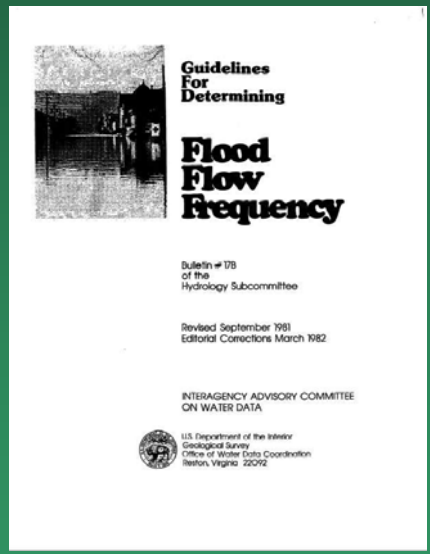
Bulletin 17B
Restudy and Future Updates



Tim Cohn
USGS Office of Surface Water
Reston, Virginia

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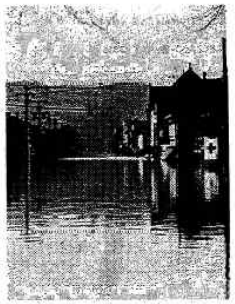
Bulletin 17B



Guidelines For Determining

Flood Flow Frequency

Bulletin # 17B
of the
Hydrology Subcommittee

Revised September 1981
Editorial Corrections March 1982

INTERAGENCY ADVISORY COMMITTEE
ON WATER DATA

U.S. Department of the Interior
Geological Survey
Office of Water Data Coordination
Reston, Virginia 22092

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Lineage of Bulletin 17B

- 1966 Bulletin 13 "**Methods** of Flood Frequency Analysis" (summary of methods used by federal agencies)
- 1967 Bulletin 15 "**A Uniform Technique** for Determining Flood Flow Frequencies"
- 1976 Bulletin 17 "**Guidelines** for Determining Flood Flow Frequency" (Regional skew; low outlier provisions; historical information)
- 1977 Bulletin 17A "**Guidelines**…"
- 1982 Bulletin 17B "**Guidelines**…"

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The Question: Bulletin 17B at 27 (!?)

- Recognized problems
- More efficient methods
- New types of data

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Who's Asking?

- Research Community
- Practitioners
- Federal agencies facing special situations
- Bulletin 17B

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"Future Work" (p. 27, B17B)

1. Selection of distribution and fitting procedures.
2. The identification and treatment of mixed distributions.
3. The treatment of outliers both as to identification and computational procedures.
4. Alternative procedures for treating historic data.
5. More adequate computation procedures for confidence limits to the Pearson III distribution.
6. Procedures to incorporate flood estimates from precipitation into frequency analysis.
7. Guides for defining flood potentials for ungaged watershed and watersheds with limited gaging records.
8. Guides for defining flood potentials for watersheds altered by urbanization and by reservoirs.

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1982-2008: Research Advances

- Fitting Techniques (1)
  - L-Moments [Hosking, Wallis]
  - EMA [Baier, Cohn, England, Griffis, Lane, Stedinger]
- Low outliers [Cohn, Stedinger, Griffis] (3)
- Historical Information (4)
  - Expected Moments
  - Graphical Methods [Stedinger, Hirsch]
- P-III Confidence Limits (5)
- Regional Methods (~7)
  - Bayesian GLS [Griffis, Ries, Stedinger, Tasker]
  - Index flood methods [Hosking, Wallis]

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Who Addresses Question?

Hydrologic Frequency Analysis Workgroup (HFAWG)

Will Thomas, Chair	Michael Baker, Jr.
Beth Faber	USACE
David Conrad	National Wildlife Federation
Jerry Coffey	(former) OMB
John England	Bureau of Reclamation
Martin Becker	
Tim Cohn	USGS
Nancy Steinbergen	FEMA
…	…

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Motivating Concern

- Between 1982-2008, analytical and simulation studies have been conducted that suggest that:
  - B17B, as usually employed, is *not efficient* with respect to
    - Historical information
    - Regional information
  - B17B uncertainty estimates are inaccurate
  - "Relatively modest changes" would make B17B competitive with best alternatives

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Relatively Modest Changes

1. Generalized description of at-site data
   - "Interval" vs. "point" estimates of data
   - "EMA"
2. Improved regional skew estimation
   - Bayesian GLS
3. Uncertainty
   - Computation
   - Incorporation in estimation procedures

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Representing Annual Peak Flood Information

- **Conventional** ("Point"): Represent each observation, Q_i, by a single value, Q_i
- **Generalized** ("Interval"): Represent each "observation," Q_i, by an interval, $[Q_{L,i}, Q_{R,i}]$

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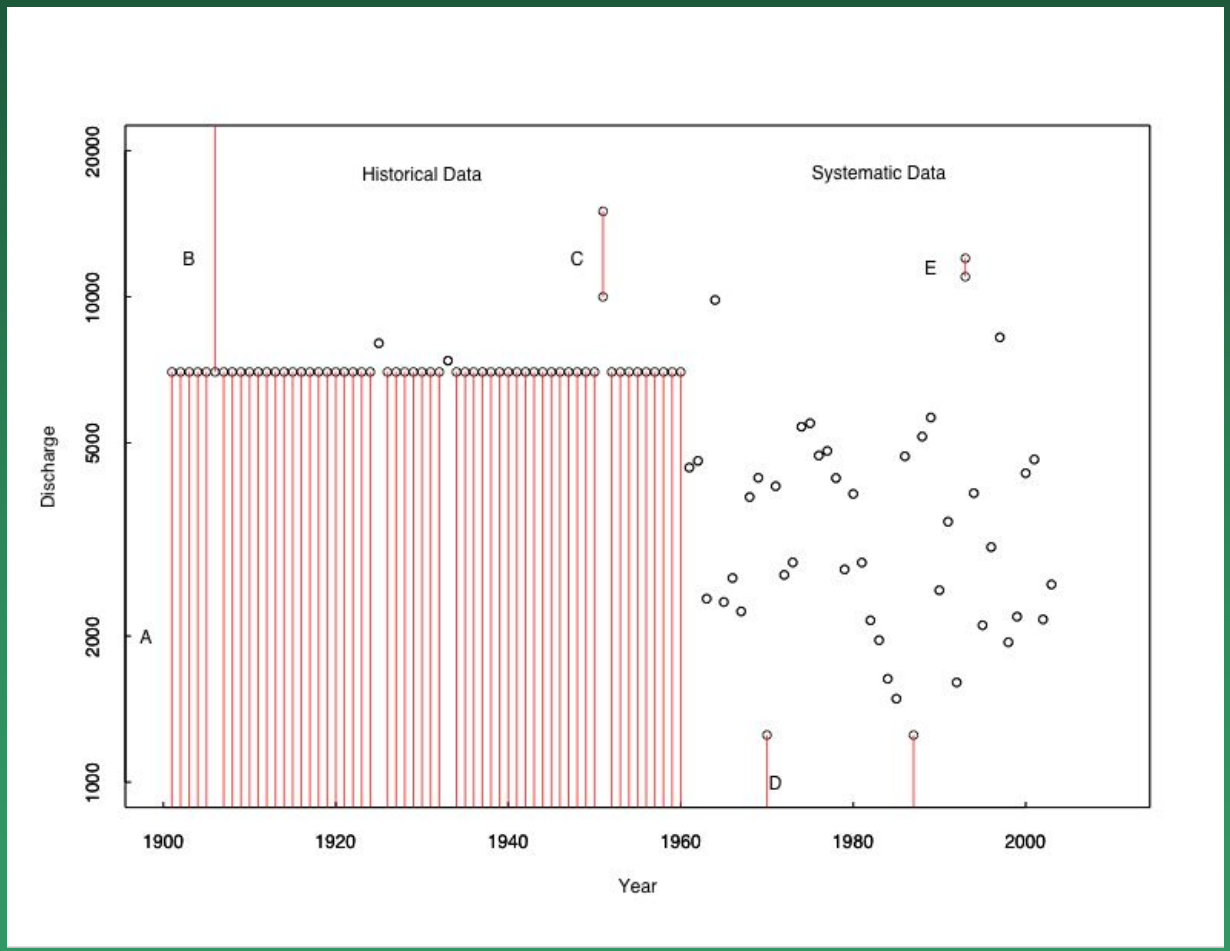
Types of Interval Data



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How Do We Know the New Methods are Better?

- Theoretical Arguments
  - Analytical results
  - Monte Carlo results
- Evaluation Using Real Data
  - 82 test sites
  - Complicated situations
  - Judgment

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Theoretical Justifications

- Cohn, T. A., Lane, W. L., and Baier, W. G. _1997_. “An algorithm for computing moments-based flood quantile estimates when historical flood information is available.” *Water Resour. Res.*, 33_9_, 2089– 2096.
- Cohn, T. A., Lane, W. L., and Stedinger, J. R. _2001_. “Confidence intervals for EMA flood quantile estimates.” *Water Resour. Res.*, 37_6_, 1695–1706.
- England, J. F., Jr., and Cohn, T. A. _2007_. “Scientific and practical considerations related to revising Bulletin 17B: The case for improved treatment of historical information and low outliers.” *World Environmental & Water Resources Conf.: Restoring Our Natural Habitat*, K. C. Kabbes, ed., Tampa, Fla., paper 40927–2565.
- England, J. F., Jr., Jarrett, R. D., and Salas, J. D. _2003a_. “Data-based comparisons of moments estimators using historical and pale of flood data.” *J. Hydrol. Eng.*, 278_1–4_, 172–196.
- England, J. F., Jr., Salas, J. D., and Jarrett, R. D. _2003b_. “Comparisons of two moments-based estimators that utilize historical and pale of flood data for the log Pearson type III distribution.” *Water Resour. Res.*, 39_9_, 1243.
- Griffis, V. W., and Stedinger, J. R. _2007a_. “Evolution of flood frequency analysis with *Bulletin 17*.” *J. Hydrol. Eng.*, 12_3_, 283–297.
- Griffis, V. W., and Stedinger, J. R. _2007b_. “The log-Pearson type 3 distribution and its application in flood frequency analysis. 1: Distribution characteristics.” *J. Hydrol. Eng.*, 12_5_, 482–491.
- Griffis, V. W., and Stedinger, J. R. _2007c_. “The log-Pearson type 3 distribution and its application in flood frequency analysis. 2: Parameter estimation methods.” *J. Hydrol. Eng.*, 12_5_, 492–500.
- Griffis, V. W., and Stedinger, J. R. _2007d_. “The log-Pearson type 3 distribution and its application in flood frequency analysis. 3: Sample skew and weighted skew estimators, submitted.” *J. Hydrol. Eng.*, submitted.
- Griffis, V. W., and Stedinger, J. R. _2007e_. “Incorporating climate change and variability into Bulletin 17B LP3 model.” *World Water and Environmental Resources Conf.*, American Society of Civil Engineers, paper 40927–2320.
- Griffis, V. W., Stedinger, J. R., and Cohn, T. A. _2004_. “LP3 quantile estimators with regional skew information and low outlier adjustments.” *Water Resour. Res.*, 40, W07503.
- Gruber, A. M., Reis, D. S., Jr., and Stedinger, J. R. _2007_. “Models of regional skew based on Bayesian GLS regression.” *World Environmental & Water Resources Conf.: Restoring our Natural Habitat*, K. C. Kabbes, ed., Tampa, Fla., paper 40927–3285.
- Hirsch, R. M., and Stedinger, J. R. _1987_. “Plotting positions for historical floods and their precision.” *Water Resour. Res.*, 23_4_, 715–727. JOURNAL OF HYDROLOGIC ENGINEERING © ASCE / APRIL 2008 / **203**
- Reis, D. S., Jr., Stedinger, J. R., and Martins, E. S. _2005_. “Bayesian generalized least squares regression with application to log Pearson type 3 regional skew estimation.” *Water Resour. Res.*, 41, W10419. Stedinger, J. R. _1980_. “Fitting log normal distributions to hydrologic data.” *Water Resour. Res.*, 16_3_, 481–490.
- Stedinger, J. R., and Griffis, V. W. _2006_. “Evolution of *Bulletin 17B* for flood frequency analysis in the United States.” *World Environmental and Water Resources Conf.: Examining the Confluence of Environmental Concerns and Water Concerns*, R. Graham, ed., Omaha, Neb., ASCE, paper 0856–14956.
- Stedinger, J. R., and Lu, L. _1995_. “Appraisal of regional and index flood quantile estimators.” *Stochastic Hydrol. Hydraul.*, 9_1_, 49–75.
- Tasker, G. D., and Stedinger, J. R. _1986_. “Estimating generalized skew with weighted least squares regression.” *J. Water Resour. Plann. Manage.*, 112_2_, 225–237.

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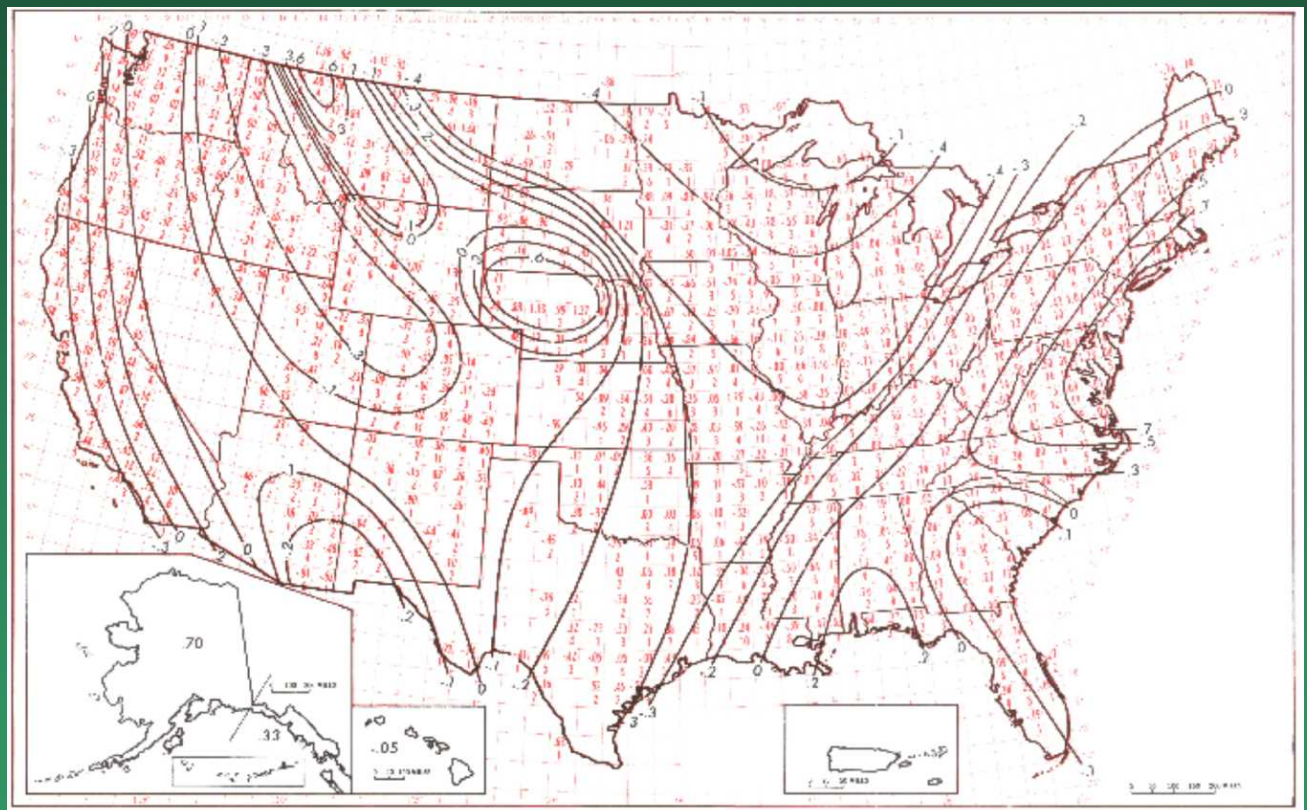
Estimating Regional Skew



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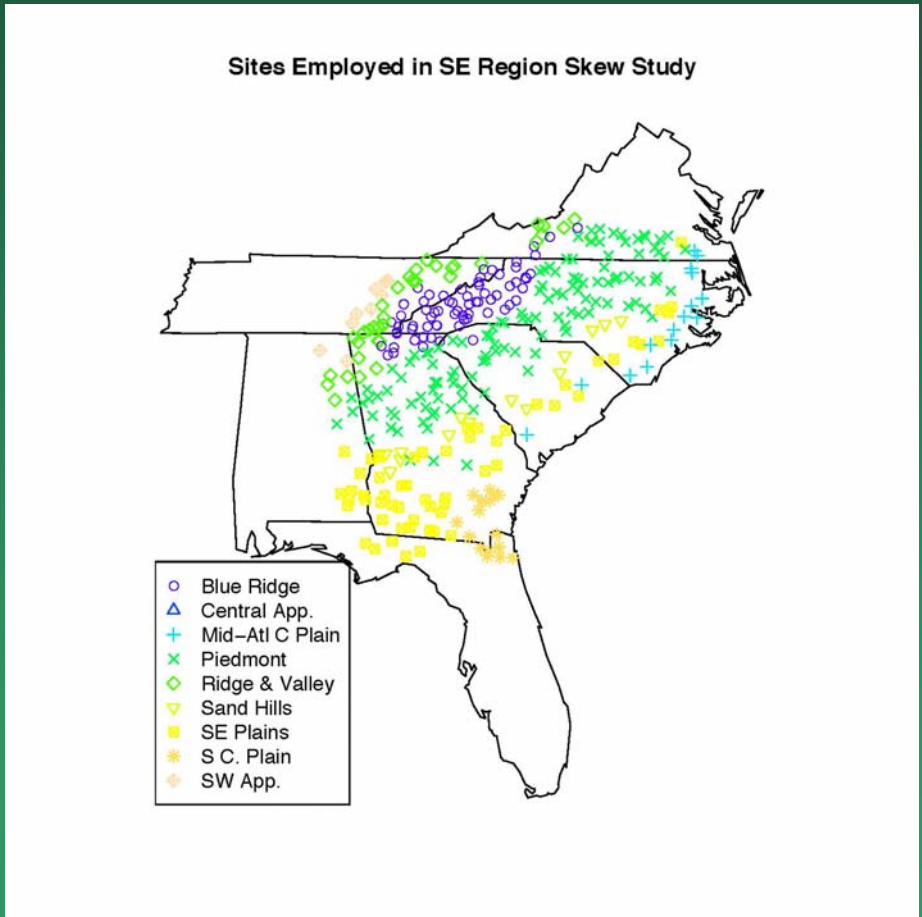
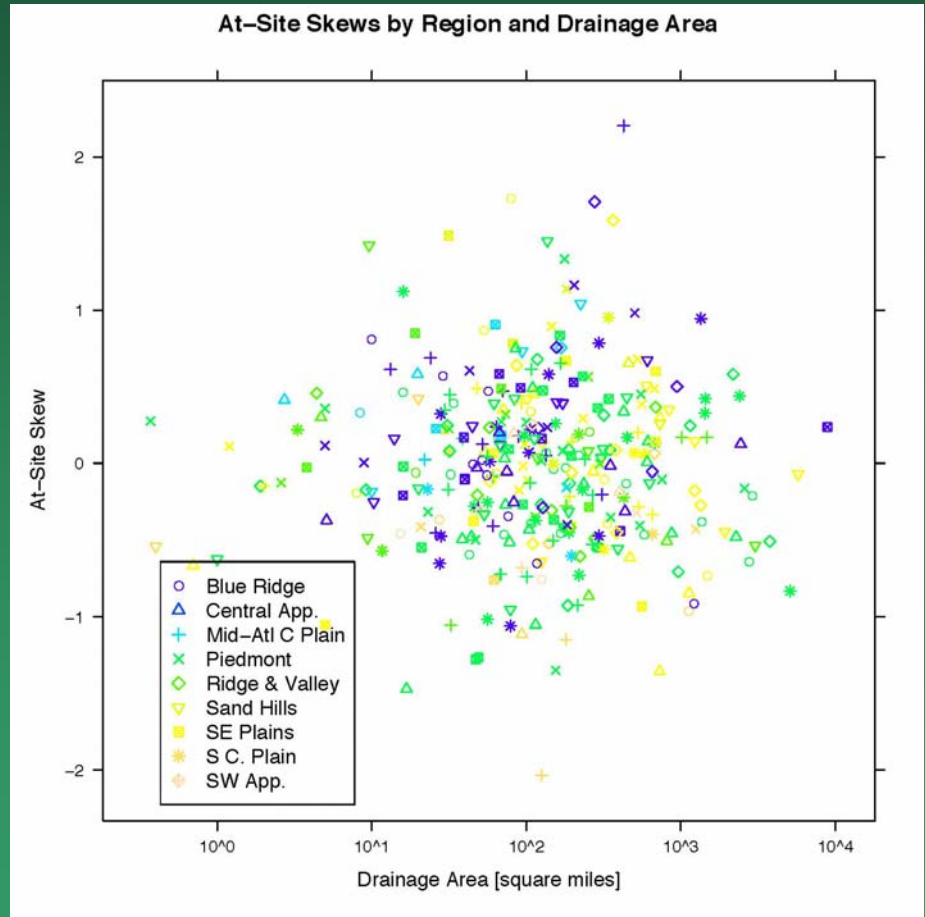
For Southeast, Regional Skew is Constant





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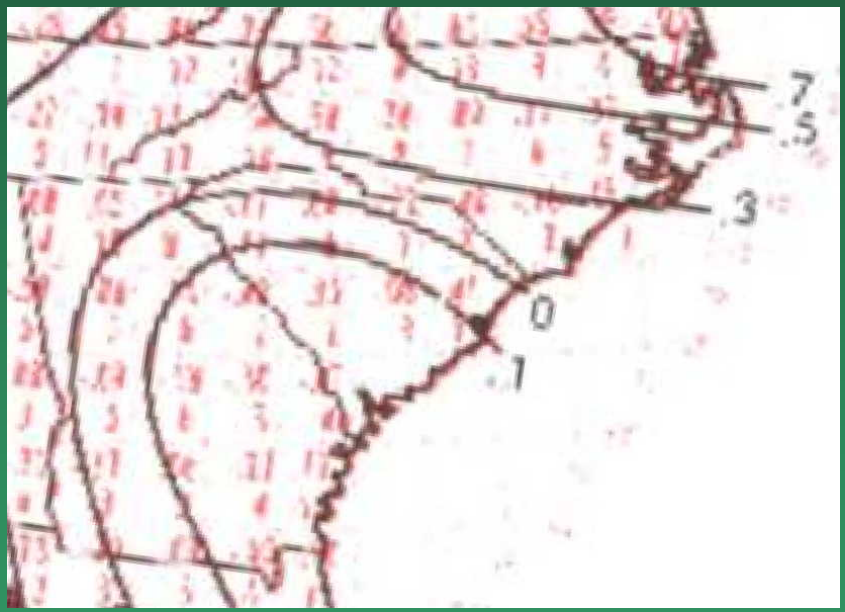
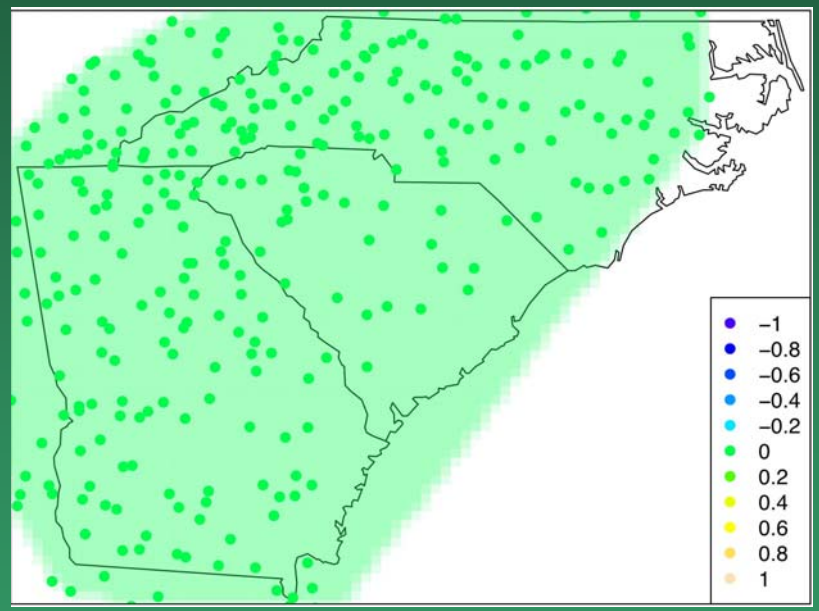
Estimated Regional Skews



1982 (MSE=0.302)



2008 (MSE=0.086)

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Implications of Bayesian/GLS

- Large increase in effective record length (ERL) for skew estimation
  - ERL= (5.2/0.302) =17 years for B17B
  - ERL= (5.2/0.086) =60 years for B17B
- LP-III/MoM w/ Bayesian/GLS skews is competitive with GEV/L-Moments and index flood

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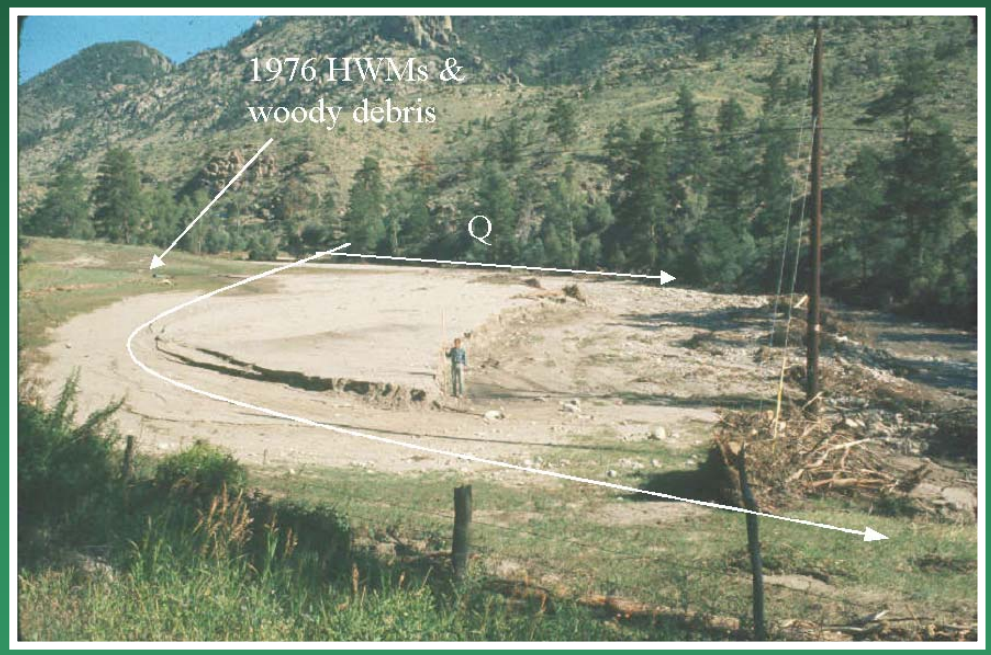
Real-World Results



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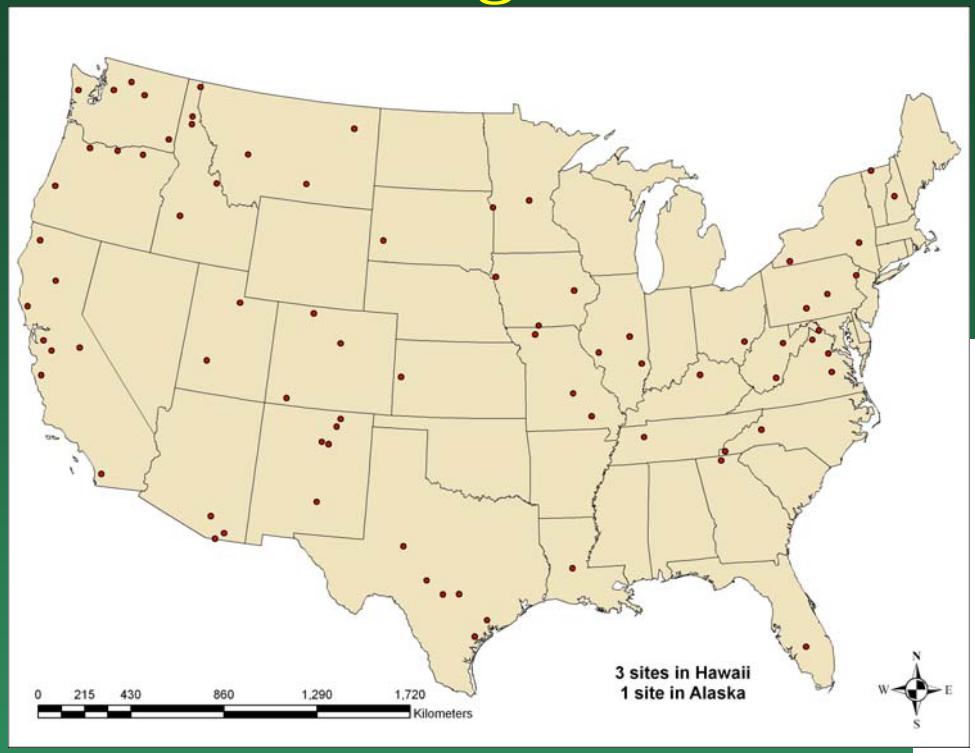
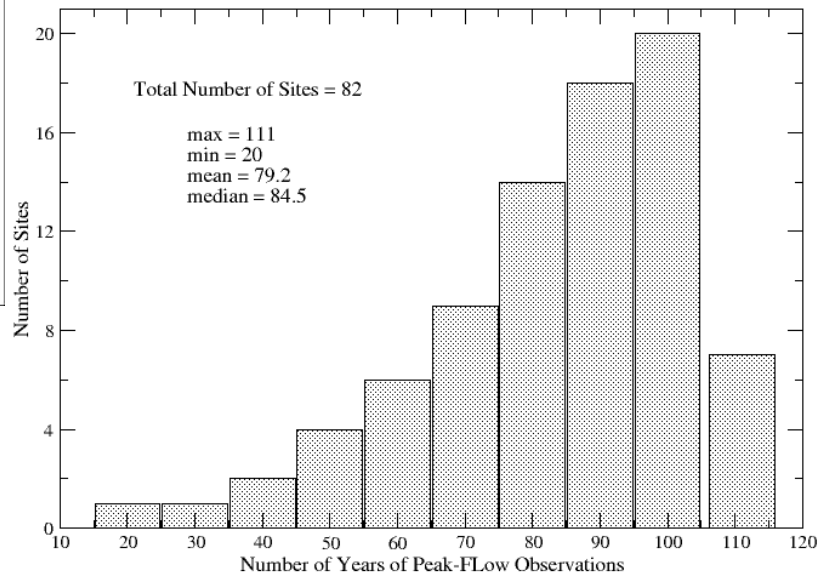
Testing Locations and Record Lengths





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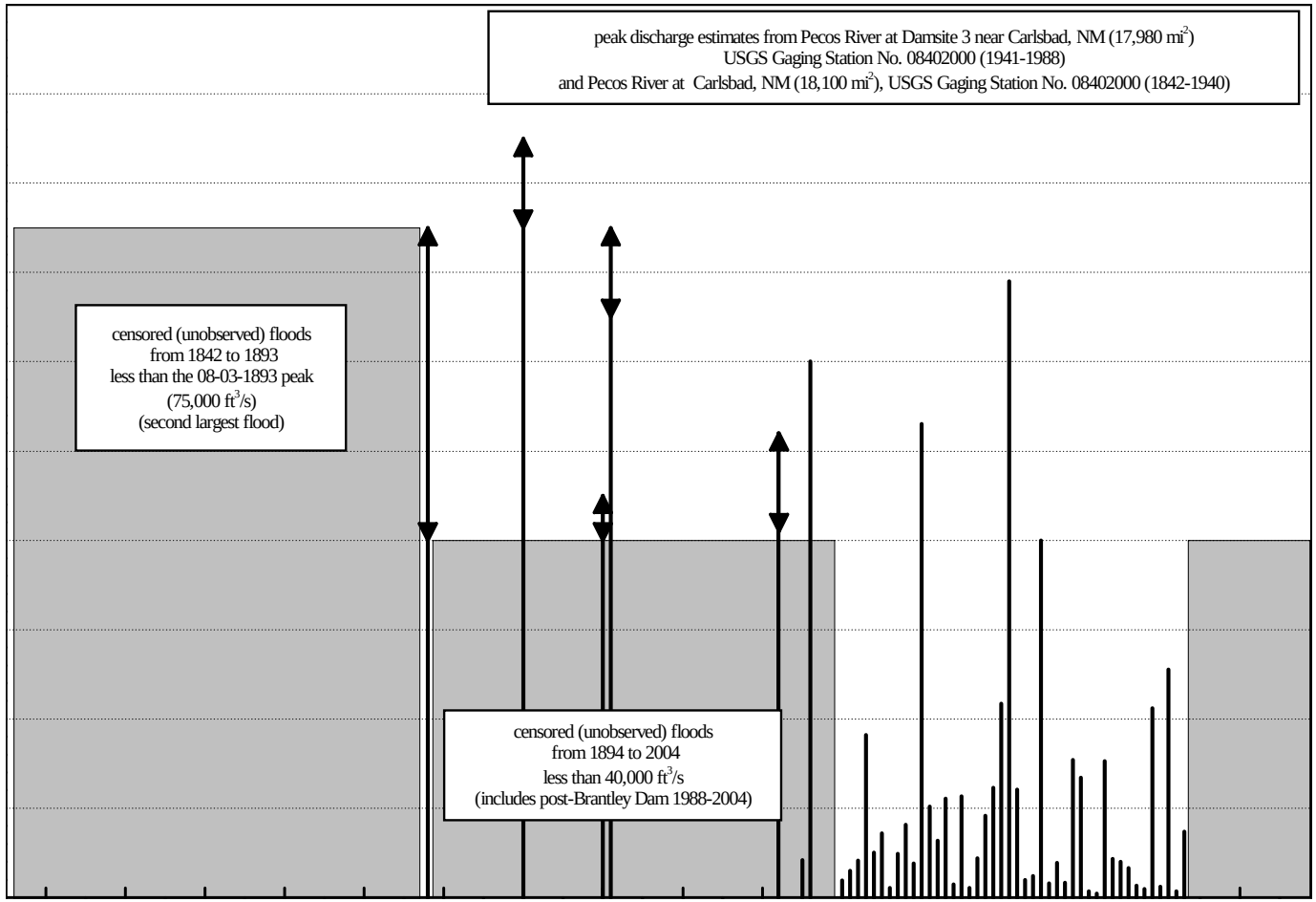
Pecos River near Carlsbad (Brantley Dam), NM



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Conclusions

- Theory suggests that modest changes to B17B will greatly improve its performance
- Study is underway comparing existing B17B procedures to proposed alternatives.
- Empirical results so far seem to confirm that relatively modest changes to B17B procedures will both improve performance and allow use of additional types of data efficiently.

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Thank You!

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