RECLAMATION
Managing Water in the West

Reservoir Operations Pilot Study

Improving M&I Water Supply Reliability Through Enhanced Drought Preparedness and Response

A Case Study on the Washita Basin Project, Oklahoma

Presentation Outline

- Executive Summary
- Background and Need
- Calculating Reservoir Firm Yield - Standard Practice vs New Approach
- Summary

Executive Summary

- The amount of Municipal & Industrial (M&I) water a reservoir can ***reliably deliver*** without going dry is referred to as the reservoir's "***firm yield***" (a.k.a., dependable yield).
- Traditionally, "reliability" = supply is assumed to be available ***~100 percent of the time*** during the worst ***drought of record observed*** since record-keeping.
- The firm yield provides the basis for ***planning and decision-making***: acquisition and protection of water rights, reservoir construction/return on investment, willingness to pay/repayment contracts, long-range planning, diversification of water supplies, etc.
- The disadvantage with this approach is that record-keeping encompasses a relatively ***narrow period of time***.
- The 2011-2015 drought of record proved our assumptions to be incorrect.

Executive Summary

- ***Tree ring data*** allow us to look further backwards in time, constructing inflow sequences (***paleohydrology***) that encompass centuries of wet and dry cycles, including “mega droughts”.
- Using proven techniques that reconstruct paleohydrology from tree rings, we developed a ***new modeling tool*** that uses the paleohydrology to calculate a broad range of reservoir firm yield values (and a corresponding probability distribution).
- The new model allows us to ***quantify the risk*** of our reservoirs going dry under different drought scenarios and demand pressures (e.g., instead of supply being 100% firm, it’s ?% firm) .
- The model can help inform ***long-range planning*** decisions or ***real-time*** drought response (i.e., planning for the drought of tomorrow versus responding to the drought of today)

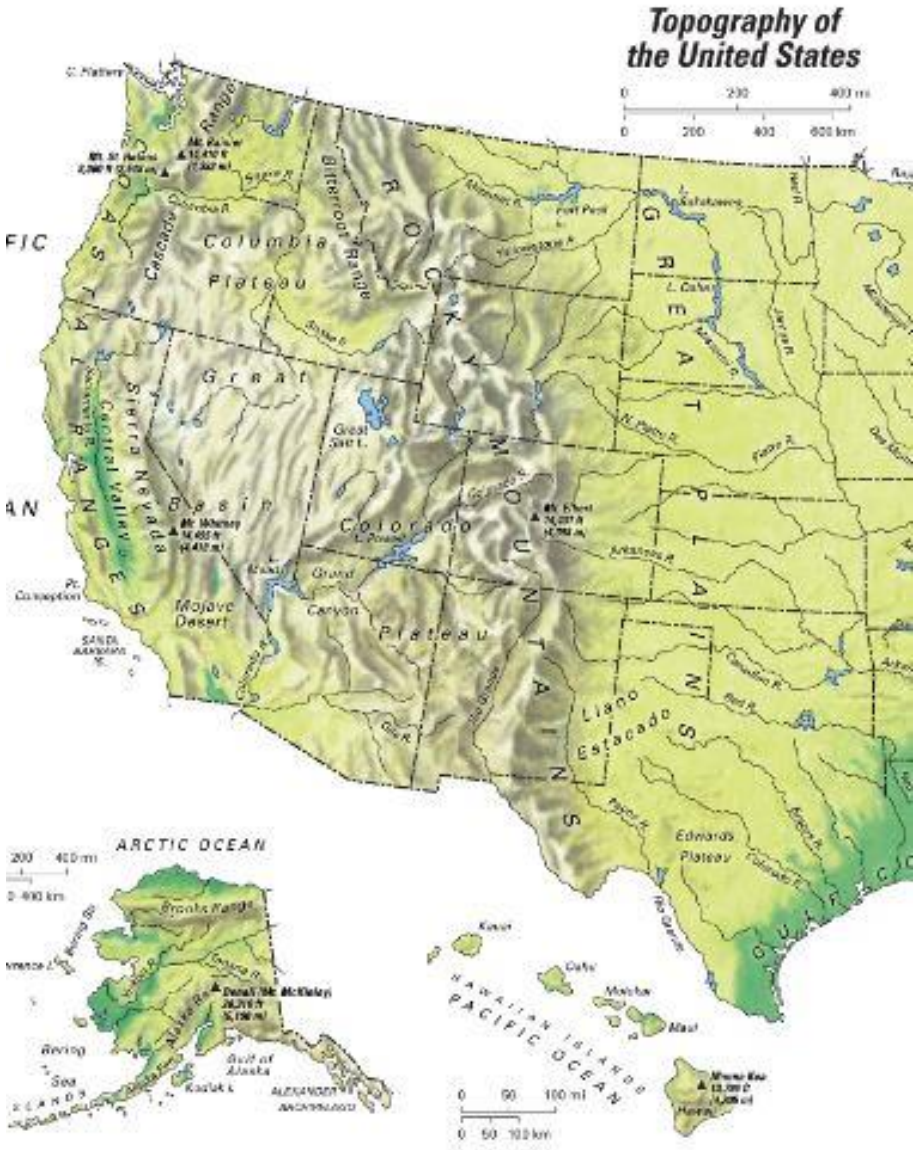
Oklahoma-Texas Area Office

- Oversees 11 reservoirs that provide regional M&I water supplies to about ***three million customers:***
  - Oklahoma City, OK
  - Corpus Christi, TX
  - Over 50 cities and rural water districts, power providers, etc.

"M&I" defined: water for consumption, residential, washing, laundering, fire protection, hospitals, offices, hotels, manufacturing, etc.

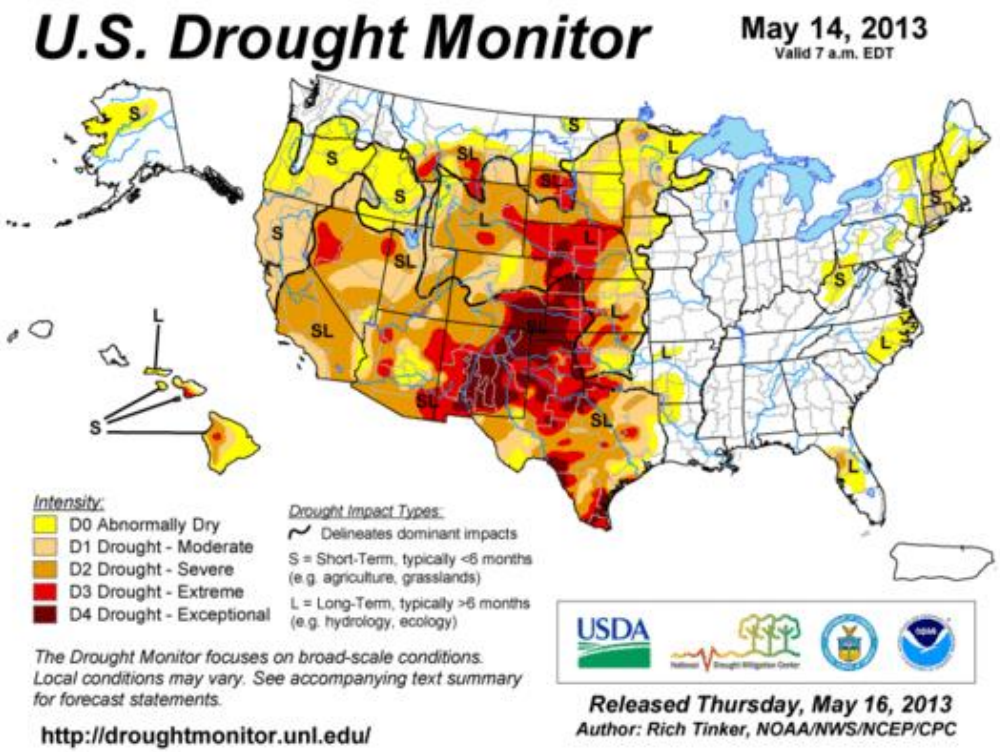
Oklahoma-Texas Area Office

- Topography and climate do not generate snowmelt that feeds streams which flow into reservoirs.
- Reservoirs depend mostly on rainfall and streamflow for their supply.
- Once in storage, temperature influences evaporation rates.

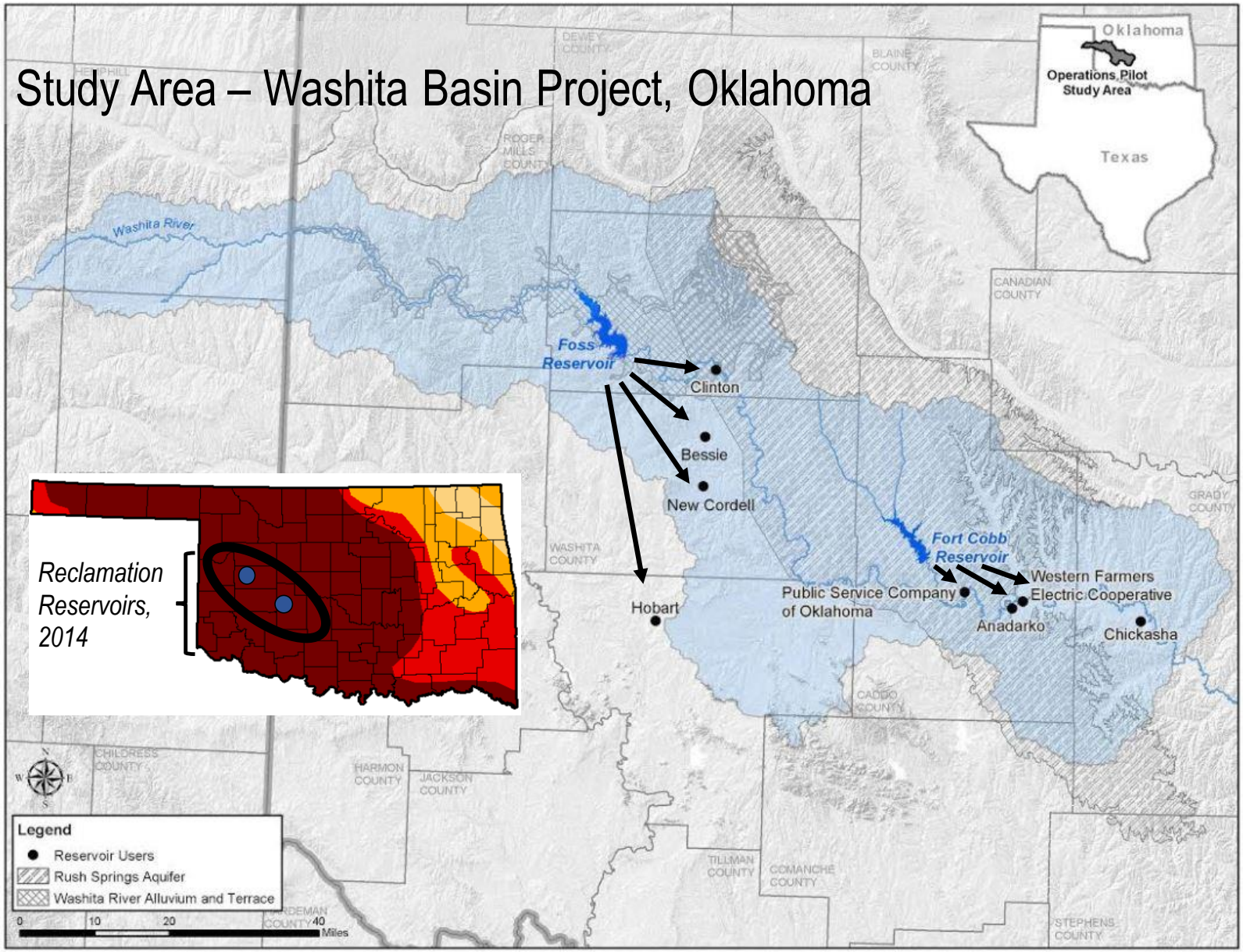


Oklahoma-Texas Area Office

- Vulnerable to drought
- Droughts are difficult to predict
- Beginning and end of a drought can be fast or slow
- No two droughts are the same



Catastrophic Drought in Western Oklahoma, 2011-2015



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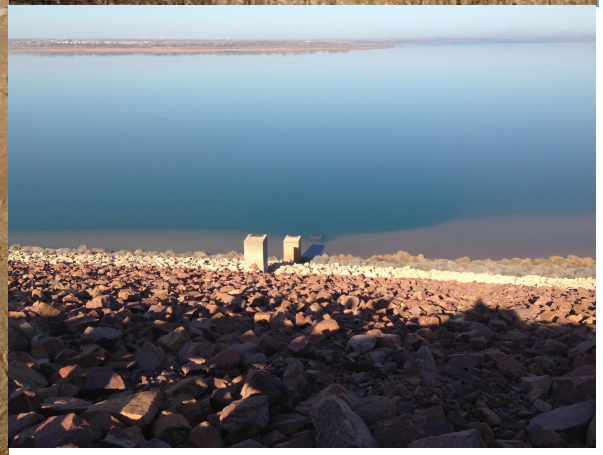
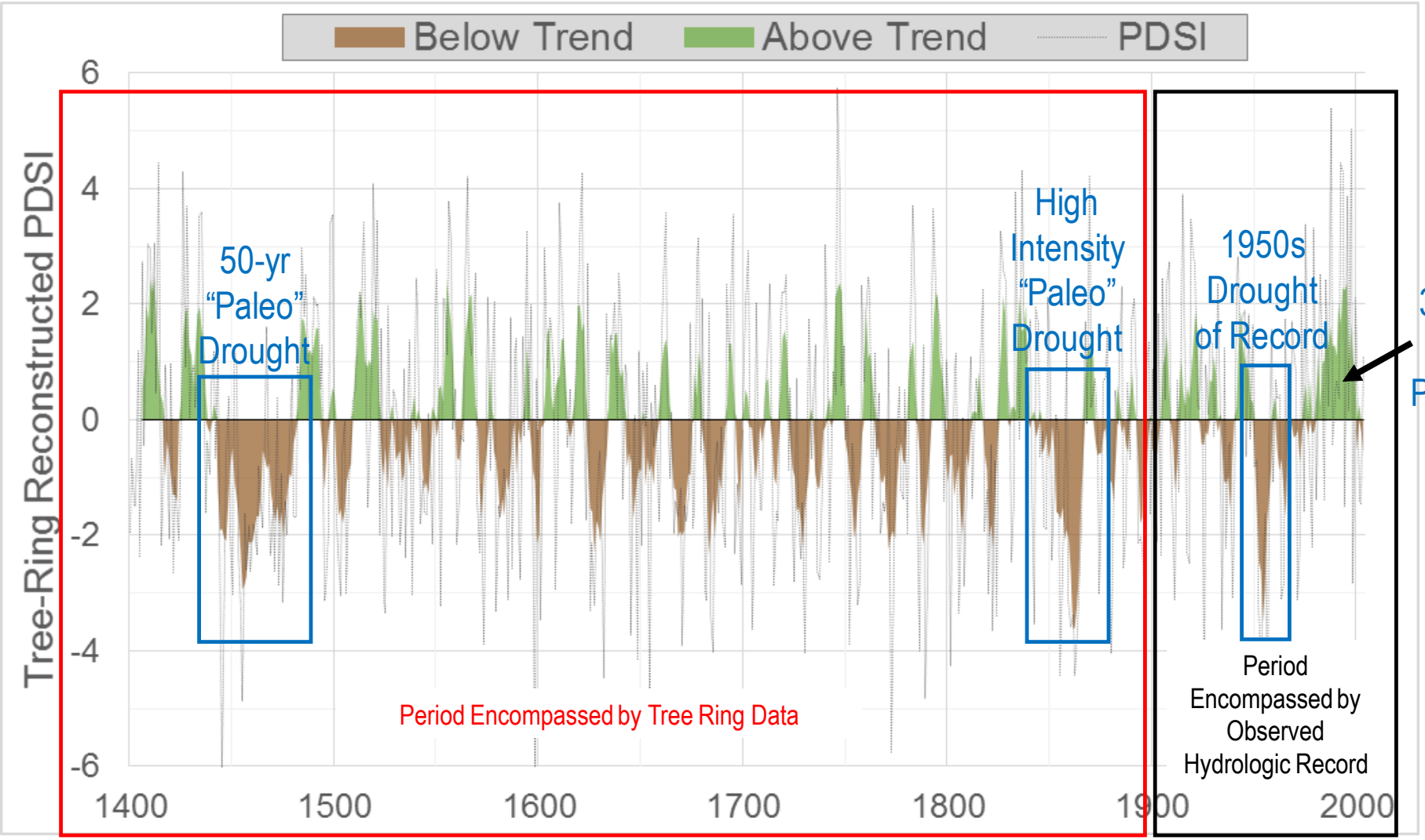


Operations Pilot Goals and New Ways of Thinking: Traditional vs New Approach



Traditional Approach

Solve for M&I Supply Availability (Firm Yield)

Observed Historical Hydrologic Record
(e.g., < 100 years)

New Approach

Cross section of a tree trunk, illustrating wet years (thicker rings) versus dry years (thinner rings)

Paleohydrologic Record (e.g., 600 years)

Solve for M&I Supply Availability (*Range* of Firm Yields)

Reservoir

New Approach

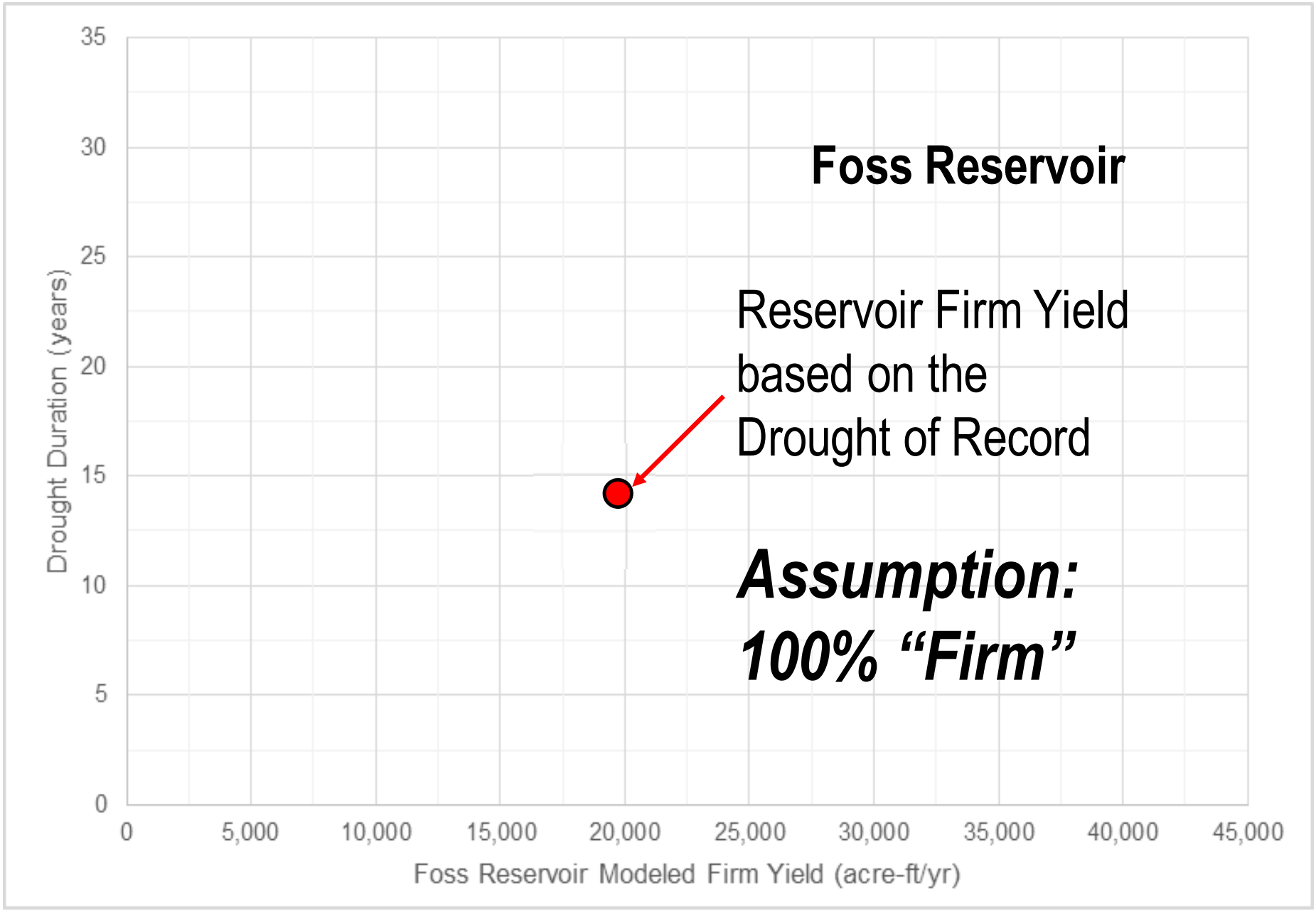
Cross section of a tree trunk, illustrating wet years (thicker rings) versus dry years (thinner rings)

Paleohydrologic Record (e.g., 600 years)

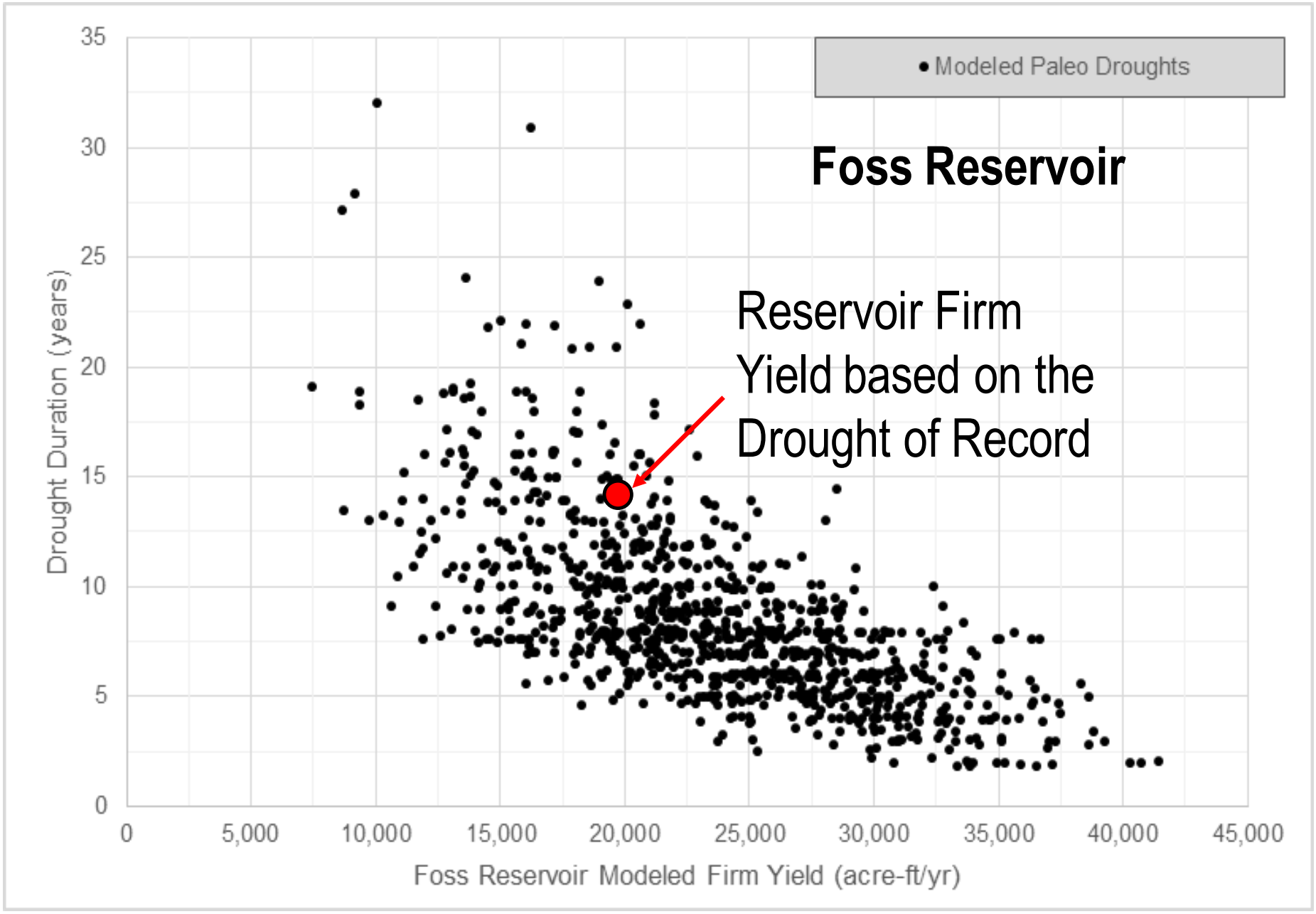
Advantages:

- Longer window of time
- Captures more variation in wet and dry cycles
- Provides a ***range*** of firm yield values
- Provides information on risk exposure
- More credible basis for decision-making

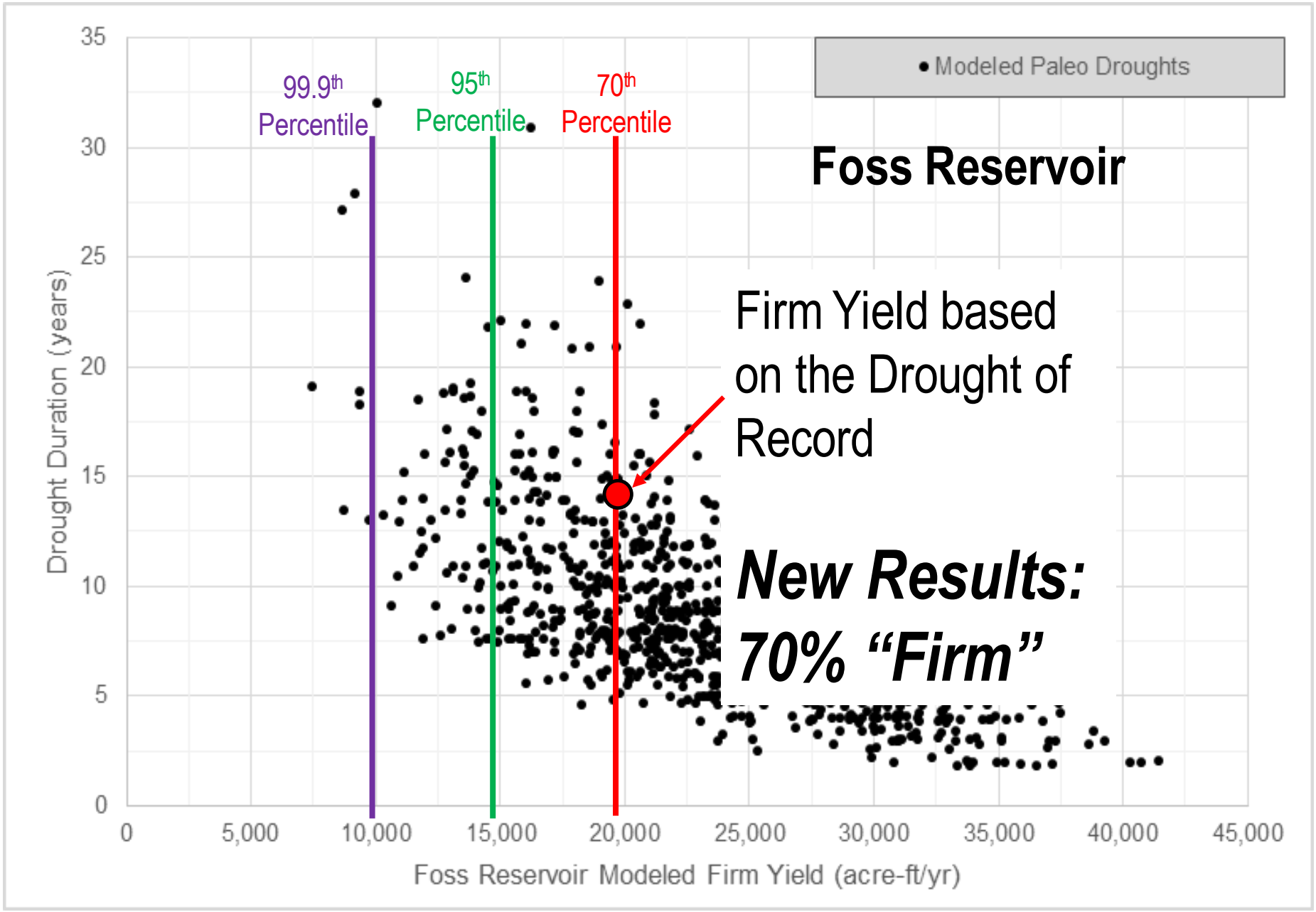
Traditional Approach – One Firm Yield



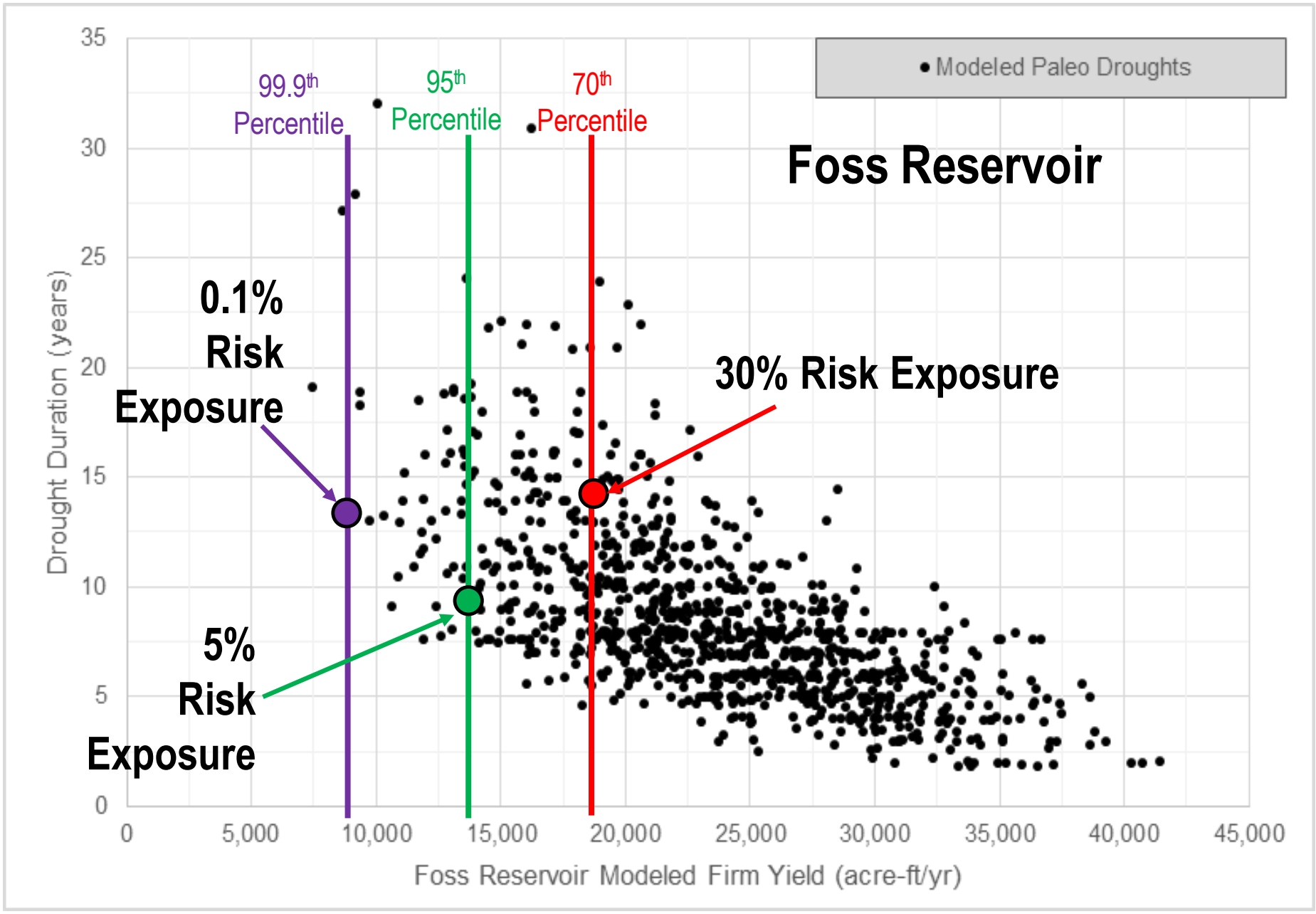
New Approach – A Range of 1,000 Reservoir Yield Values



New Approach – With Probability Distributions



New Approach – Risk Exposure



Which drought do we plan for?

Risk Exposure

Risk Tolerance

- Who uses the water?
- How much water is being used?
- How much can they be curtailed?

New Approach - Closing the Gap between Risk Exposure and Risk Tolerance

Risk Exposure > Risk Tolerance = Take Action

- Credible justification for informed decision-making:
  - Conservation and efficiency measures
  - Water supply diversification
  - Water marketing

Traditional Approach – Near-Term Drought Response

Storage Based on Assumed Demands

Observed Historical Hydrologic Record (e.g., 3, 6, 12 months repeat themselves)

New Approach – Near-Term Drought Response

Cross section of a tree trunk, illustrating wet years (thicker rings) versus dry years (thinner rings)

Paleohydrologic Record (e.g., 95th, 99.9th, and Worst Paleo Droughts)

Real-Time Storage Based on Actual Use

Reservoir

New Approach – Near-Term Drought Response

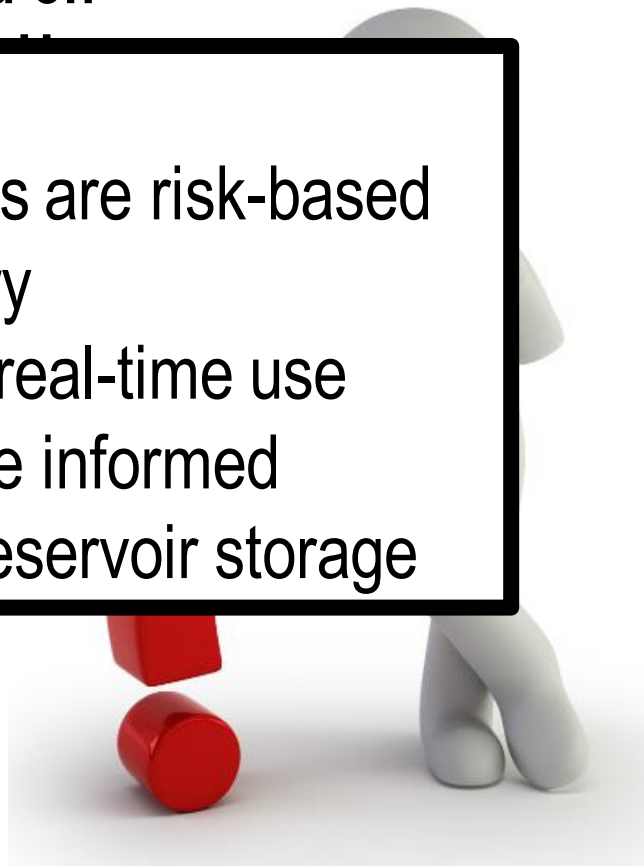
Cross section of a tree trunk, illustrating wet years (thicker rings) versus dry years (thinner rings)

Paleohydrologic Record (e.g., 95th, 99.9th, and Worst Paleo Droughts)

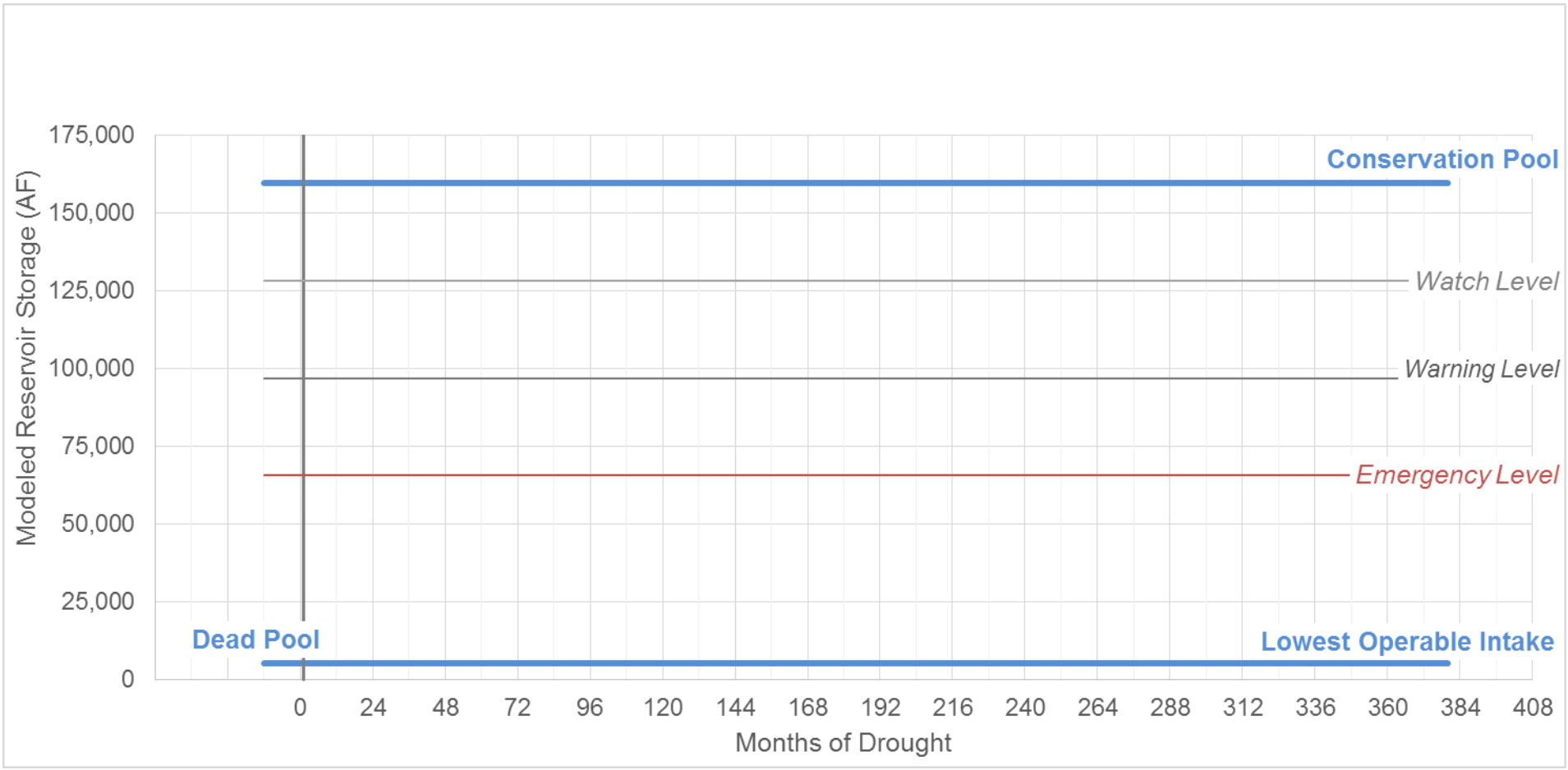
Real-Time Storage Based on

Advantages:

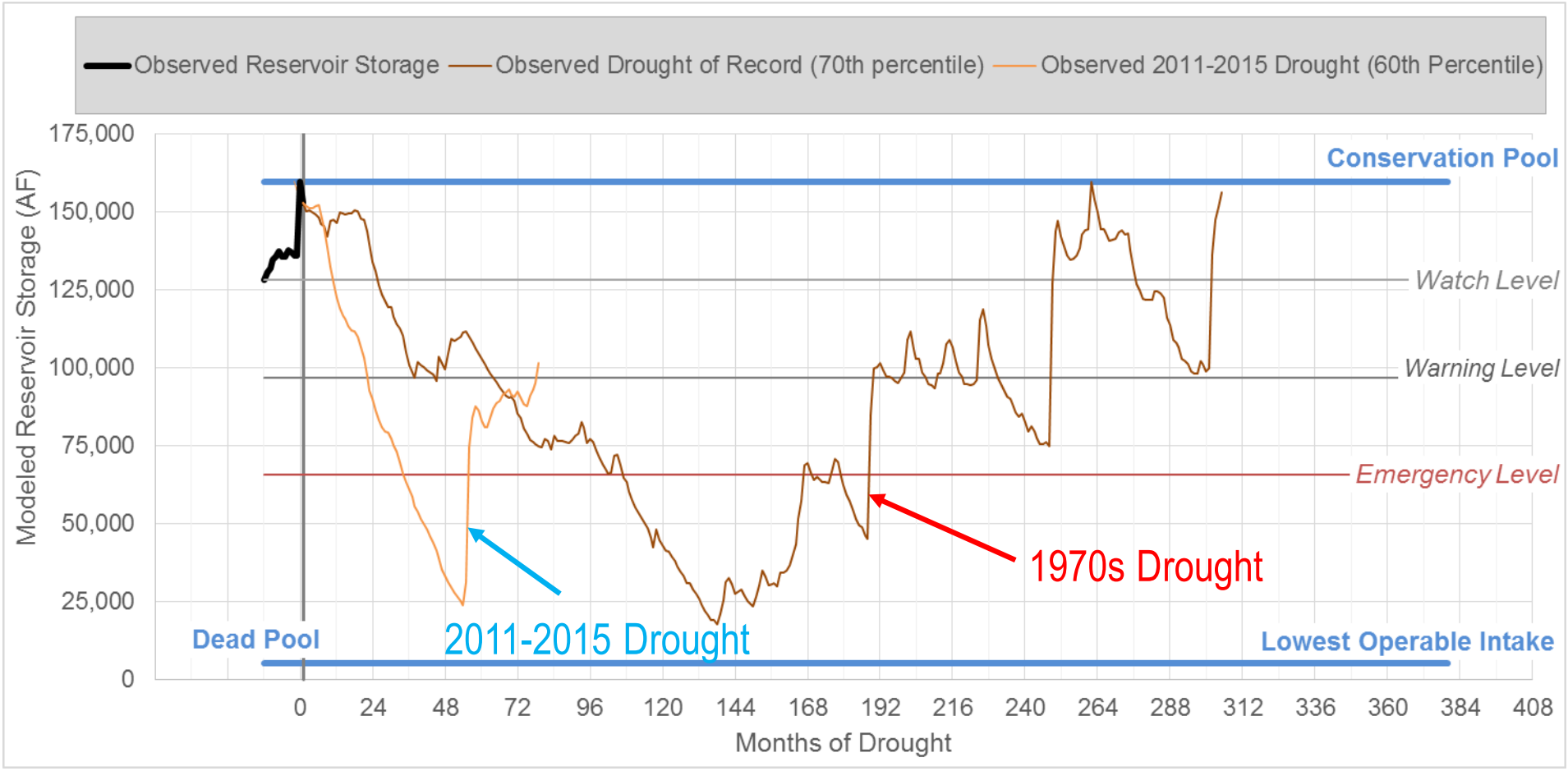
- Selected inflows are risk-based and not arbitrary
- Accounting for real-time use provides a more informed calculation of reservoir storage



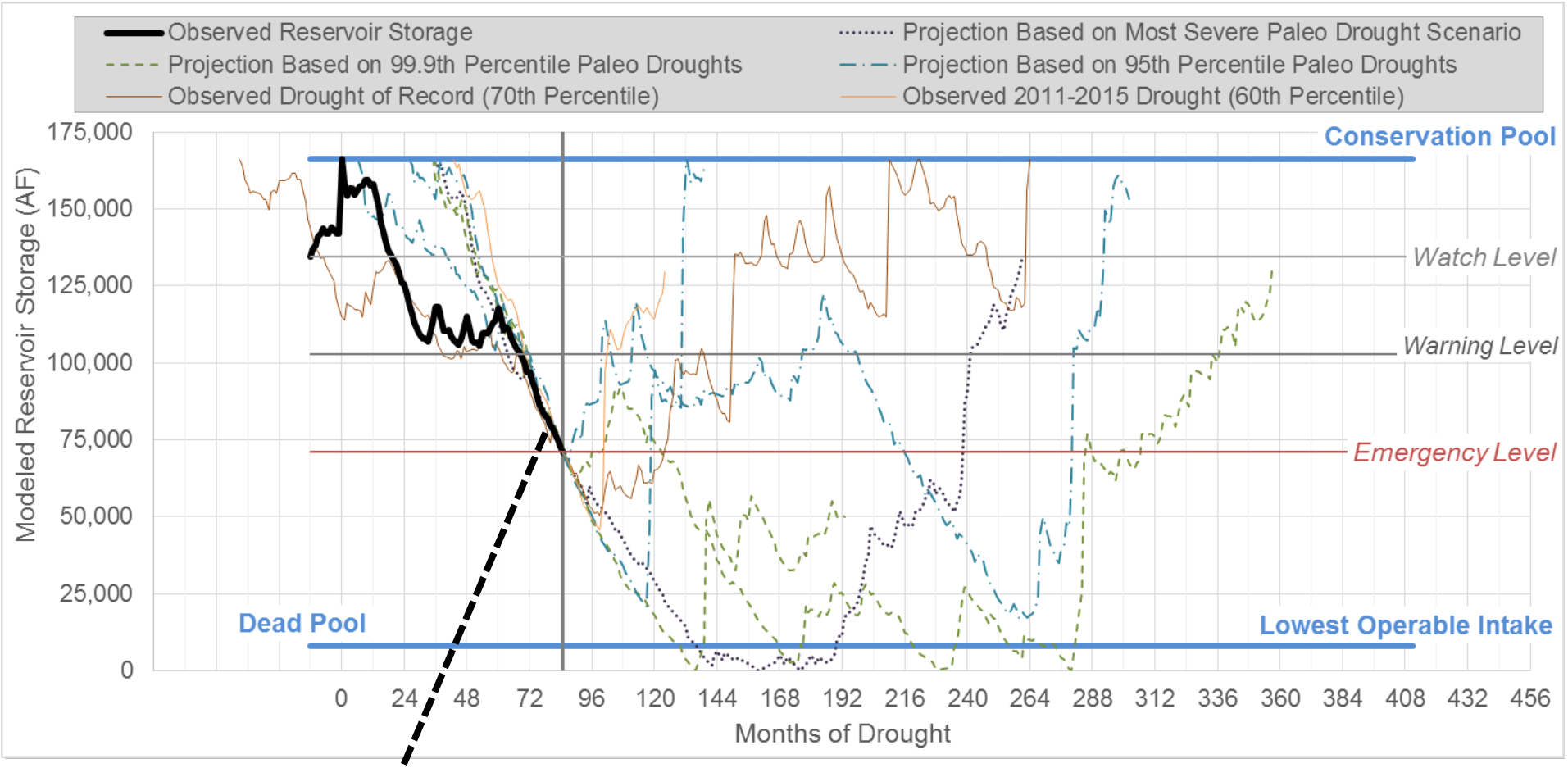
New Modeling Platform – Reservoir Storage



Traditional Approach

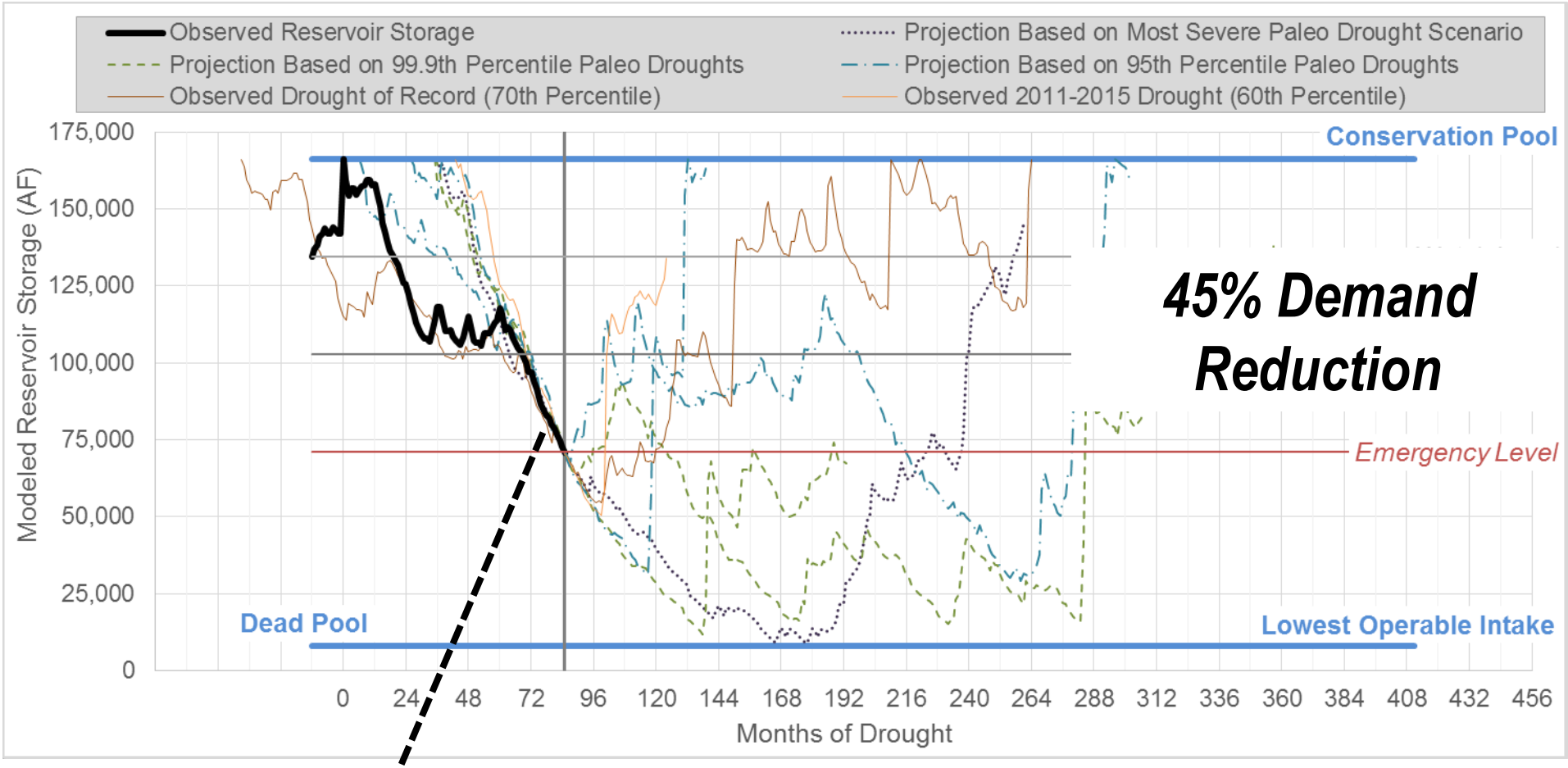


New Approach: Drought Response



Real-time Reservoir Storage Based on Actual Water Use

New Approach: Drought Response



Real-time Reservoir Storage Based on Actual Water Use

Summary

- Delivery of M&I water supplies is a significant portion of Reclamation's mission – cities are growing and pressures will increase. We deliver to 31 million people now? How many in 2060?
- Running out of M&I water can have major impacts on public health and sanitation, economic viability, etc.
- A depleted reservoir also affects recreation; fish and wildlife benefits.
- Reclamation has an interest in preserving authorized Project benefits, facilitating repayment of Projects, reducing competition among water users, etc. – *We can't control Mother Nature, but we can be good partners and stewards*.

Thank you – Team work!

Contributors

- Oklahoma-Texas Area Office: Collins Balcombe (study lead), Anna Hoag, P.E. (technical lead), James Allard, P.E. (peer review), Matt Warren, P.E. (peer review)
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- Lower Colorado Region: Jim Prairie, Ph.D. (peer review)
- Policy & Administration: Avra Morgan, Katharine Dahm, P.E., Ph.D. et al. (policy leads)