

How to see speaker notes . . .

- The following slide set contains the speaker's notes (when provided) explaining the slide.
- To see the notes, look for an orange-colored text icon in the upper left corner.
- Double click the icon and the notes will appear. Adjust the size of the text box containing the notes by dragging the lower corners.

The Problem: Estimating Extreme Floods

Too Much Statistics - No Common Sense

Joseph D. Countryman, PE, D.WRE

2011 California Extreme Precipitation Symposium

June 28 at UC Davis

World Environmental and Water Resources Conference 2007

500-Year Flood– Can it be Reliably Estimated?

By

Joseph D. Countryman PE, D. WRE

Presented May 17, 2007

Tampa, Florida

Flood Frequency Confidence Bounds: Art, Science or **Guess!!**



Joseph D. Countryman PE, M. ASCE, D.WRE
and
Ben Tustison PE, M. ASCE

**World Environmental & Water Resources Congress
2008**

May 12-16, 2008 Honolulu, Hawaii

Hydrologic Uncertainty

- Probability Density Function LP3
- Extrapolation of Curve Fitting
- Calculation of Uncertainty of the Estimate (Confidence Intervals)

What is a pdf?

(Probability Density Function)

- Ordered Data – Assigned Exceedance Probability
- Mathematical Function
 - Curve Fitting of PDF to Data
 - Parameters to adjust PDF
 - Mean
 - Std Dev
 - Skew

Show me a pdf!!!

Log Pearson Type III

$$f_{LP}(u) = k |\alpha| e^{-\alpha(\log_a u - m)} [\alpha(\log_a u - m)] / u \Gamma(\lambda); k = 1 / \ln a$$

u , a and λ are function parameters that can be used to fit the distribution to the ordered data set

Source: The Gamma Family and Derived Distributions Applied in Hydrology
Bobee & Ashkar

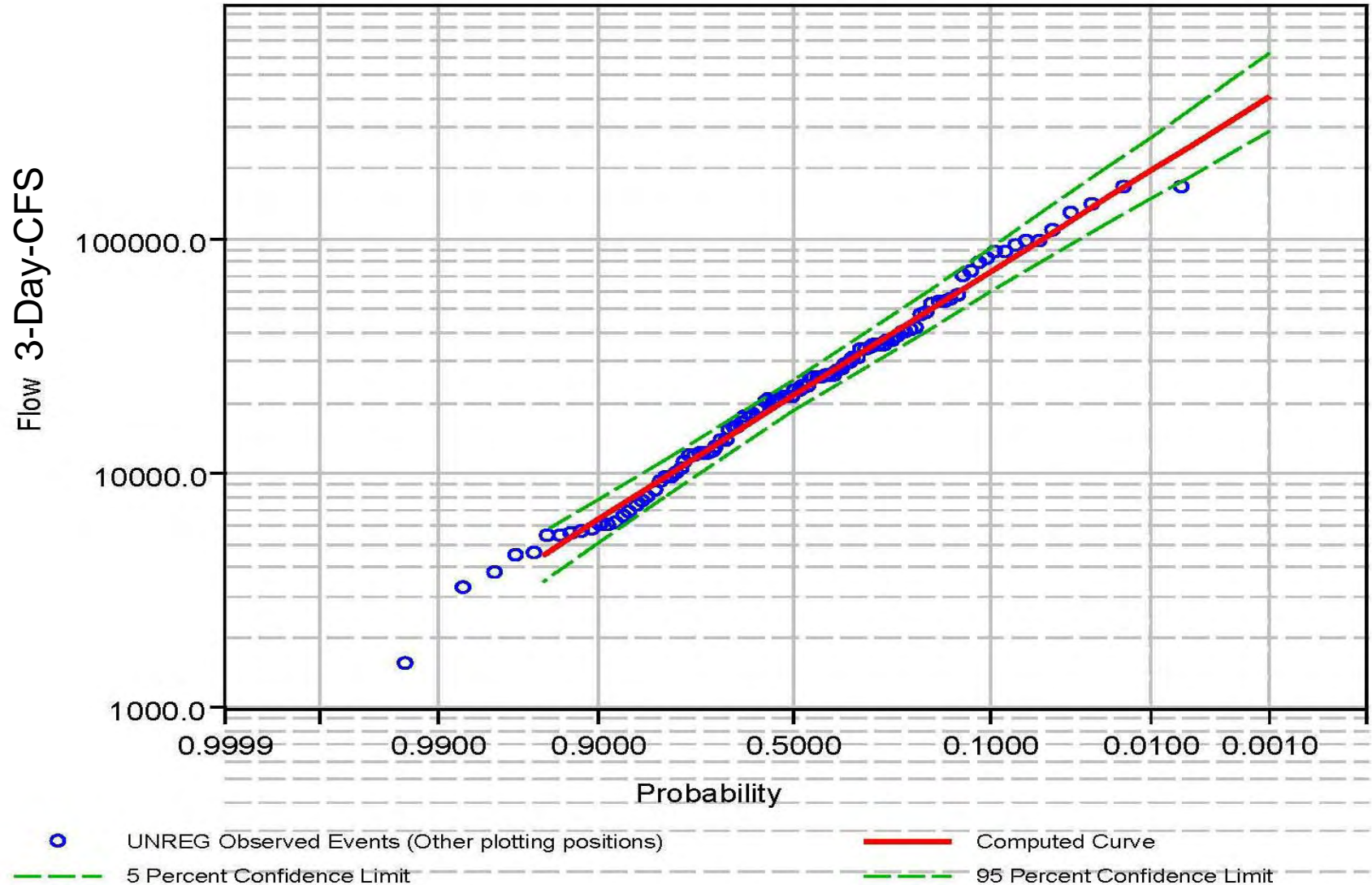
What Is Missing?

- Drainage Area?
- Elevation??
- Watershed Characteristics???
- Precipitation Potential????
- Any Physical Characteristic?????
- Everything Pertaining to the Science of Hydrology!!!!!!!!!!!!!!

American River LP III

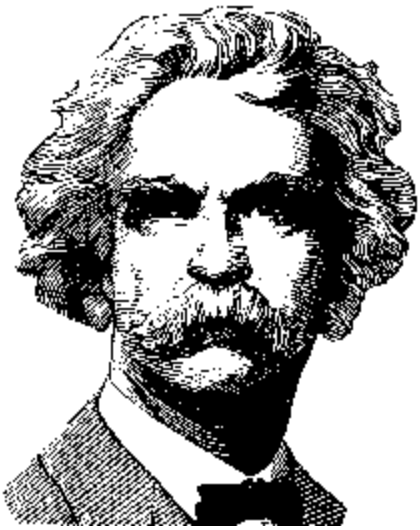
(Log Scale)

Exceedance Probability for American River



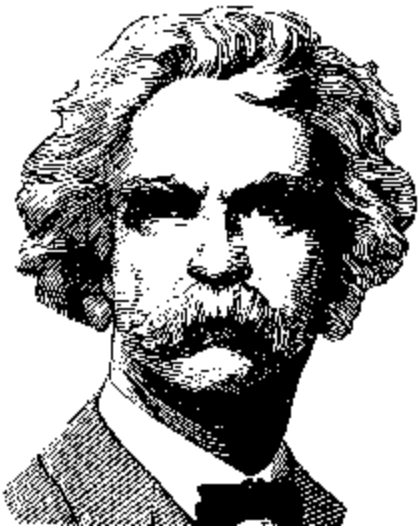
Ex·trap·o·late

1. to infer (an unknown) from something that is known; conjecture.
2. Statistics. to estimate (the value of a variable) outside the tabulated or observed range.



Extrapolation Explained!

In the space of **176 years** the **Lower Mississippi** has **shortened** itself **242 miles**. This is an average of a trifle over **one mile and a third per year**. Therefore, any calm person, who is not blind or idiotic, can see that in..., just a million years ago next November, the Lower Mississippi River was upward of one million three hundred thousand miles long, and stuck out over the Gulf of Mexico like a fishing-rod.



Extrapolation Explained!

And by the same token any person can see that **742 years** from **now** the Lower Mississippi will be only a **mile and three-quarters long**, and Cairo and New Orleans will have joined their streets together, and be plodding comfortably along under a single mayor and a mutual board of aldermen. **There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact.**

Mark Twain, *Life on the Mississippi* 173-6 (1883)

Vit Klemes

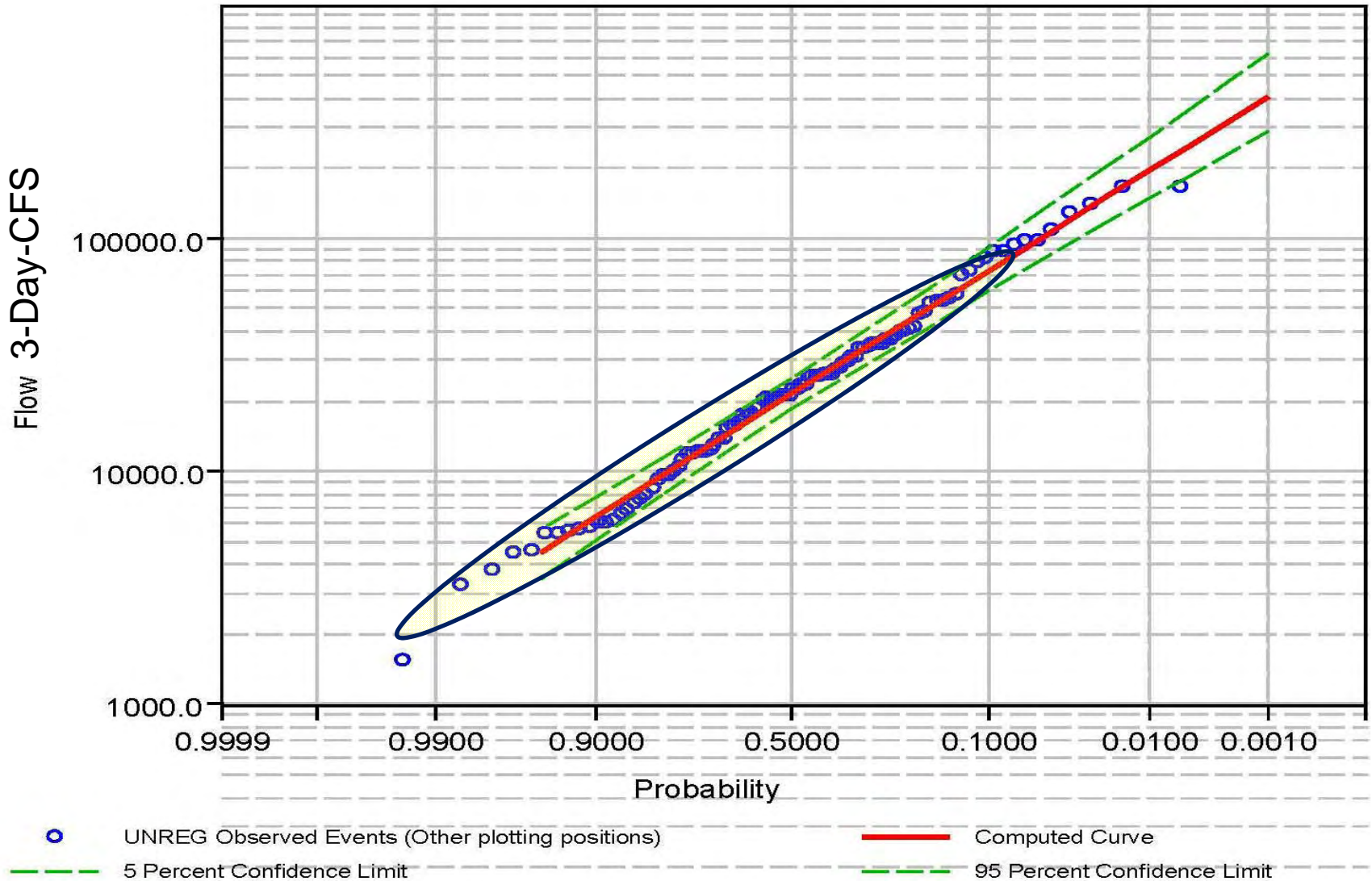
Common Sense and Other Heresies

- “ ...from a hydrological point of view, very extreme floods and their causes tend to be outliers by definition, i.e., very little, if any, information about their likelihood is contained in the frequencies of relative small floods of which the bulk of a typical flood sample is composed. Extrapolating distribution models fitted to these samples is tantamount to extrapolating the small flood dynamics beyond the range it can physically function.”

American River LP III

(Log Scale)

Exceedance Probability for American River



Impact of Log's

- **Log Statistics Emphasize Lower Flows.**
 - Real Numbers **100/10=10** with logs **2/1**
- **American River Mean Annual 3-Day Flow**
 - Real Numbers **33,056 CFS**
 - LN Numbers **21,705 CFS**



Bulletin 17B

- “The accuracy of flood probability estimates based upon statistical analysis of flood data deteriorates for probabilities more rare than those directly defined by the period of systematic record. This is partly because of the sampling error of the statistics from the station data and partly because the basic underlying distribution of flood data is not known exactly.” Pg. 19
- “**All types of analyses** should be incorporated when defining flood magnitudes for exceedence probabilities of less than 0.01 (larger than the 100-year)” Pg. 20

Guidelines for Determining Flood
Flow Frequency, 1982

Why is Bulletin 17B Ignored?

- Statistical Software allows for **Easy Extrapolation** of data, **Thinking** and **Evaluating** is a Problem!
- Many believe that **Statistical Extrapolation** is based on Science and that it can be reliably used. The ability to state with confidence limits an annual exceedance probability is proof. **(Ignorance is Bliss!!)**

Bureau of Reclamation

- “An ultimate goal would be to arrive at a frequency curve that is valid over the entire range of possible flood flows. This of course **is not possible** because sufficient data do not exist to verify the **choice of base distribution.** ... The **errors** that are unavoidable in the parameter estimates become **intolerable** once the frequency curve is **extrapolated beyond a certain point.**” Pg. 204

Bureau of Reclamation

- **“Practical rule-of-thumb knowledge, which is supported by statistical calculation, indicated that frequency curves are reasonably reliable out to return periods of about the sample record length or even twice the sample length.”** Pg. 204

Flood Hydrology Manual, 1992

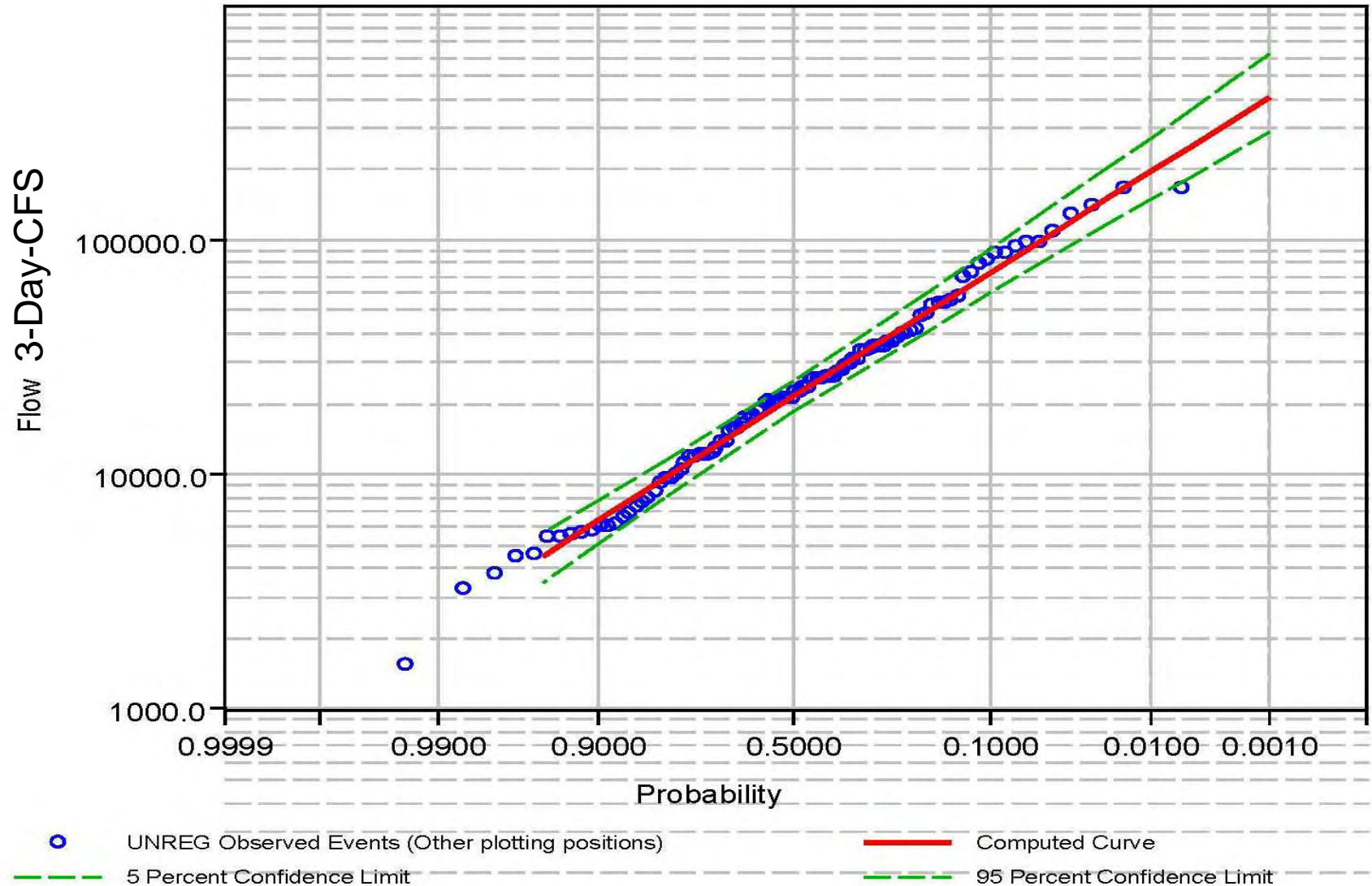
The American River

- The Extrapolation of the Annual Exceedance Probability for 3-Day Flows.
 - 104 years of record
 - Stationarity of data **Unknown**
 - Rain Flood Flows + Snowmelt Enhancement Variable

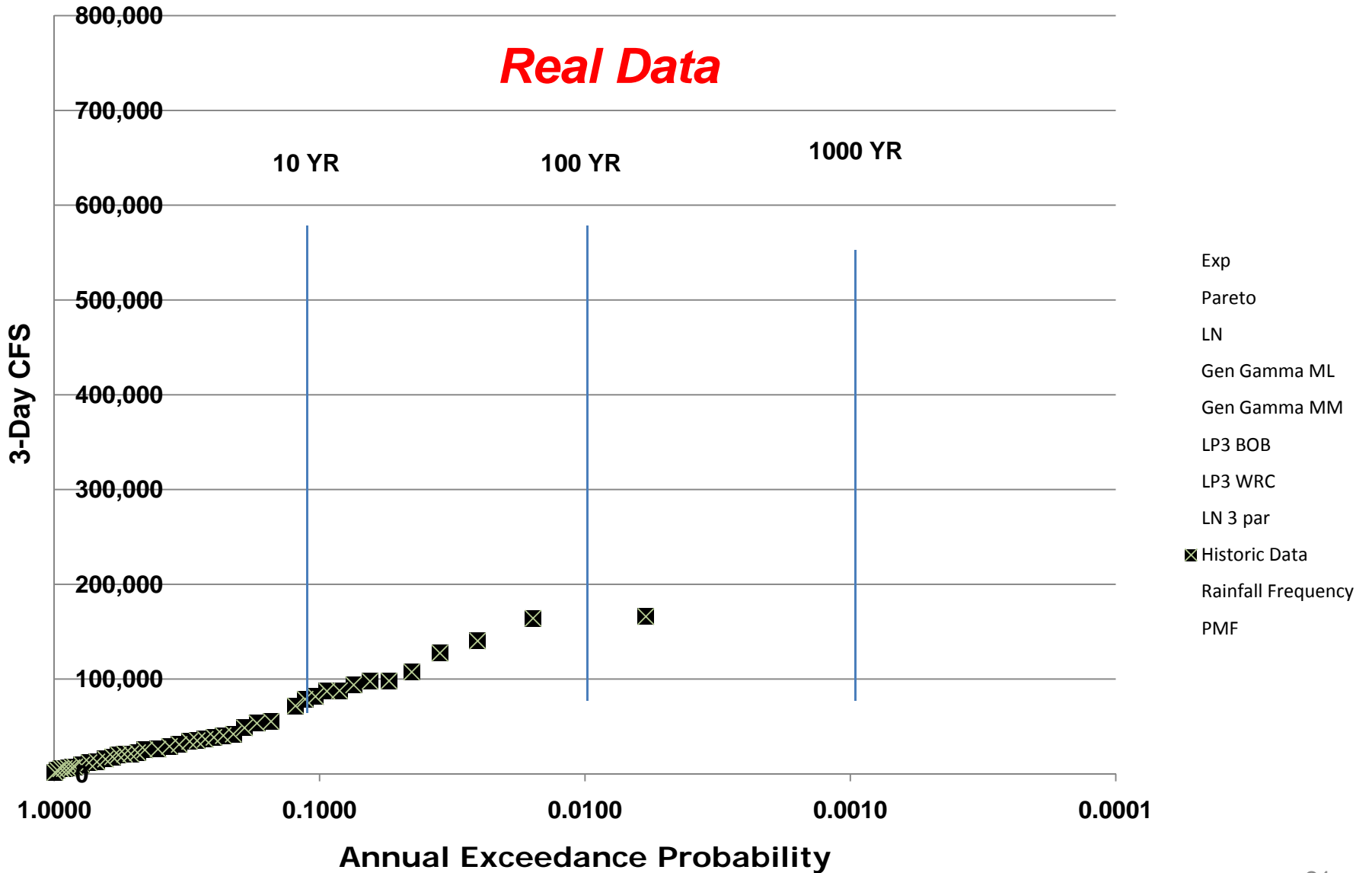
American River LP III

(Log Scale)

Exceedance Probability for American River



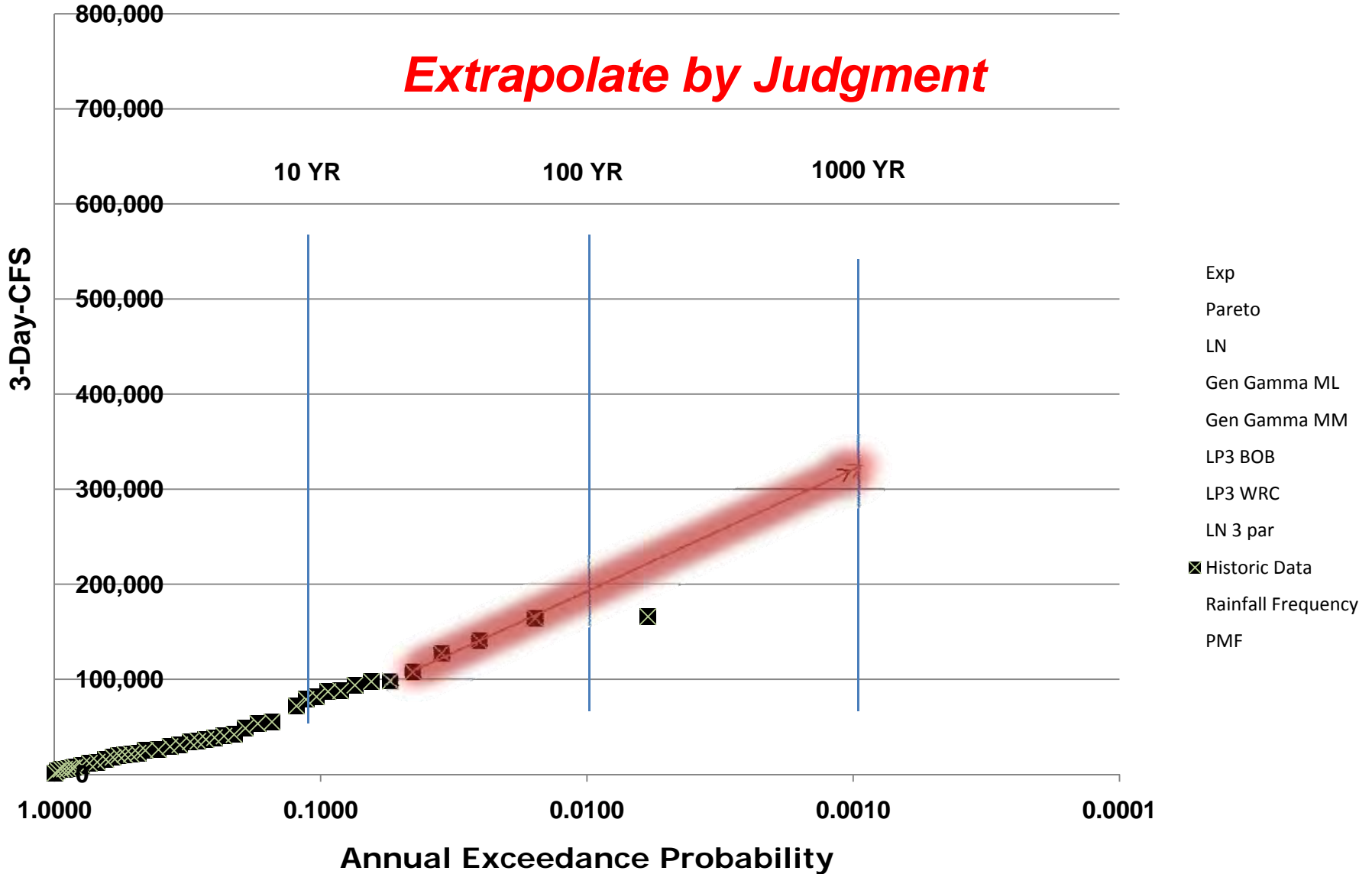
American River





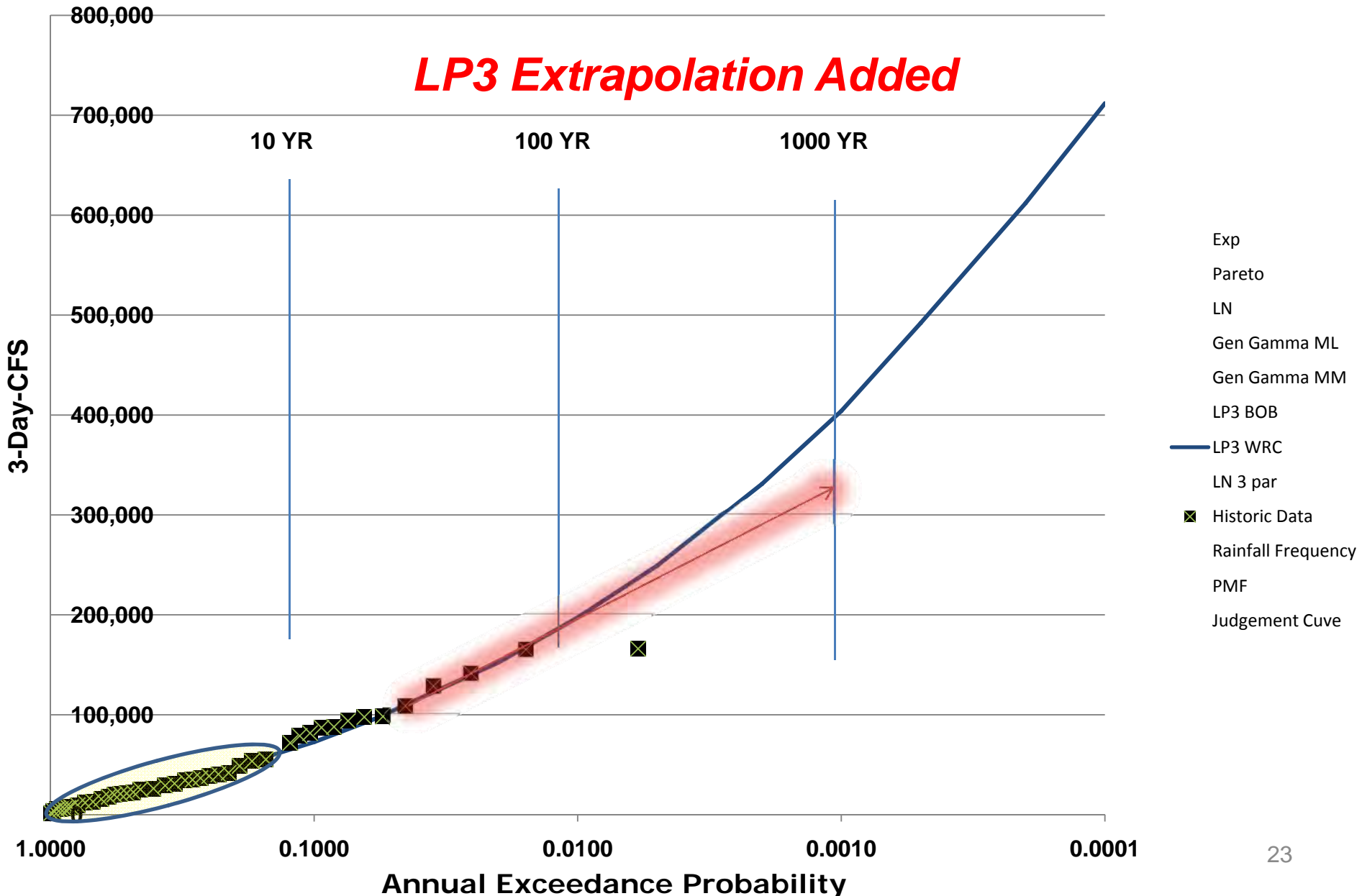
American River

Extrapolate by Judgment

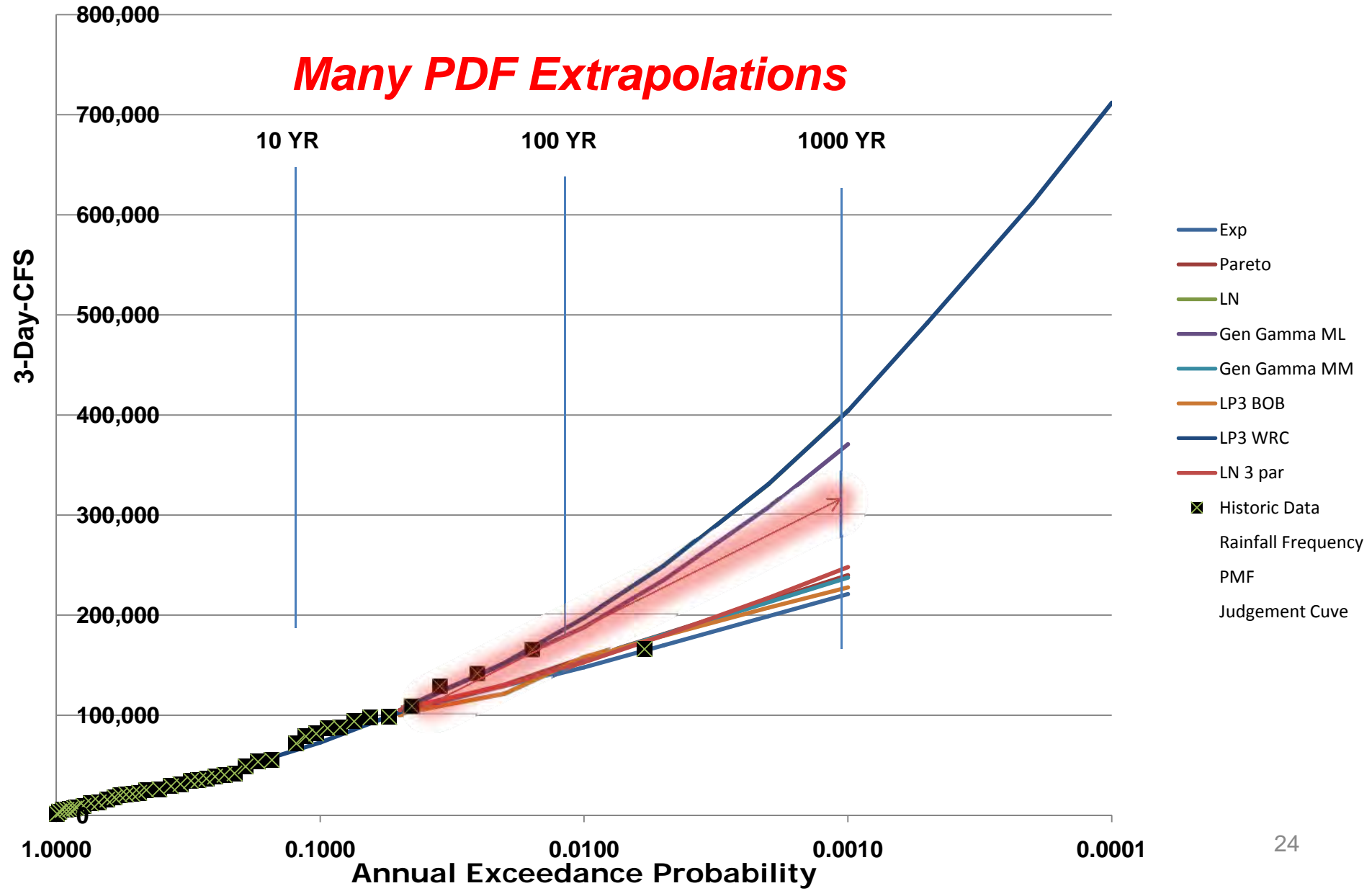


American River

LP3 Extrapolation Added



American River



American River

Add More Information

10 YR

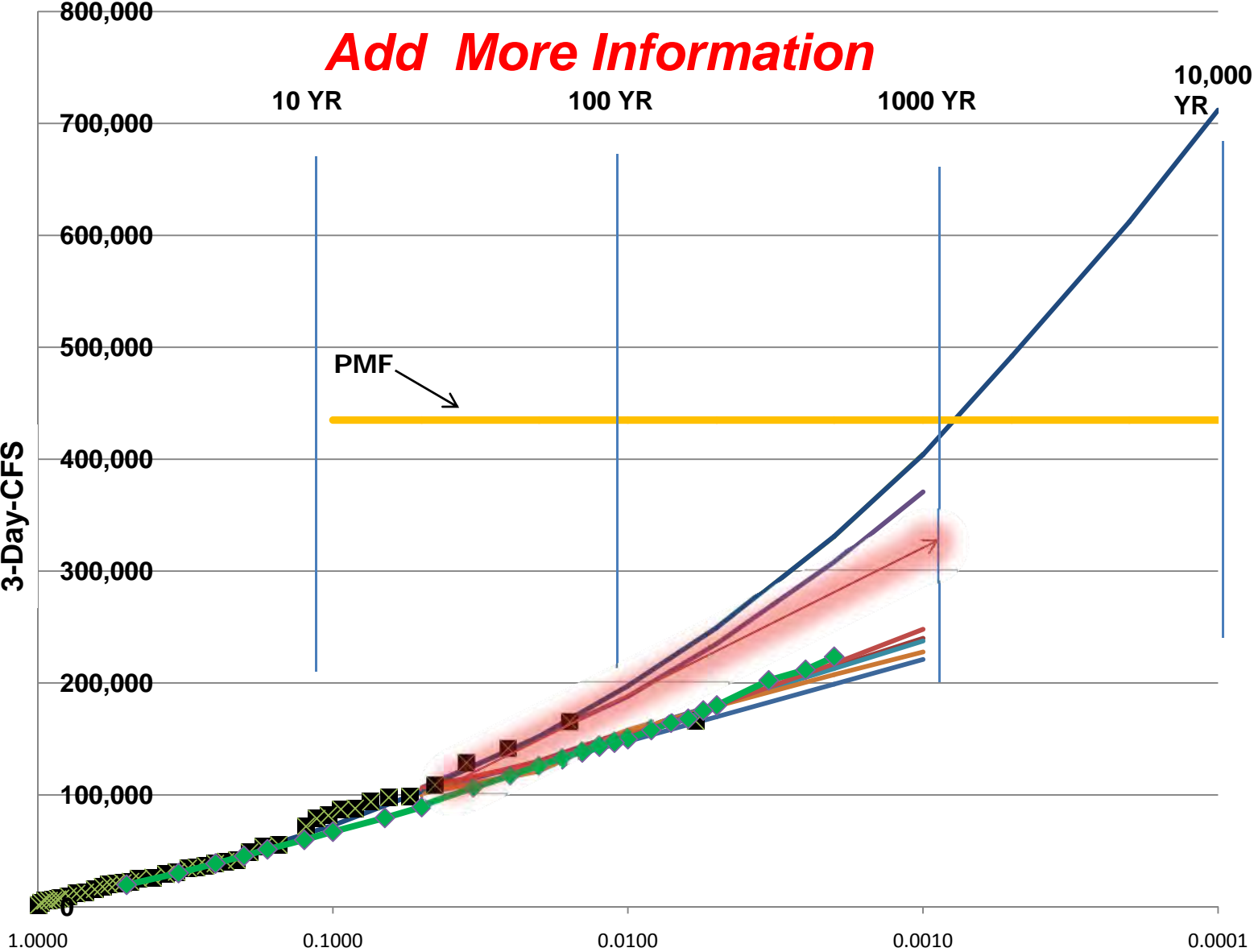
100 YR

1000 YR

10,000 YR

PMF

- Exp
- Pareto
- LN
- Gen Gamma ML
- Gen Gamma MM
- LP3 BOB
- LP3 WRC
- LN 3 par
- Historic Data
- Rainfall Frequency
- PMF
- Judgement Cuve



Remember This!!!

- LP3 is JUST curve fitting
- No information about the basic factors of the meteorology or Hydrology of the Watershed is included in the LP3 parameters!
- Extrapolation of curves is an Estimate. Statistics based on primarily small events do not help make a better extrapolation estimate!

Questions That Need to be Asked & Answered

- Is there a relationship between Rainfall and Streamflow?
- Shouldn't the Extrapolation of Flow Frequency Curves be consistent with Rainfall experience and potential?

The answer is **YES!!!!!!**



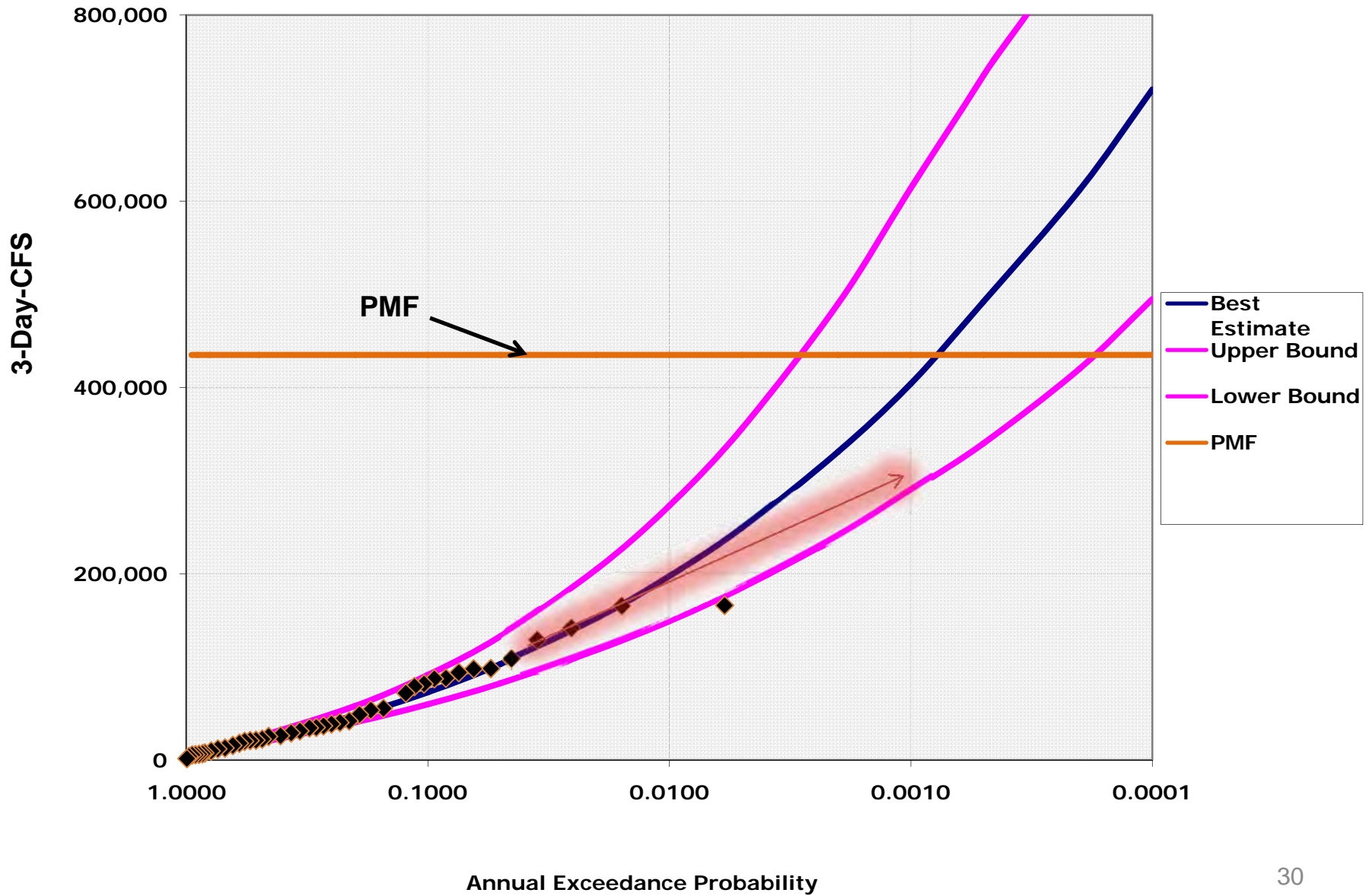
Confidence Intervals

- A way to estimate the Uncertainty of the estimate based on sampling error
- Assumes the pdf chosen is a true representation of the Flood Data population
- *Validity cannot be Proven for Real Flood Data– NEVER!!!!!!*

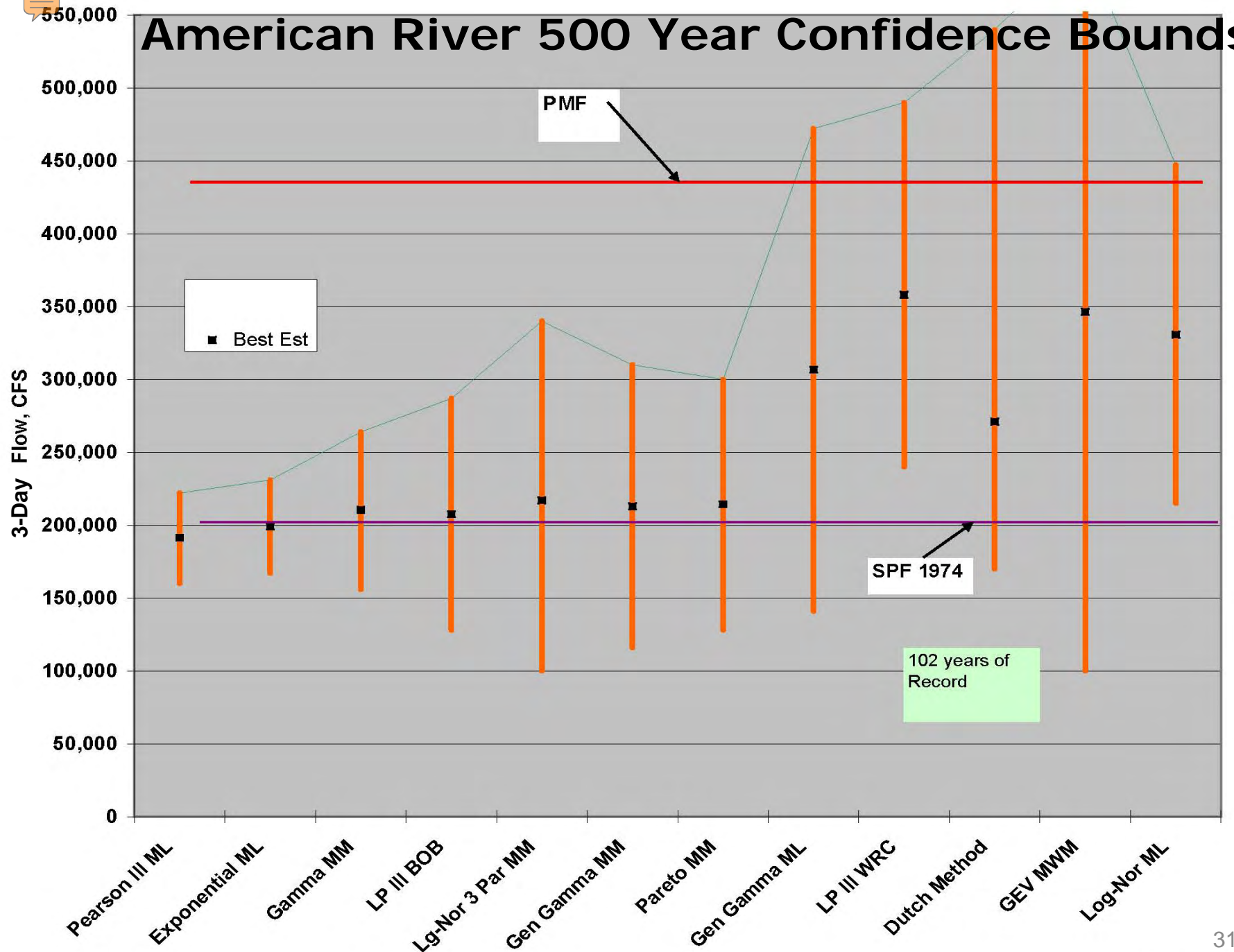
What do Confidence Bounds Look Like?

- **Very Impressive!!!**
- **Impossible to verify**

American River



American River 500 Year Confidence Bounds



What is Next?

- **Bulletin 17B is not doing the job for Extreme Flood Events**
 - **Bul 17B** guidance on **extrapolation** is being **ignored**
- **Integrate Precipitation Frequency, Storm Potential, Paleo-Flood estimates and PMF information when making Extreme Flood estimates**

What to do about Uncertainty?

- **Stop Pretending** that the Confident Limit Calculations provides useful information!!!
- Use experience and expertise to establish uncertainty bounds
 - Suggest a fixed percentage for flows greater than the 10 year flood
 - Above all make sure the limits are compatible with Precipitation Estimates!!

The Problem: Estimating Extreme Floods

Too Much Statistics - No Common Sense

Joseph D. Countryman PE,D.WRE

2011 California Extreme Precipitation Symposium

June 28 at UC Davis