Status of the Hydrologic Frequency Analysis Work Group (HFAWG)
July 11, 2012

Report to the Advisory Committee on Water Information

Will Thomas

Chair of the HFAWG

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Hydrologic Frequency Analysis WG

- Established December 1999 under the Subcommittee on Hydrology of the Advisory Committee on Water Information
- First meeting in January 2000
- Representatives from Federal agencies, private consultants, academia, water management agencies

- http://acwi.gov/hydrology/Frequency/
- http://water.usgs.gov/osw/bulletin17b/bulletin_17B.html

Hydrologic Frequency Analysis WG

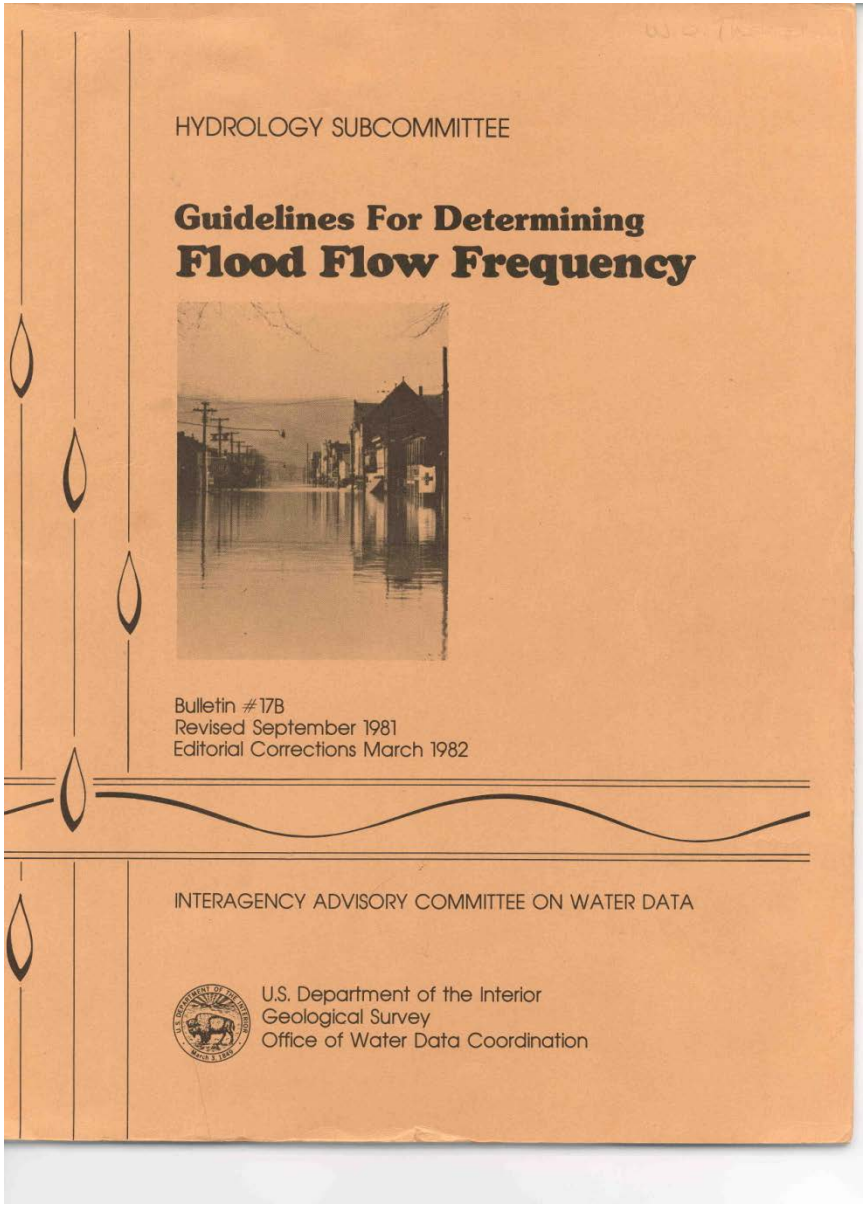
Purpose: **"The overall goal of the Hydrologic Frequency Analysis Work Group (HFAWG) is to recommend procedures to increase the usefulness of the current guidelines for Hydrologic Frequency Analysis computations (e.g. Bulletin 17B) and to evaluate other procedures for frequency analysis of hydrologic phenomena."**

http://acwi.gov/hydrology/FA_terms.html

Existing Guidelines - Bulletin 17B

Published in March 1982, includes guidelines for:

- Fitting Pearson Type III distribution to logs of annual peak flows
- Estimating generalized skew
- Weighting generalized skew with station skew
- Low- and high-outlier detection tests
- Conditional probability adjustment for low outliers
- Adjustments for historical flood information



Possible Revisions to Bulletin 17B

- Since November 2005, the HFAWG has been planning possible improvements in Bulletin 17B
- The four major revisions are related to:
  - Improved procedures for analyzing historical floods and paleoflood data
  - Improved procedures for analyzing low outliers and zero flow data
  - Improved procedures for estimating generalized/regional skew
  - Improved procedures for estimating confidence intervals

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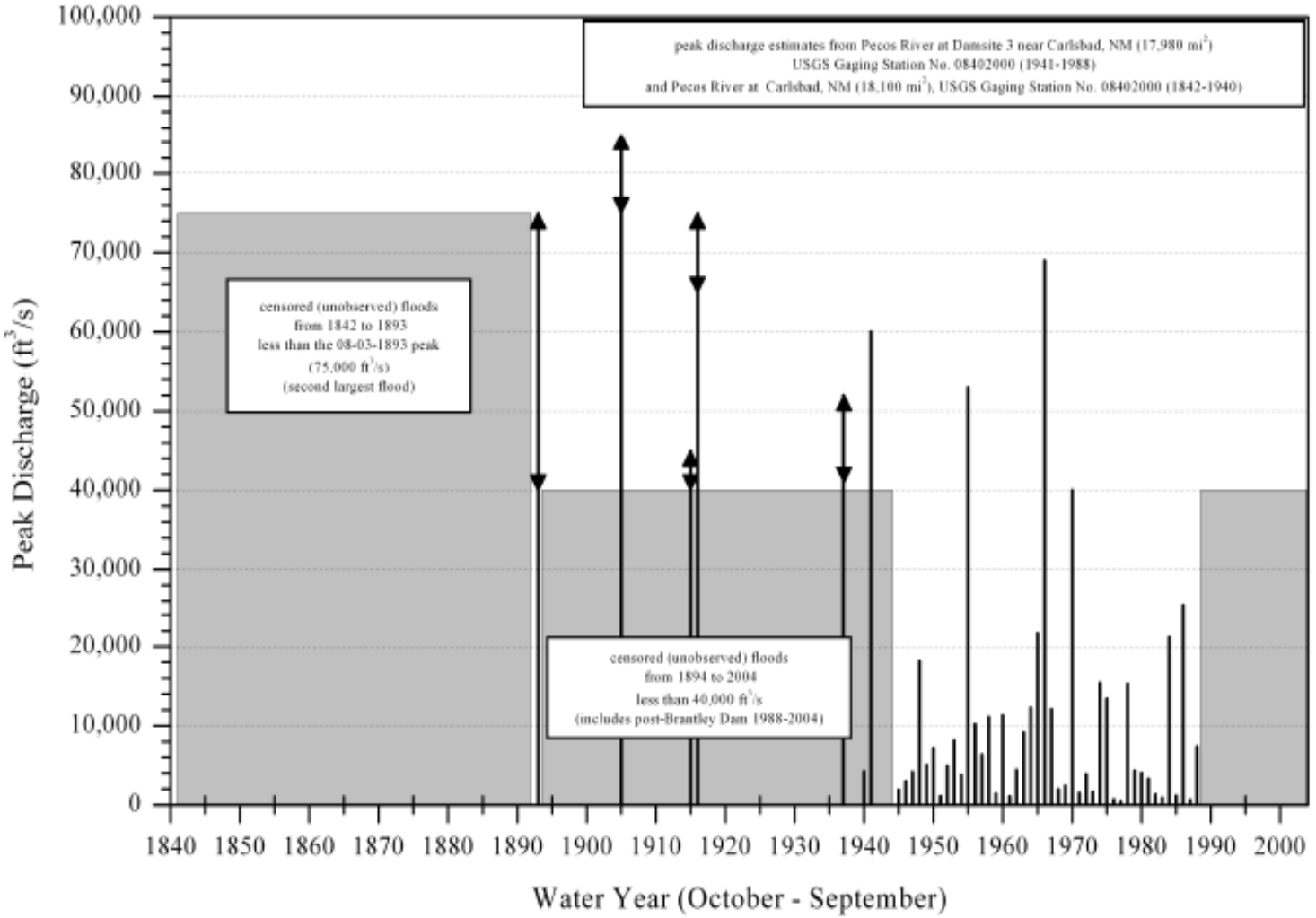
Improved Procedures

- A major effort of the HFAWG has been the testing and evaluation of a new technique for estimating the parameters of the Pearson Type III distribution – Expected Moments Algorithm (EMA)
- Why is EMA needed in the Bulletin 17B flood frequency analysis?
- To provide a better analysis of nonstandard flood data – interval data, less than and greater than values, exceedances and nonexceedances of multiple thresholds

Need for Improved Procedures

- Bulletin 17B is not efficient with respect to utilizing historical information and regional skew information
- Bulletin 17B confidence limits do not consider all the uncertainty in the flood estimates
- EMA will provide improved procedures but still utilizes the Pearson Type III distribution and the method of moments, i.e., modest change in approach

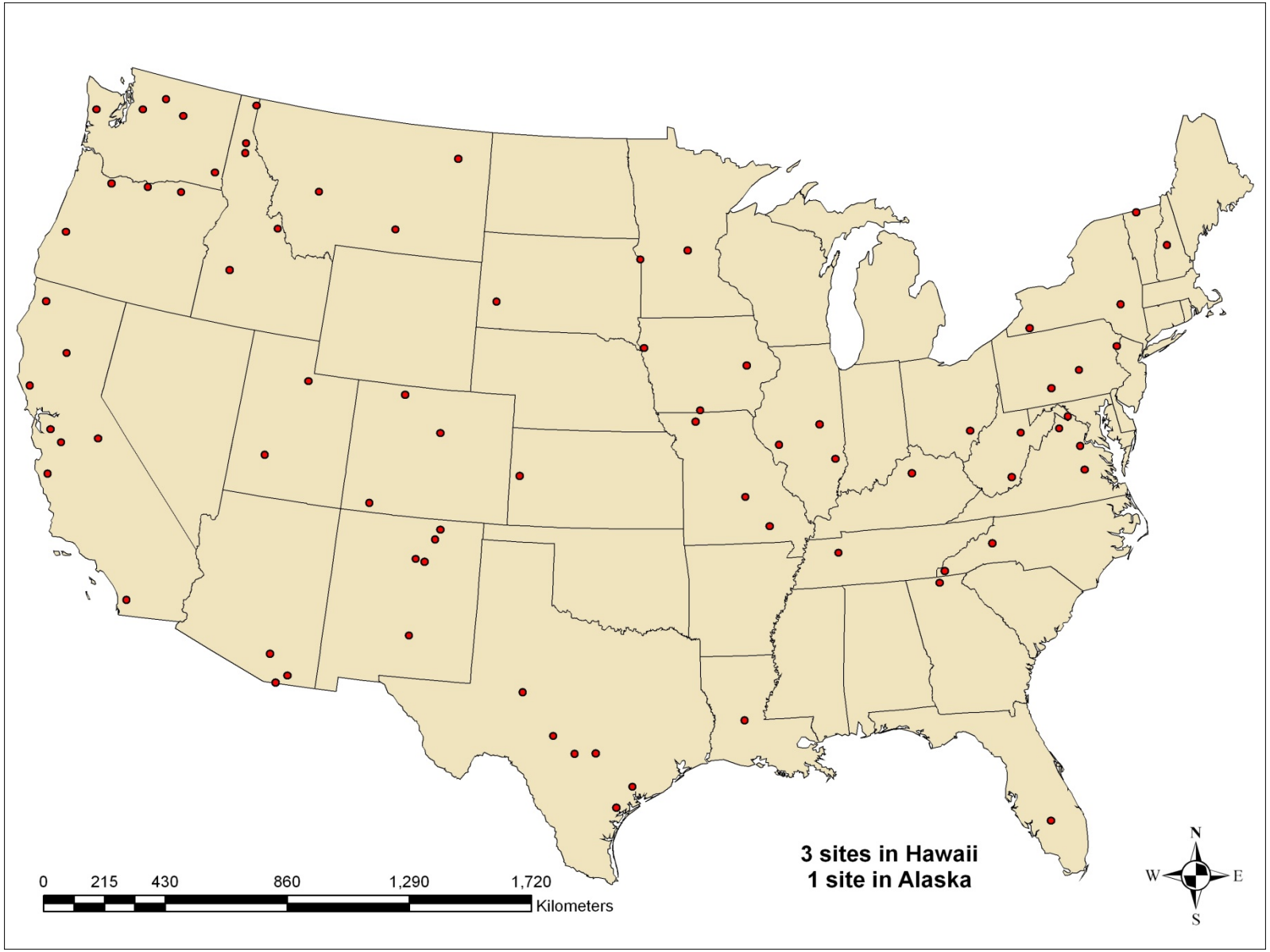
Multiple thresholds and interval data



HFAWG Testing Approach

- Testing of EMA for two approaches
  - Observed data – 82 gaging stations with historic peaks, high and low outliers
  - Monte Carlo simulation – simulate data from six assumed frequency distributions (LP III with negative and positive skews, mixed distributions, etc.)
- August 2007, testing plan and annual peak flows provided to John England (USBR), Tim Cohn (USGS)

Location of Gaging Stations



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HFAWG Progress

- HFAWG meeting in November 2009 discussed test results on observed data at the 82 gaging stations
- In the Fall of 2011, Testing Group (USGS, USBR, USACE) completed testing on simulated and observed data (82 stations)
- Recent testing included a new Multiple Grubbs-Beck (MGB) test for detecting low peaks (draft paper, Cohn et al., 2011)

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HFAWG Progress

- The test results were summarized in a draft report "Updating Bulletin 17B for the 21st Century", Cohn et al., 2012 (posted at http://acwi.gov/hydrology/Frequency/)
- These test results were discussed at a March 19, 2012 meeting of the HFAWG (minutes on HFAWG web site)
- At the March 19 meeting HFAWG also discussed seven recommended changes in Bulletin 17B
  - All documents, references, recommendations posted at ftp://ftp.usbr.gov/jengland/HFAWG/

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Recommended Changes in Bulletin 17B

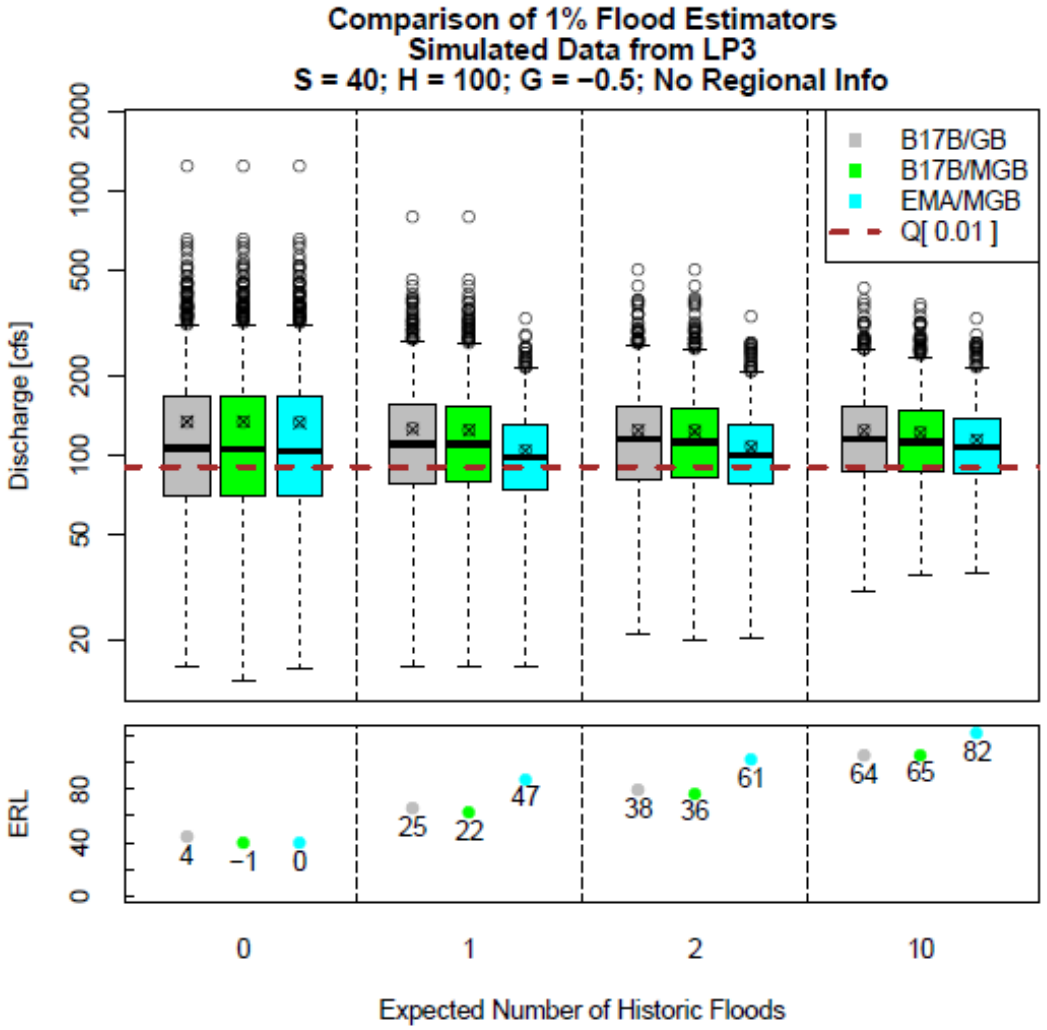
- 1. Replace Historical Weighted Moments and Conditional Probability Adjustment (CPA) with EMA
- 2. Generalize the Grubbs-Beck (GB) test with the new Multiple Grubbs-Beck (MGB) test
- 3. Replace confidence interval formulas with computations based on EMA
- 4. Revise procedures for estimation of generalized (regional) skew

Recommended Changes in Bulletin 17B

- 5. Replace the single threshold plotting position with multiple-threshold plotting position (Hirsch and Stedinger, 1987)
- 6. Replace outdated statements on “Climate Trends” with a revised statement reflecting the current understanding of climate change
- 7. Remove the discussion of “Expected Probability” since it is no longer used by USACE

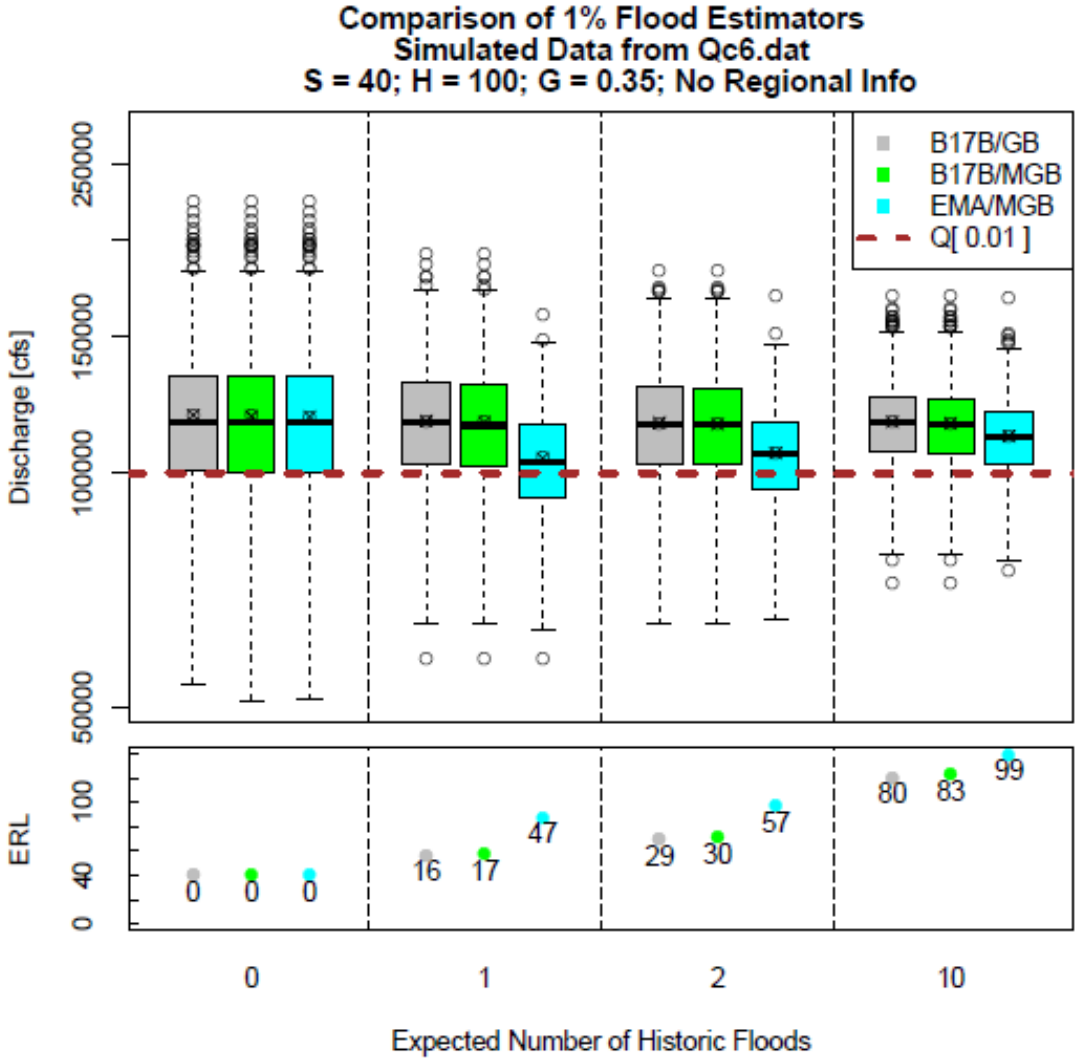
Simulated Data Test Results (Cohn et al., 2012)

Figure 15: Results are based on 1000 replicate samples drawn from a Log-Pearson Type 3 distribution with skew $\gamma = -0.5$.

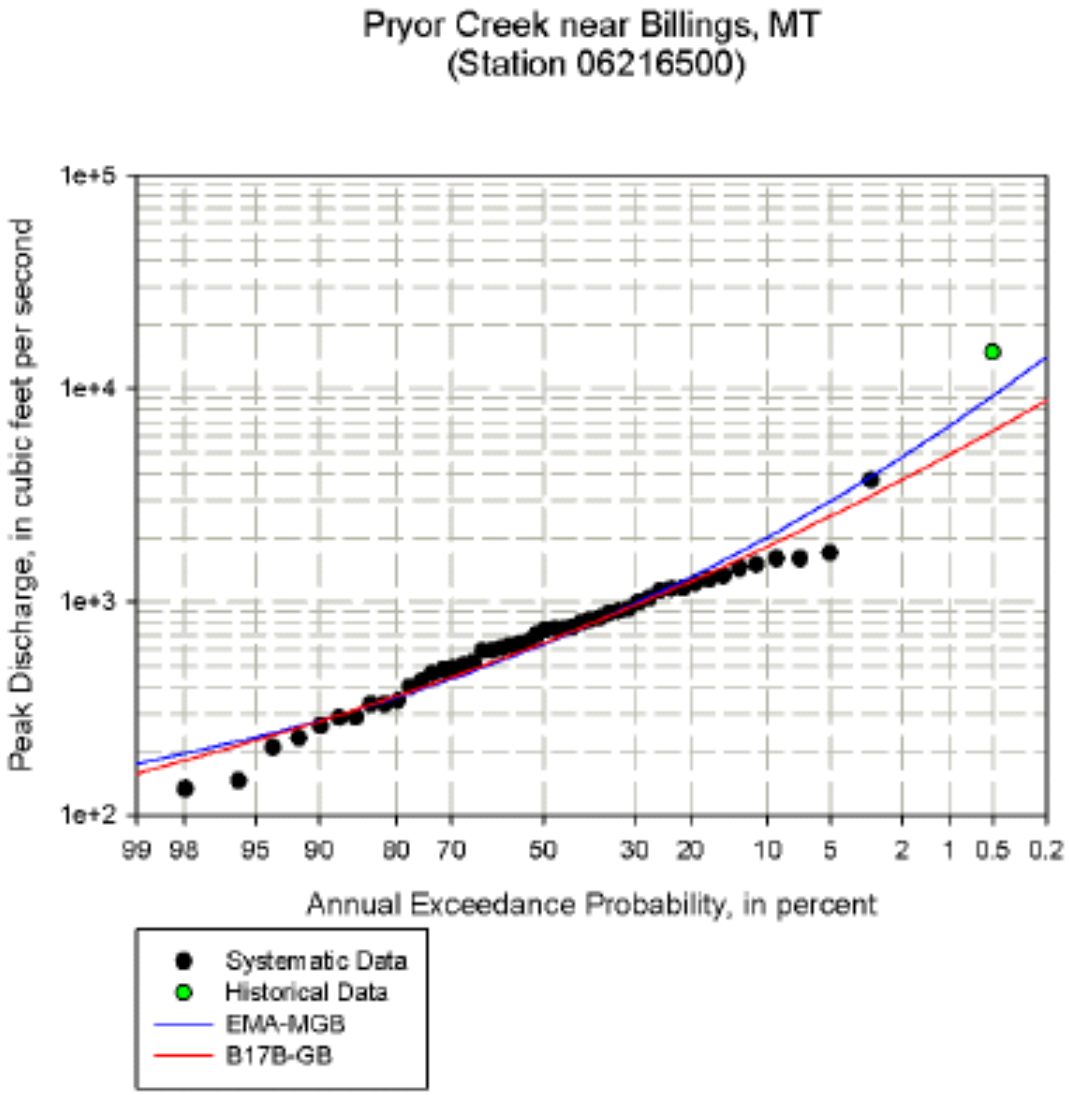


Simulated Data Test Results (Cohn et al., 2012)

Figure 20: Results are based on 1000 replicate samples drawn from robustness test curve 6



Comparison of EMA and B17B (Cohn et al., 2012)



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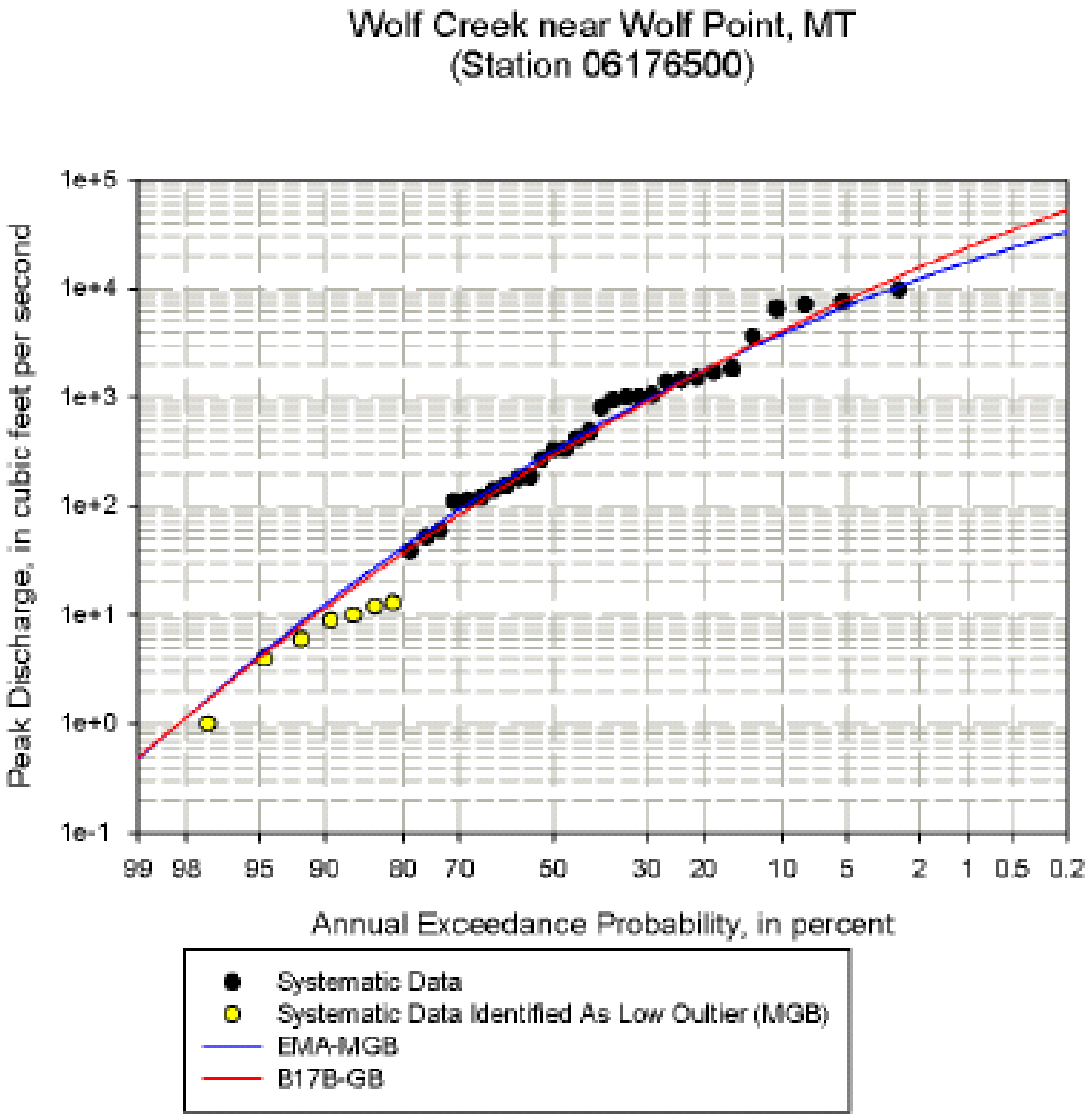

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Need for Improved Confidence Intervals

- Confidence intervals provide estimates of uncertainty in flood discharges
- EMA confidence intervals are more accurate than Bulletin 17B because they:
  - Consider uncertainty in skew coefficient
  - Account for the effects of historical data
  - Consider impact of censoring low peaks

Climate Change

- **Bulletin 17C could say:**
  - **There is much speculation about changes in flood risk over time. Available evidence indicates that major changes may be occurring over decades or centuries. While time invariance was assumed when developing this guide, where changes in climate and flood risk over time can be accurately quantified, the impacts of such changes should be incorporated in frequency analysis by employing time-varying parameters or using other appropriate techniques. All such methods need to be thoroughly documented and justified.**

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Testing Software Used in Cohn et al (2012)

- **USGS PeakFQ Version 5.2 was used for Bulletin 17B** (http://water.usgs.gov/software/PeakFQ/)

- **PeakqSA v 0.95 was used for EMA** (http://www.timcohn.com/TAC_Software/PeakfqSA/faq.html)

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Production Software

- USGS is currently updating PeakFQ to Version 6.0
- PeakFQ Version 6.0 will feature:
  - interactive graphics of time series and EMA thresholds
  - Self documenting analysis and graphics
- USGS to add EMA thresholds (where available) to Peak Flow File in the National Water Information System (http://water.usgs.gov/nwis/sw)

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HFAWG Plans Moving Forward

- Complete new PeakFQ and distribute code to HFAWG members for testing (August 2012)
- Obtain approval from SOH on recommendations discussed earlier (October 2012)
- Begin drafting Bulletin 17C based on the recommended changes (October 2012)
- Develop supporting material for Bulletin 17C
  - Web site for FAQs, references, software links
  - Prepare training courses (within agencies and for technical conferences)

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HFAWG Plans Moving Forward

- Publish "Updating Bulletin 17B for the 21st Century" (Cohn et al., 2012) as a USGS publication (Spring 2013)
- Complete draft of Bulletin 17C and obtain approval of SOH (Spring 2013)
- Have public comment period on Bulletin 17C through the Federal Register (Summer 2013)
- Publish Bulletin 17C by the end of 2013