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Managing Water in the West

Progress On Use of Paleo-Conditioned Streamflow Data On Gunnison River Basin For Aspinall EIS

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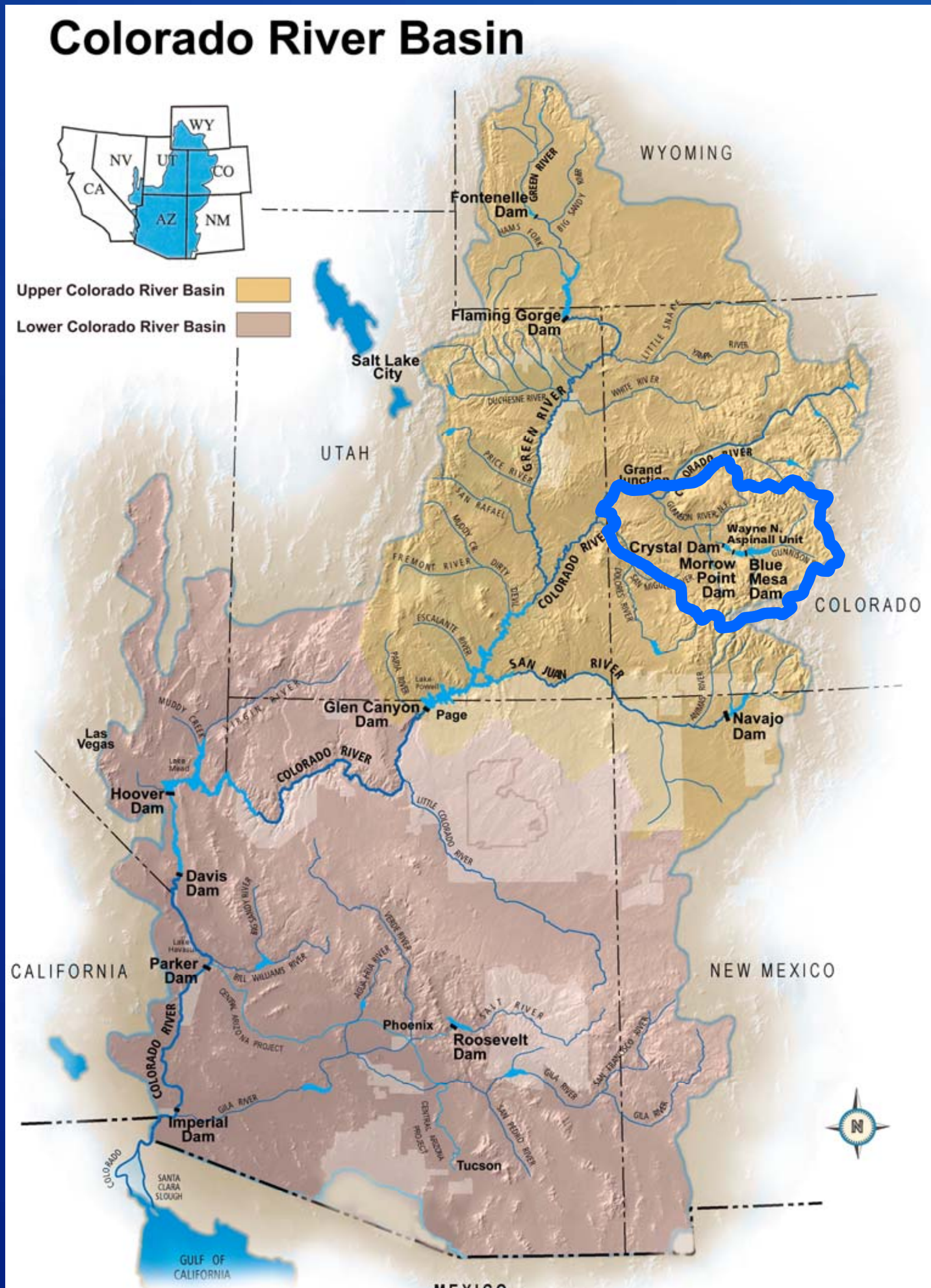

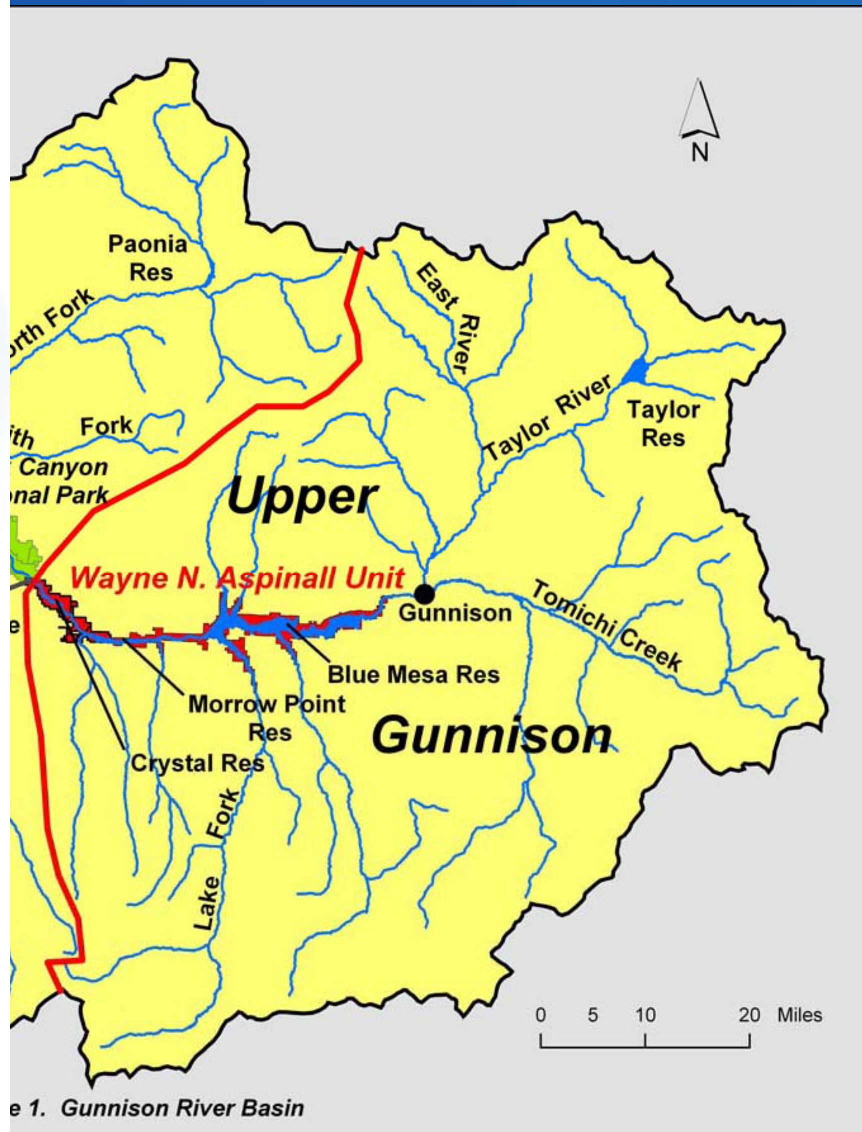

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Tree Ring Data Related Developments

- June ’05
  - Hydrologic Period of Record
  - Tree Ring Data Discussed
  - Single trace / index sequential / stochastic analysis
  - Depletions – staged or up-front
- September ’05
  - Committed to iterative trace analysis (at a min)
- December ’05
  - Began statistical analysis of unique periods of record including proxy data 1569 to 1997
- February ’06
  - Dr Rajagopalan and Dr Ray presented preliminary plan for implementing tree-ring data

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Tree Ring Data Developments, continued

- April ’06
  - Developed Forecasting Algorithm for any given hydrology
  - Solved leap-year problem (daily model issues)
  - Decided to use natural flow data (StateMod -> RiverWare)
  - Settled on ’37-’97, with paleo-conditioned data in appendix
- August ’06
  - Continued debate on period of record (!)
  - Jim Prairie presented single trace/ISM/stochastic comparison, and techniques for handling data and interpreting results

Paleo Problems…

- Large extremes are outside scope of study
- Annual volumes applied, but seasonal variability is needed (fixed with transition sequencing)
- May not capture magnitudes of events
- Temporal (year-year) transitions problematic
- Spatial distributions problematic
- “This must be voodoo!” :)

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Udall, 2005

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Paleo Game Plan 1/2

1) Stochastic Historic Flow Sequences
    a) Generation of annual flow sequences using KNN
    b) Historic data: 1937-1997 (flow recs)
    c) Compare results to ISM
2) Statistical Support
    a) Compute suite of statistics
        i. Wet and dry period stats
        ii. Run lengths of droughts and floods
        iii. Monthly flow properties
    b) Compare with results from historic data

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Paleo Game Plan 2/2

- **Baseline Risk Assessment**
  - Develop a sequent-peak algorithm
    - Storage required for given yield over various drought deficits
    - Assess system risk (reliability)
    - Provides storage required for various levels of firm yield

- **Transition Sequencing of Prehistoric Data**
  - Using paleo reconstruction from Woodhouse et al. 2006:
    - Simple block bootstrap of paleo data
    - Determine the state of the system for paleo data
    - For each year use a KNN method to resample the observed data to conditionally generate the flow magnitudes that are consistent with the generated "state" of the (paleo) system

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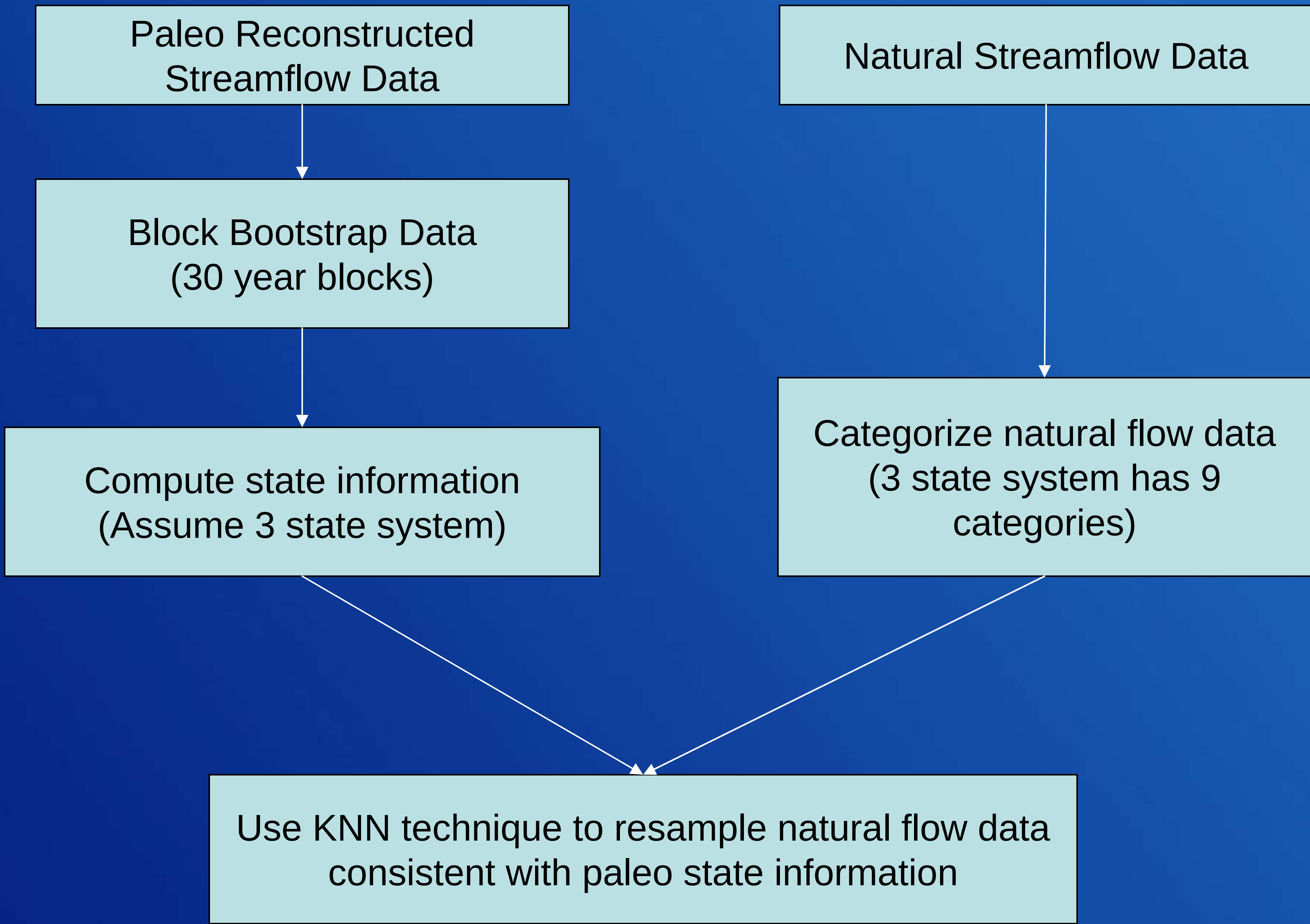

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Periods under Consideration

- **1569-1997** Proxy Data Obtained From Recent Dendrochronology (Woodhouse, 2006)
- **1906-1916** Regressed Monthly Gauge Data
- **1917-1936** Recorded Monthly Gauge Data
- **1937-1997** USFWS Flow Recommendations
- **1937-2004** Updated Flow Recs
- **1975-2004** Daily Gauged Data Record

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Comparison of basic statistics on Annual Flow Volumes

Period	Mean	Median	Count
• 1569-1997	2,330	2,393	429
• 1906-1916	2,630	2,809	11
• 1917-1936	2,501	2,454	20
• 1937-1997	2,319	2,269	61
• 1937-2004	2,247	2,192	68
• 1975-2004	2,313	2,276	30

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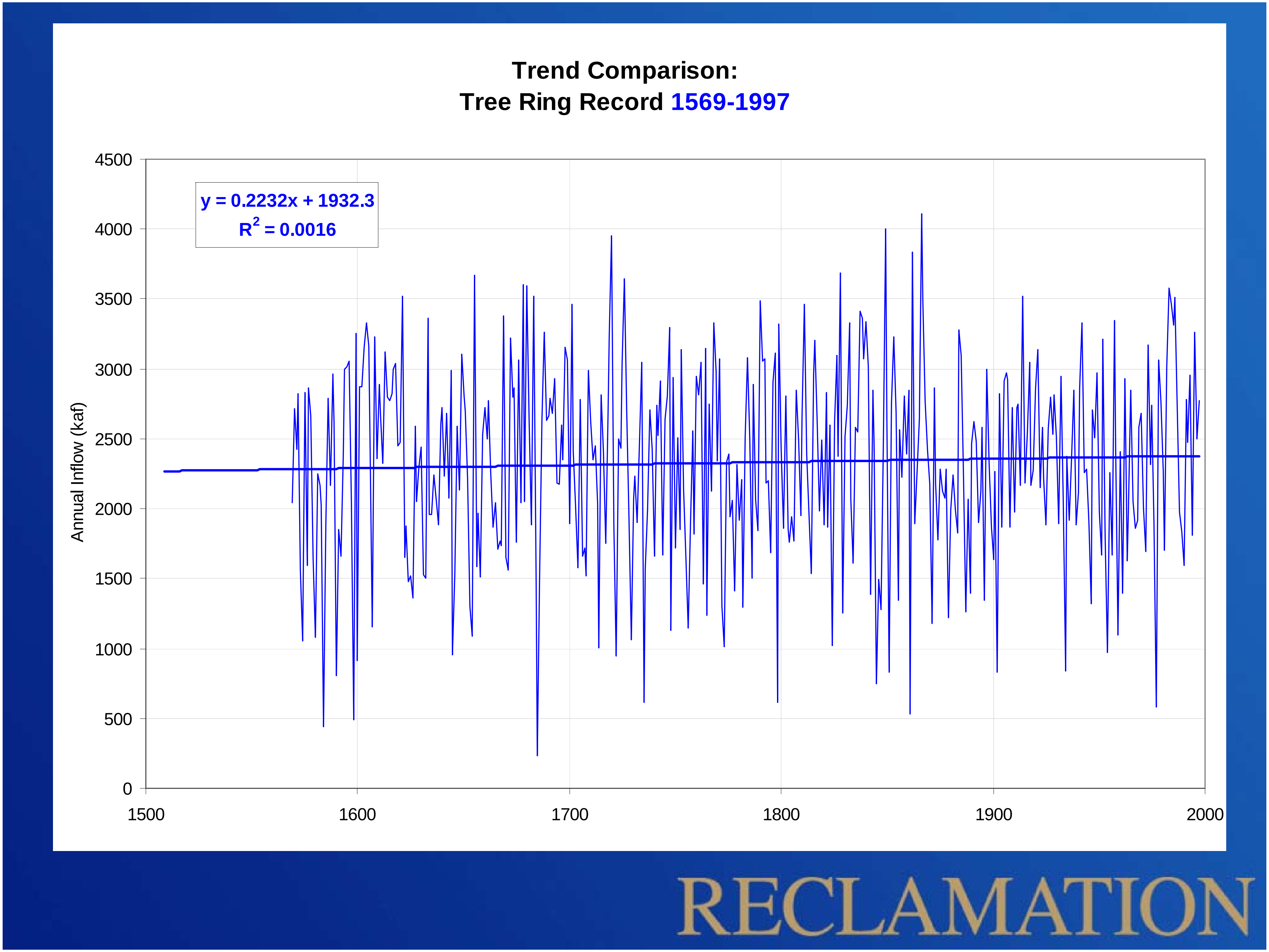

Trend Comparison:
Tree Ring Record 1569-1997
y = 0.2232x + 1932.3
R^2 = 0.0016
Annual Inflow (kaf)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
1500
1600
1700
1800
1900
2000
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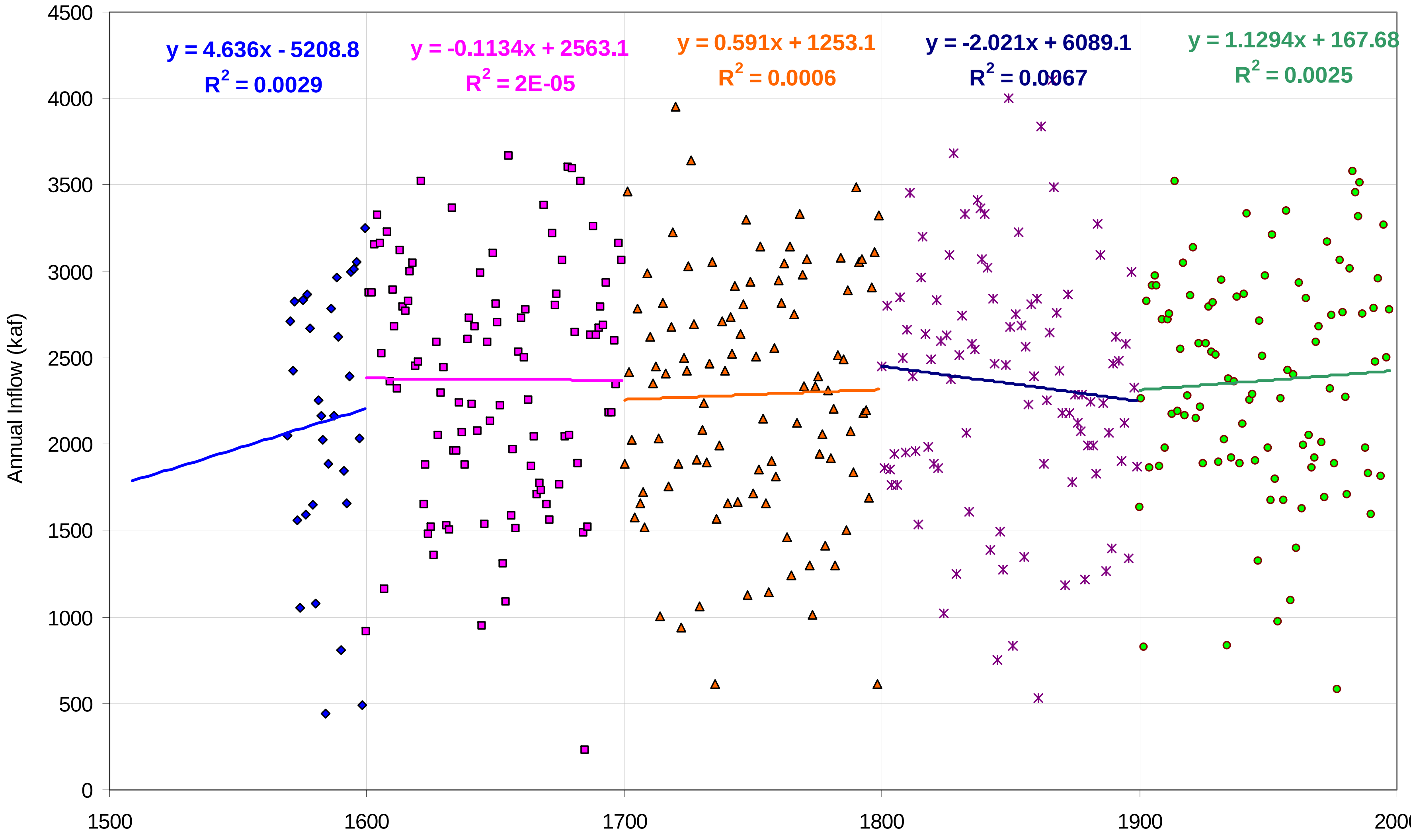
Trend Comparison:
Tree Ring Record by Century



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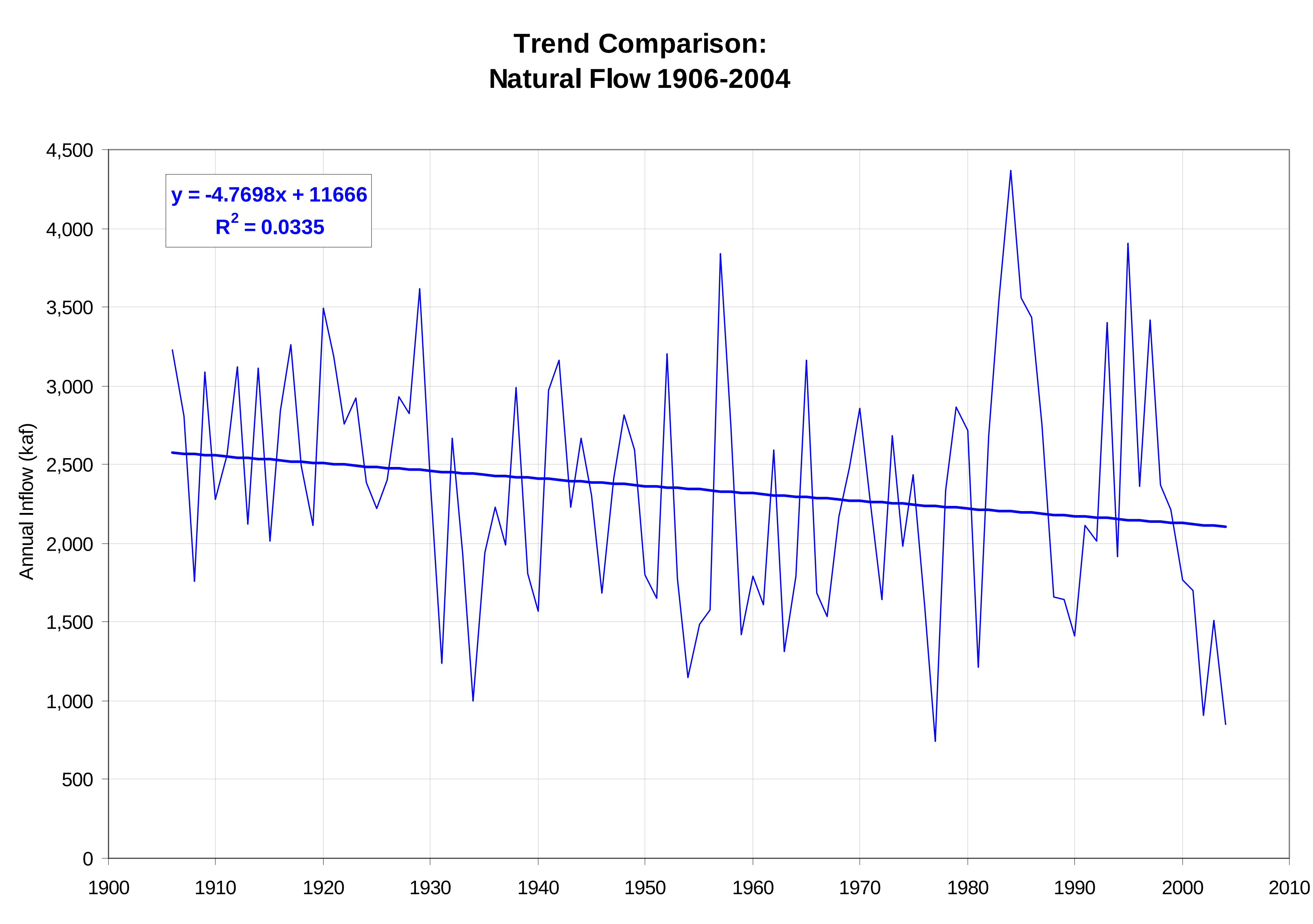

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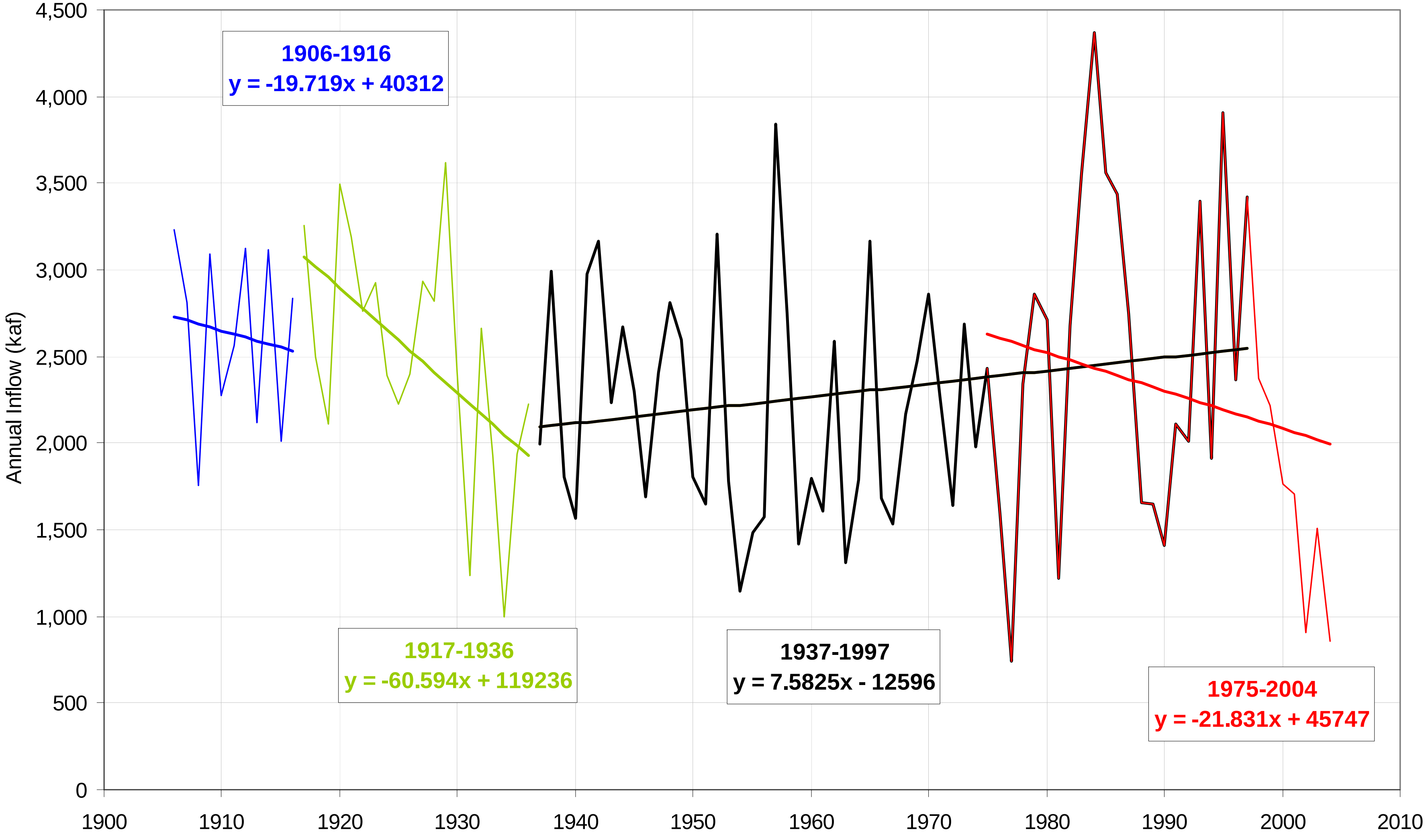
Trend Comparison: Natural Flow 1906-2004



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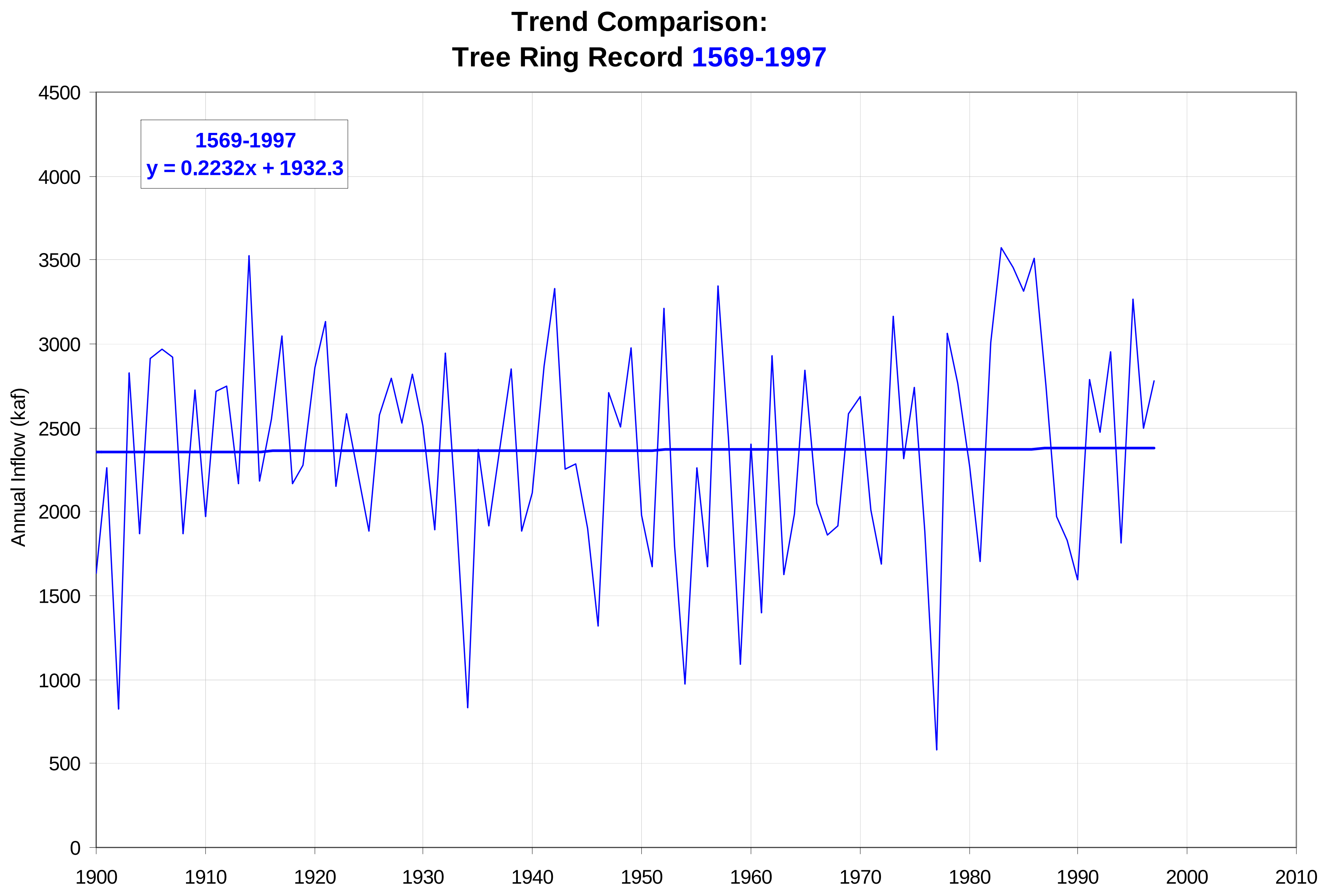

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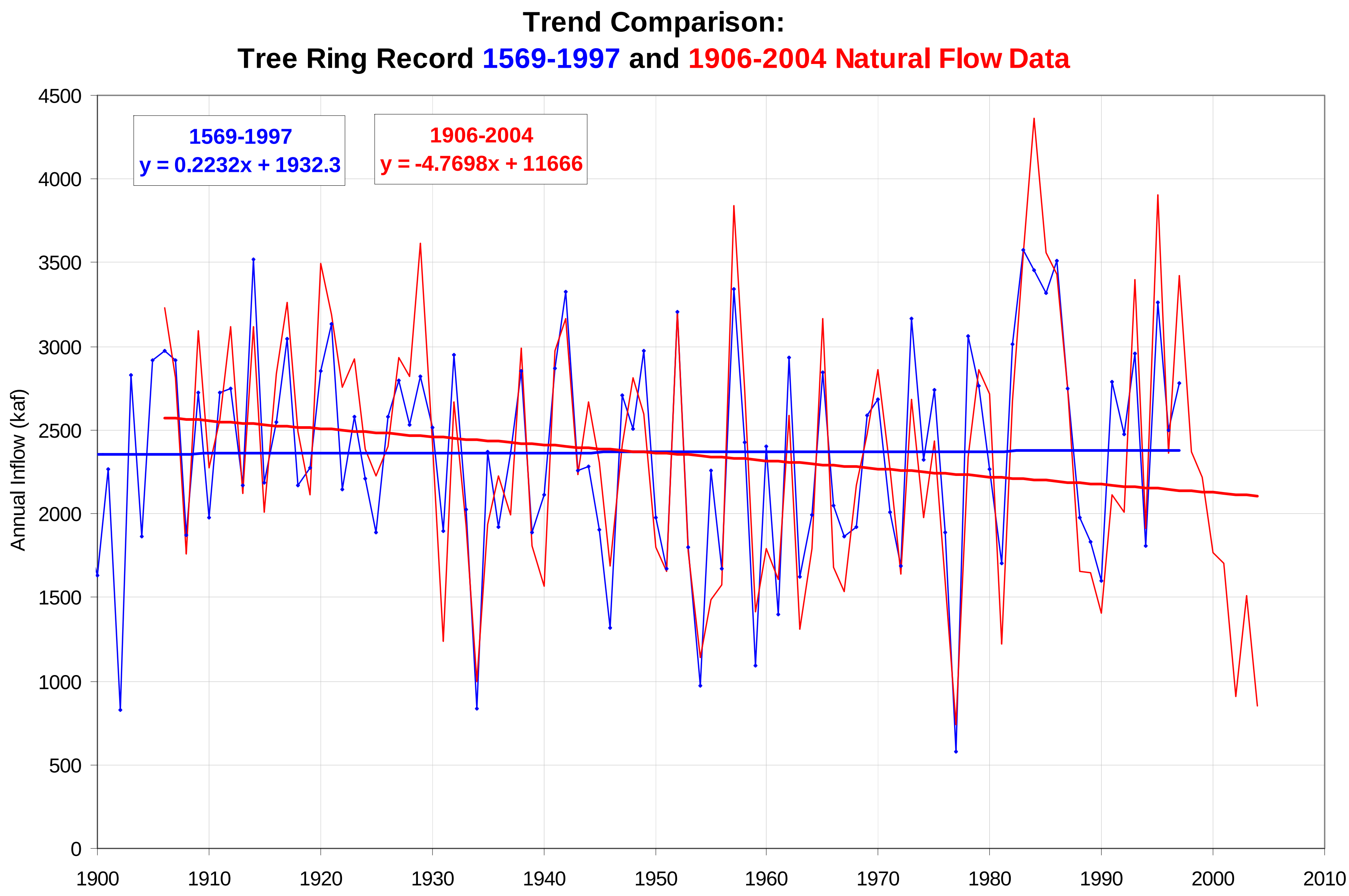

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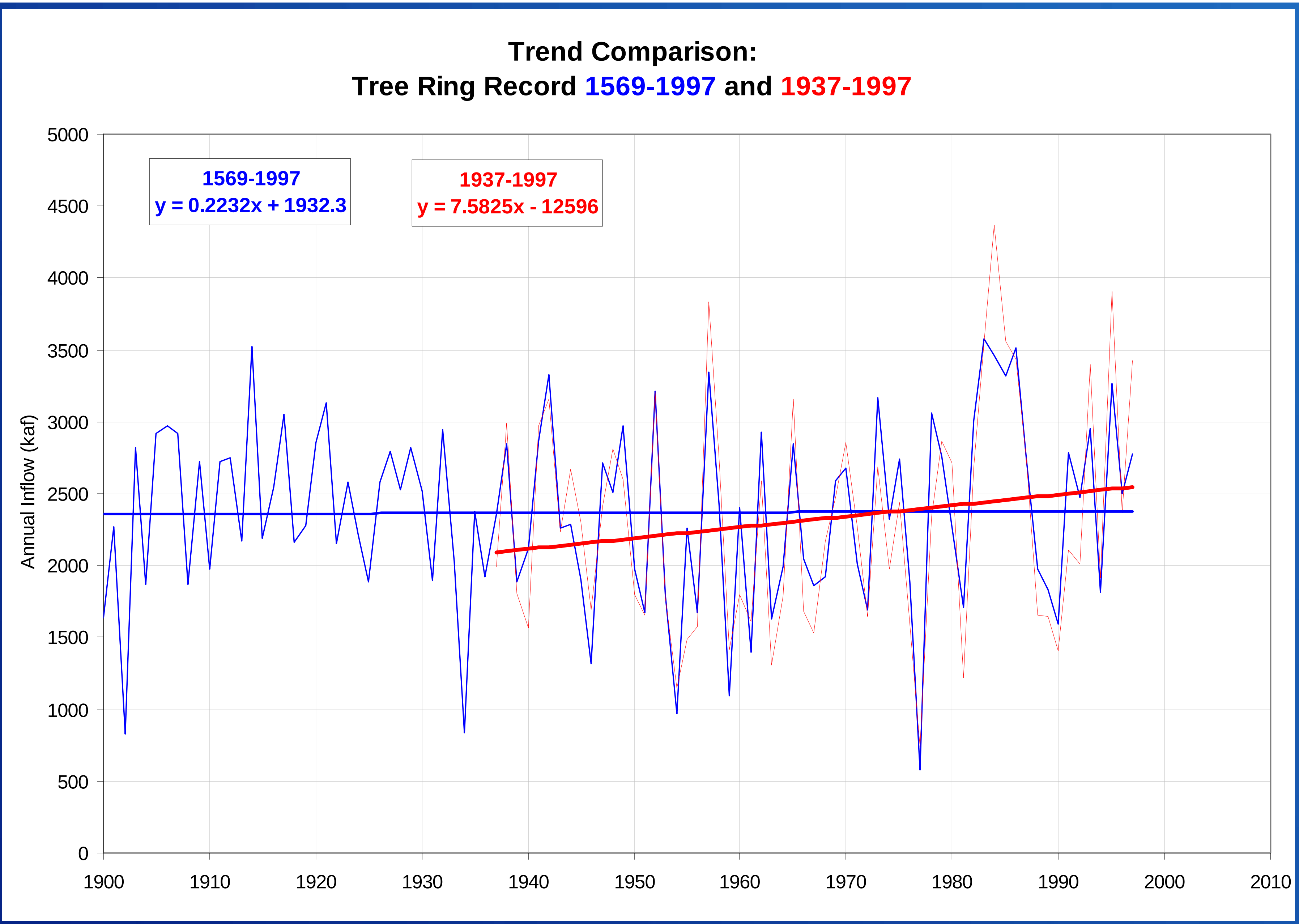

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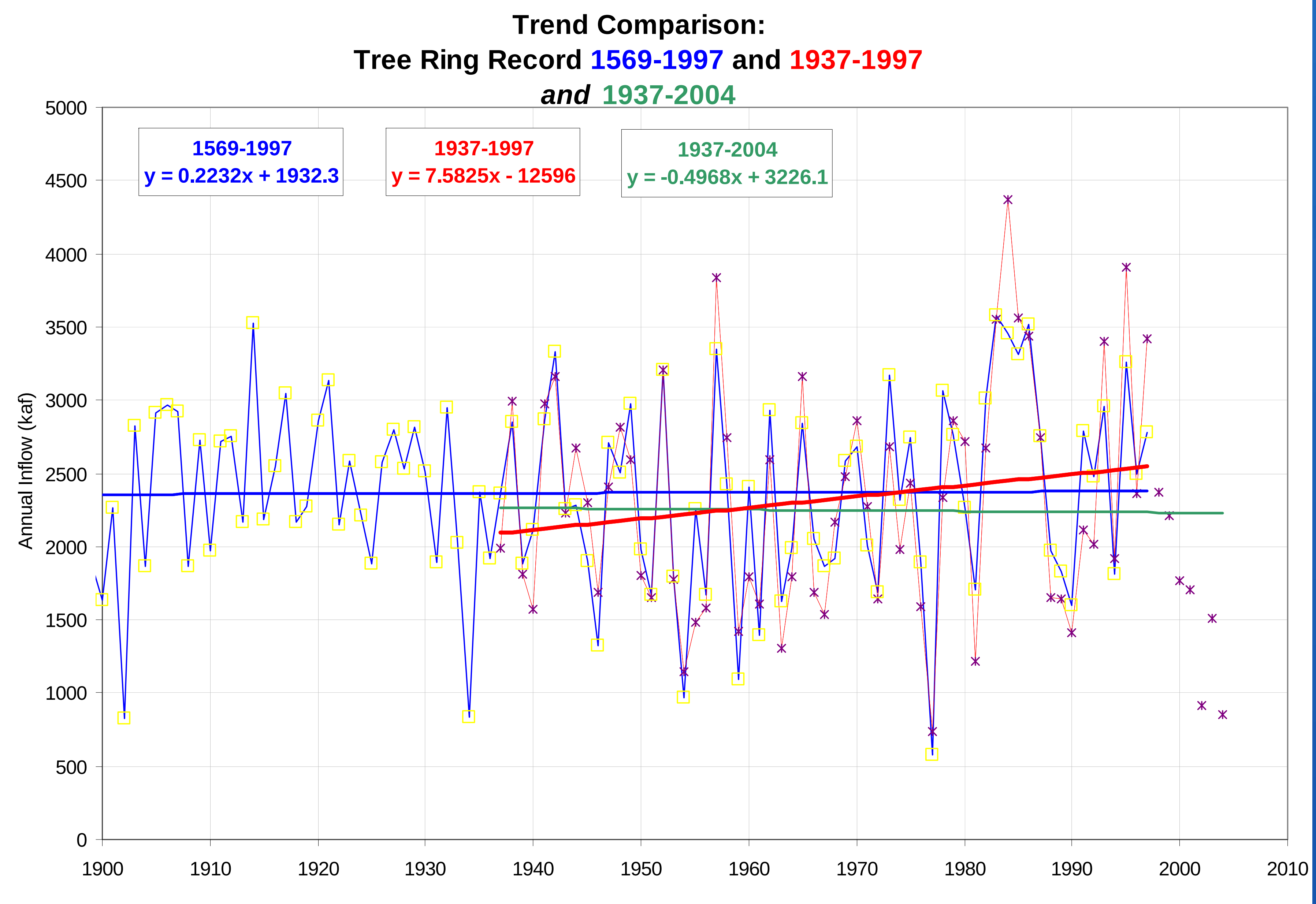

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