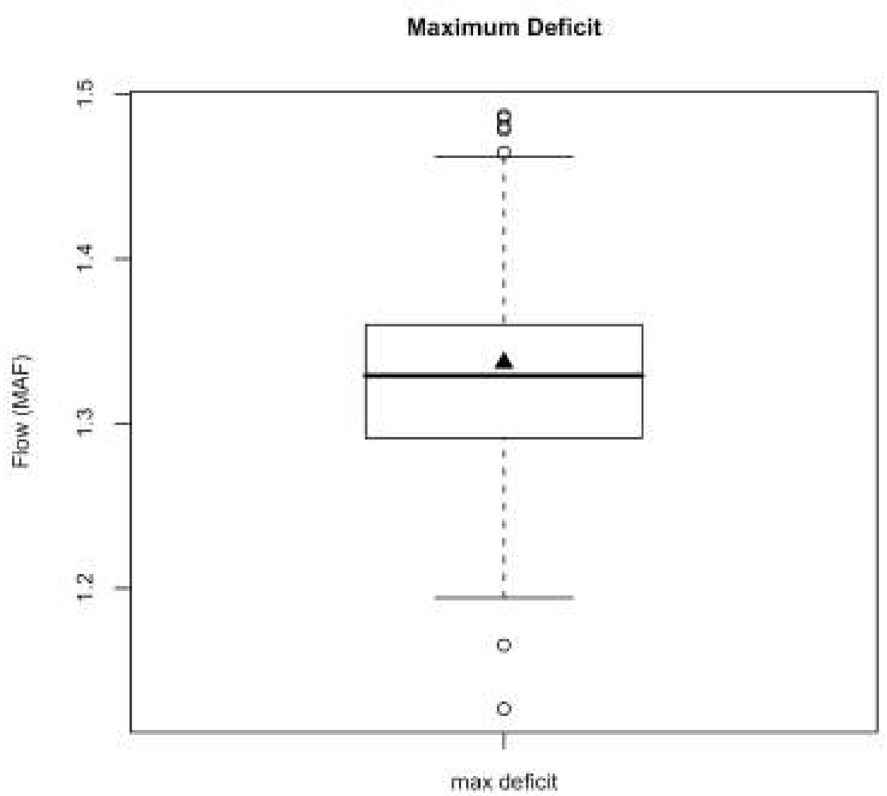
Synthetic Trace Statistics





Synthetic Trace Statistics





Results (Preliminary)