Water Resource Management Activities and Climate Change

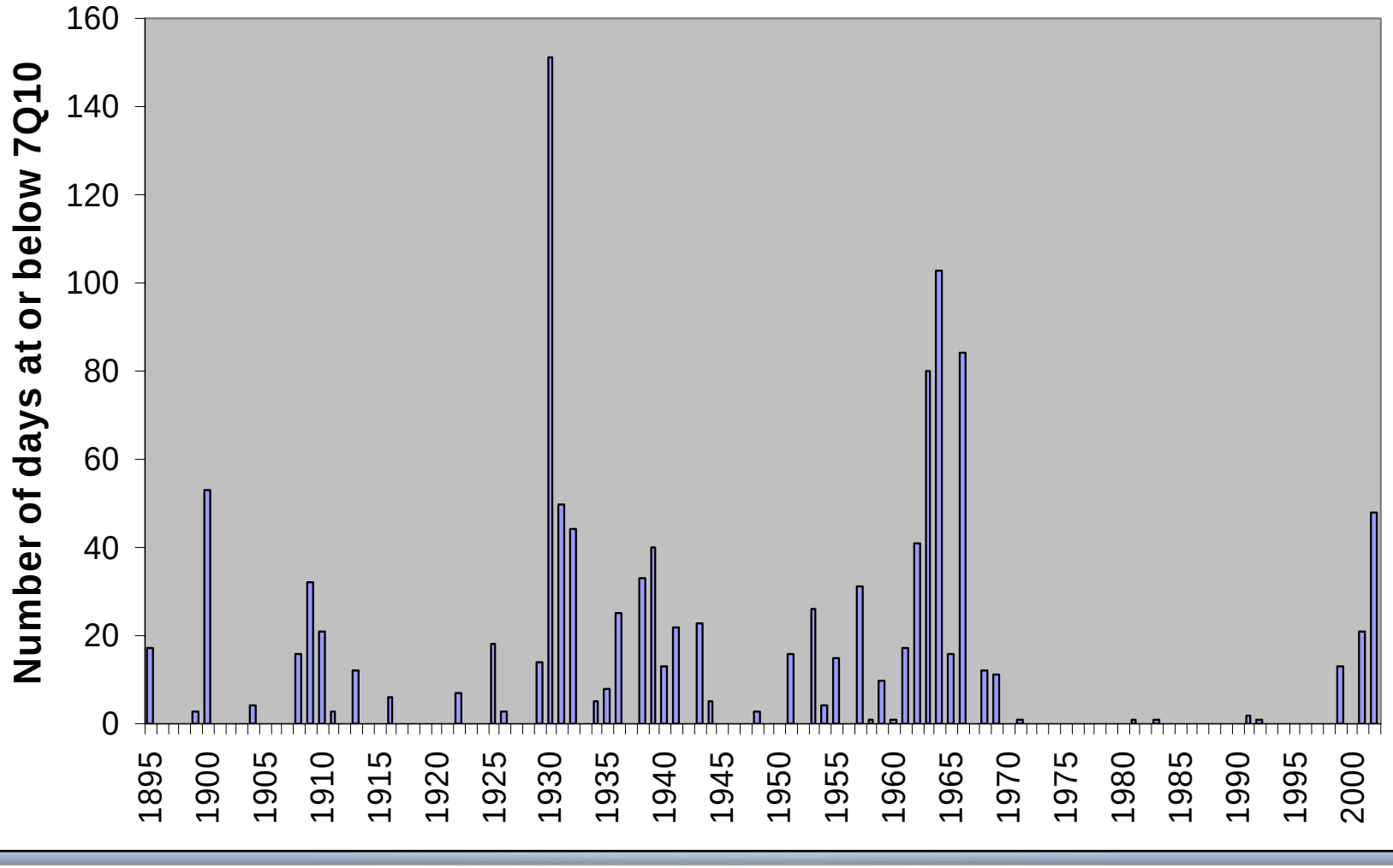
Climate Change Issues in Draft Comprehensive Plan

- Changes to rainfall patterns
  - More frequent and severe floods and droughts
  - Shift in hydrologic regimes and characteristics
- Loss of reliability of flow data
  - Are records reflective of new conditions?
  - What should be used for long-term planning?
- Impacts of flow and temperature changes to meeting Chesapeake Bay goals

Flow Regime Investigation

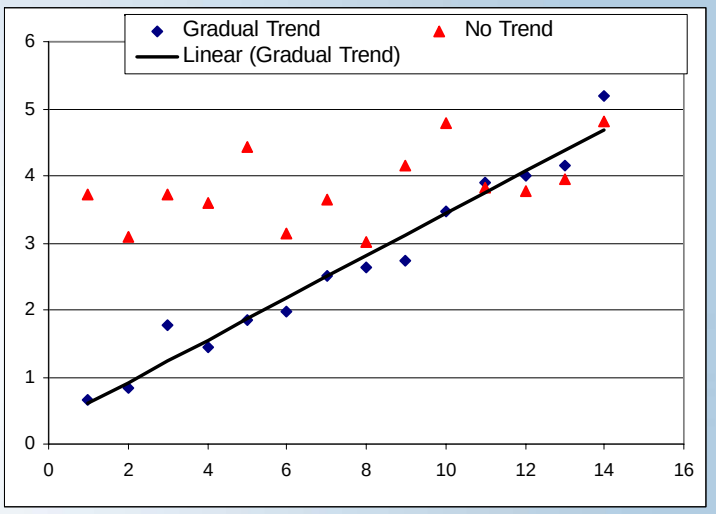
- Knowledge of streamflow characteristics is needed for water resources management
- Streamflow traits are assumed to have stationarity
- If watershed is sensitive to global and/or regional climate change, streamflows may not demonstrate stationarity
- Q710 events in SRB have substantially decreased since 1970s

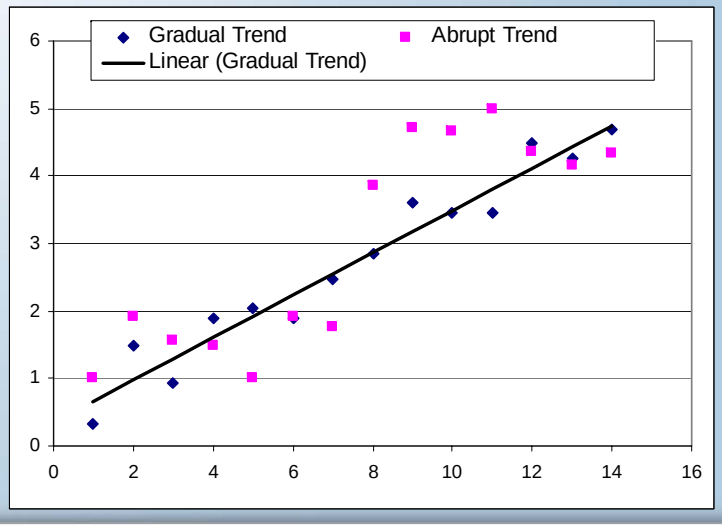
Histogram of number of 7Q10 events for 8 gages in the Susquehanna River Basin from 1895-2002



Trends Analysis of Streamflows

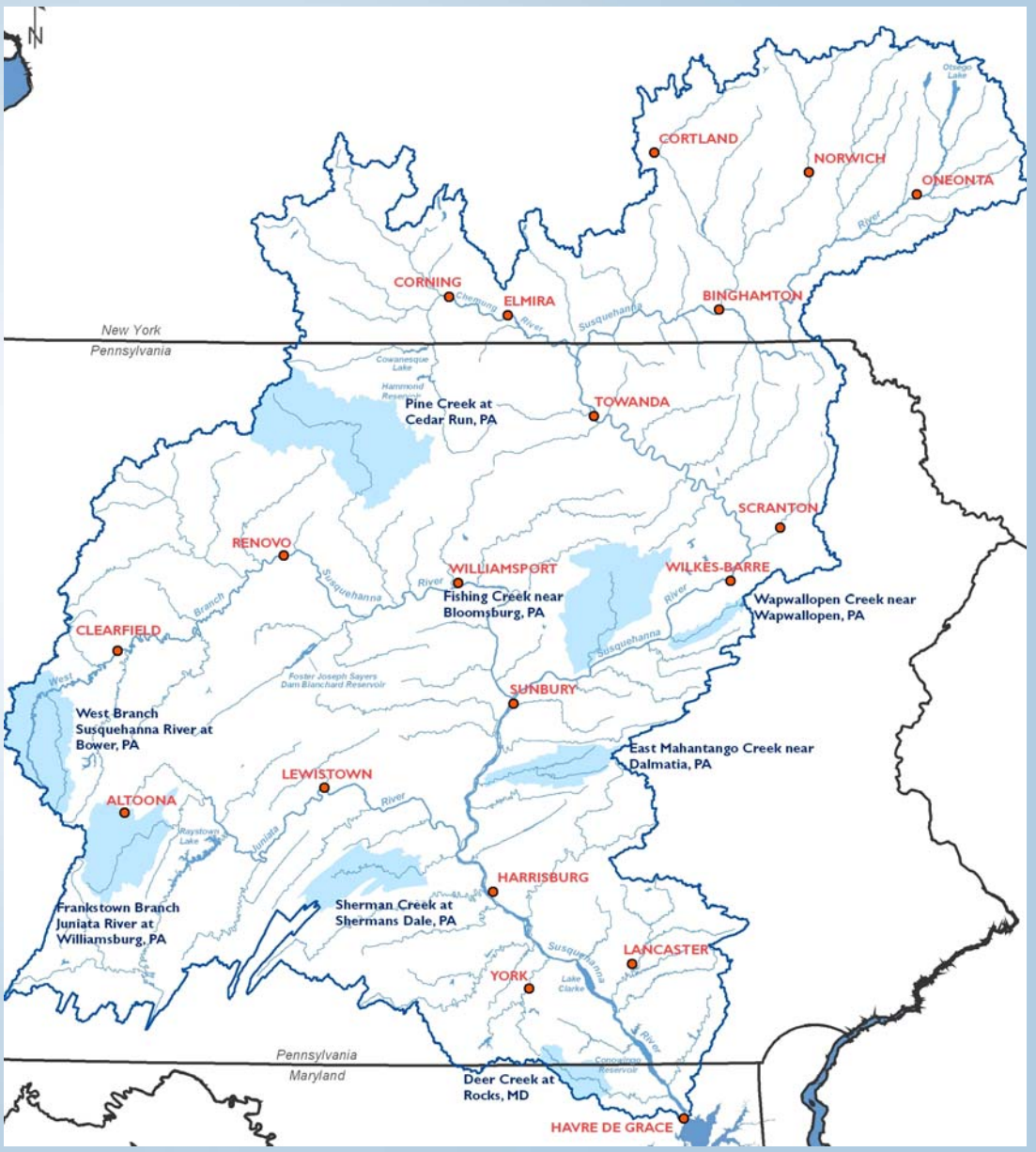
- Are there trends in SRB streamflows?
  - Statistical trend test for significance
- Are the trends gradual or abrupt?
  - Varying starting and ending years
- Yearly or monthly trends?
  - Annual minimum, median, and maximum flows
  - Monthly flow statistics





Watersheds Analyzed

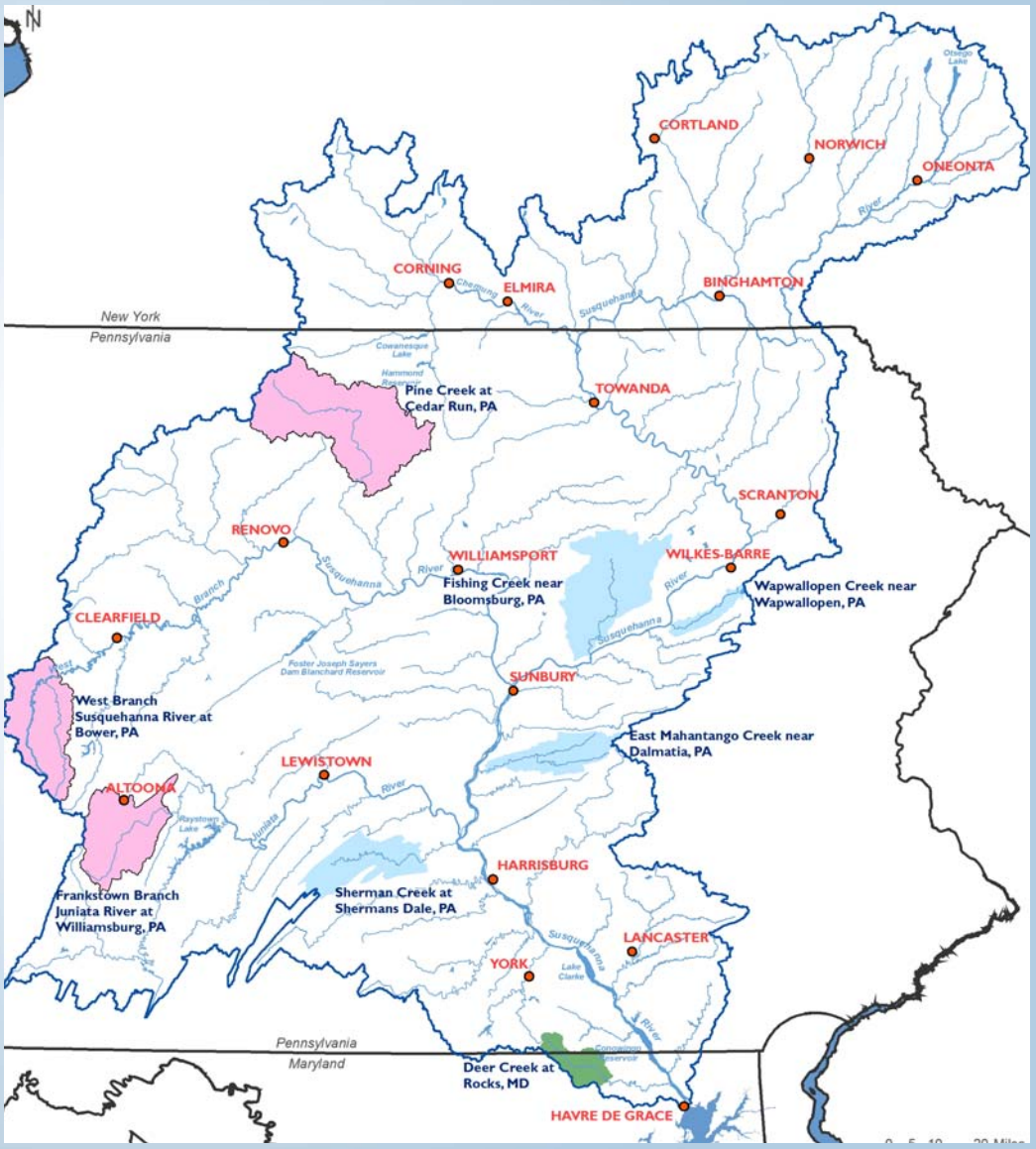
- Eight gages
- Unregulated reaches
- Long-term continuous records



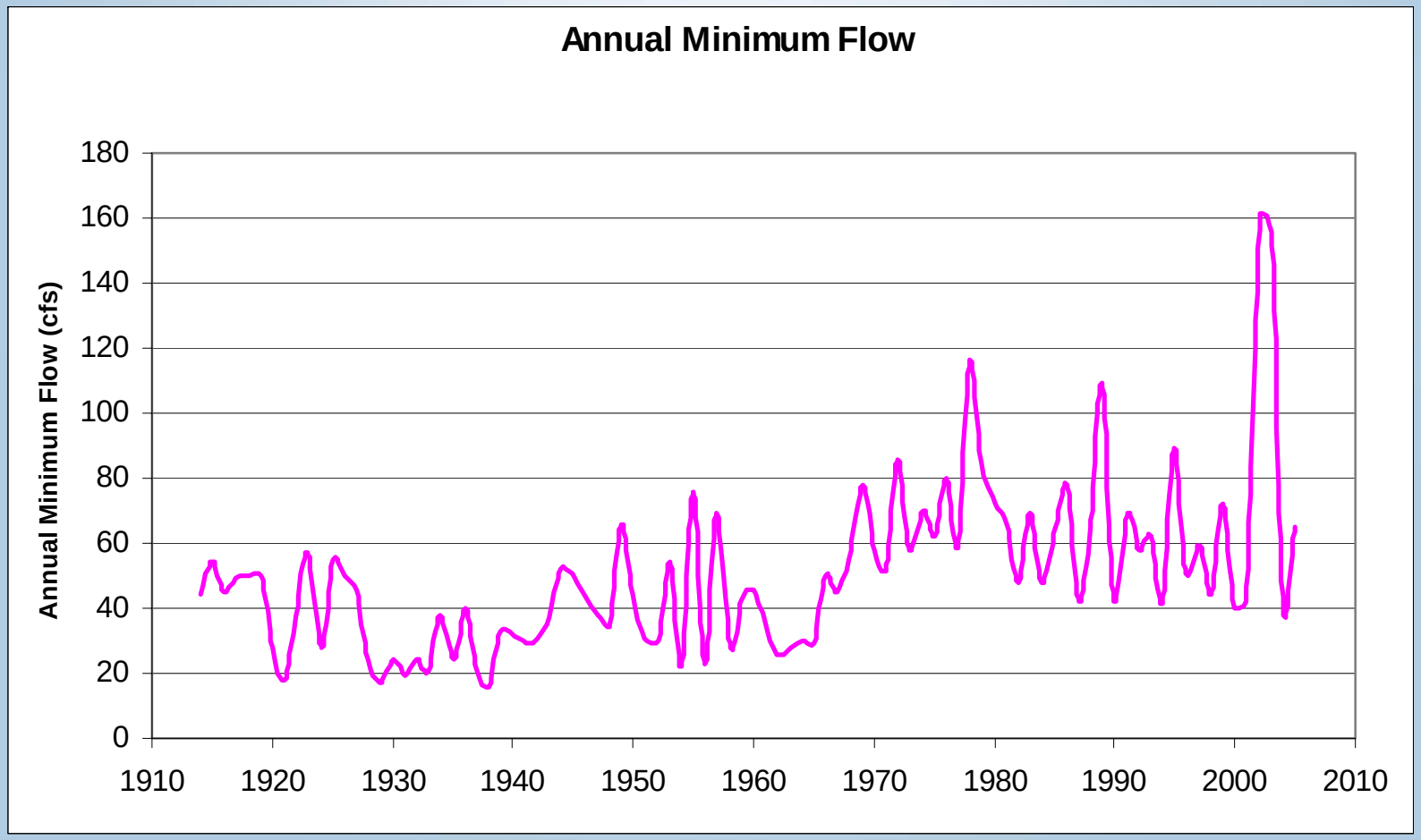
Station Name	Drainage Area (sq mi)	Record Length (years)
Wapwallopen Creek near Wapwallopen, PA	44	86
Fishing Creek near Bloomsburg, PA	274	67
West Branch Susquehanna River at Bower, PA	315	92
Pine Creek at Cedar Run, PA	604	87
East Mahantango Creek near Dalmatia, PA	162	76
Frankstown Branch Juniata River at Williamsburg, PA	291	89
Sherman Creek at Shermans Dale, PA	200	76
Deer Creek at Rocks, MD	94	79

Findings

- Trend tests for significance
- Watershed groupings by similar results



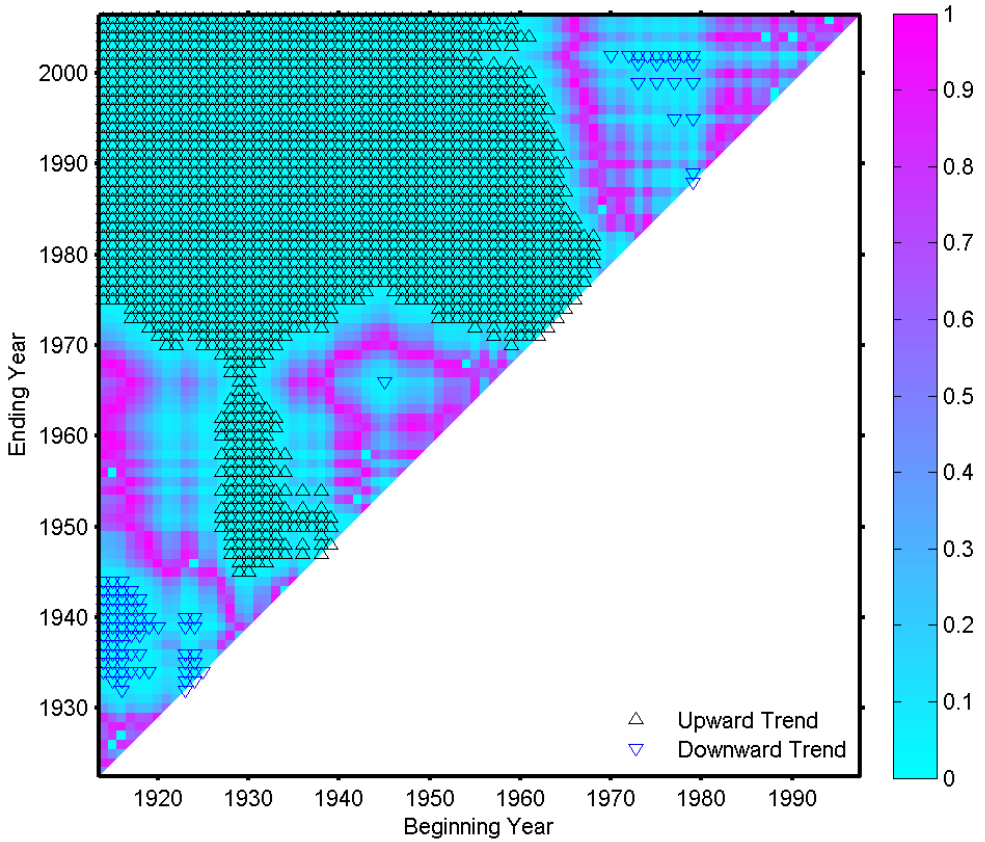
Results
Annual Minimums @ Bower, PA



Results - West Group

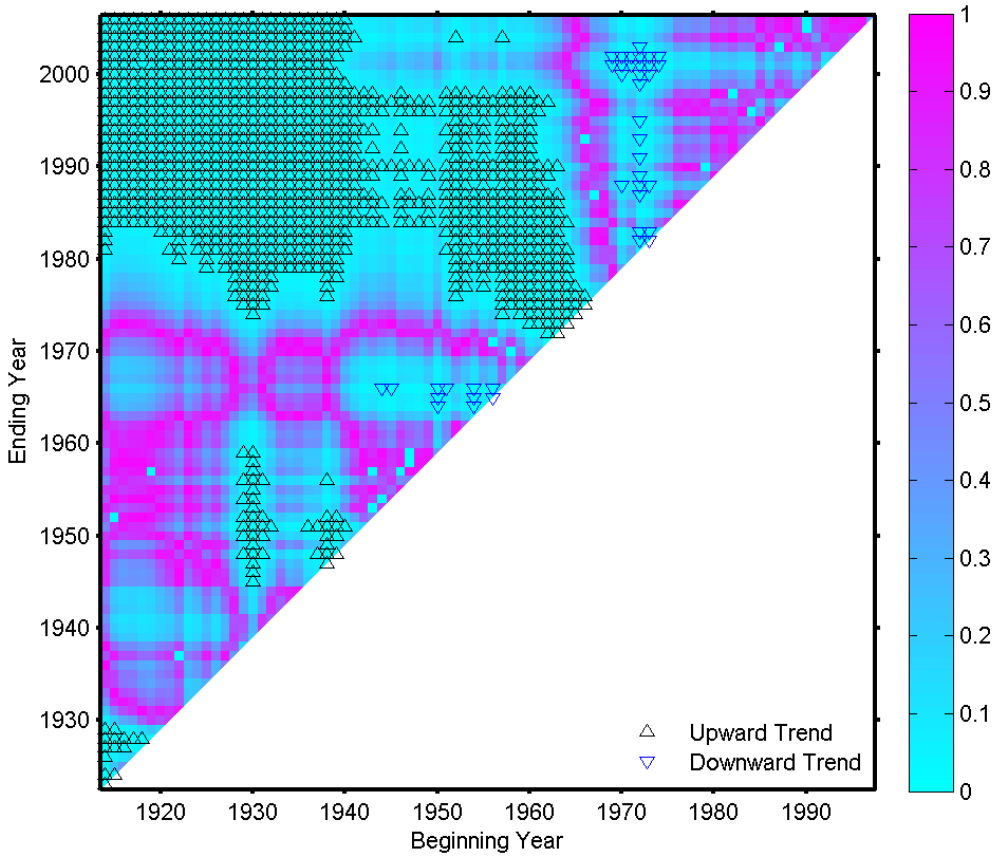
Annual minimums at Bower

The p-values of trend tests with varying record lengths at least 10 years



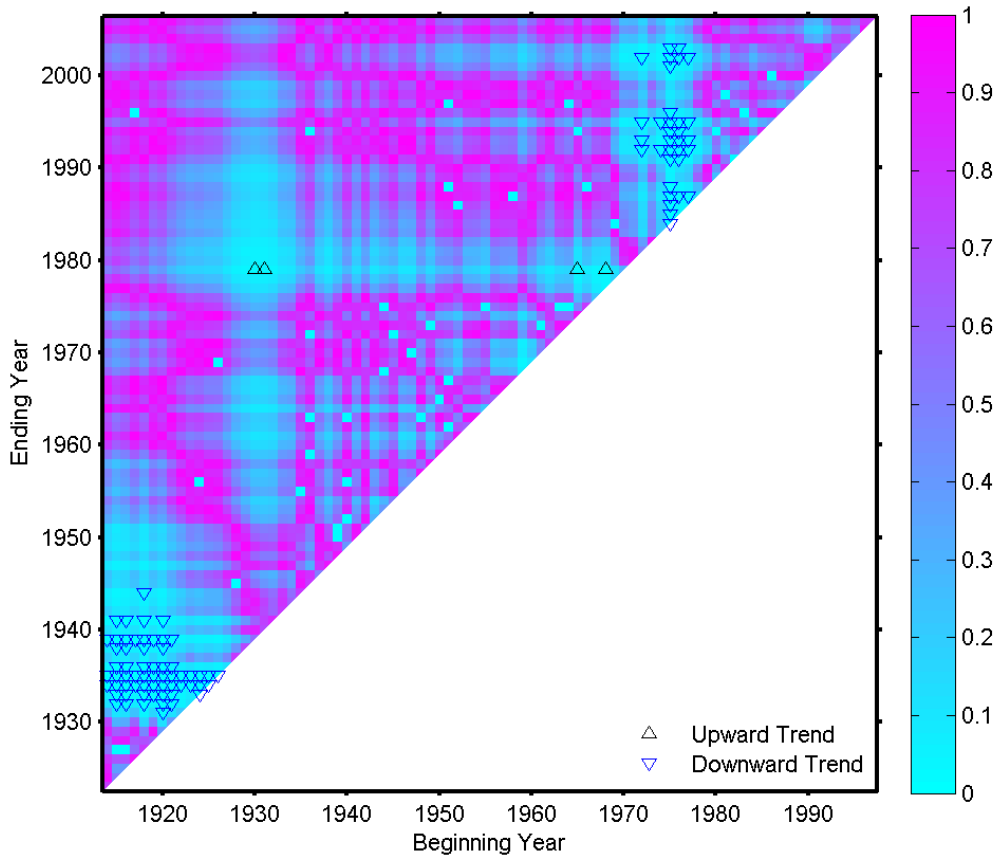
Results – West Group

Annual medians



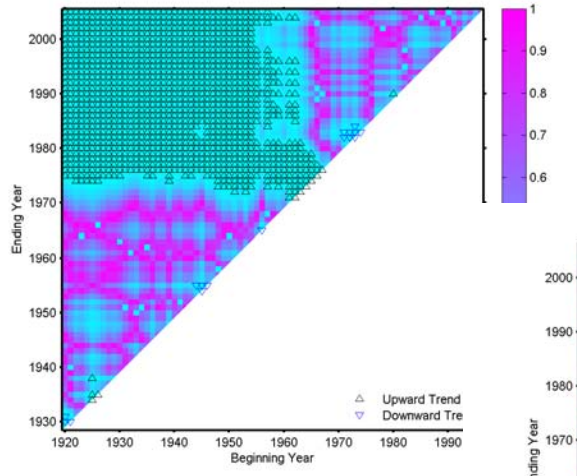
Results – West Group

Annual maximums

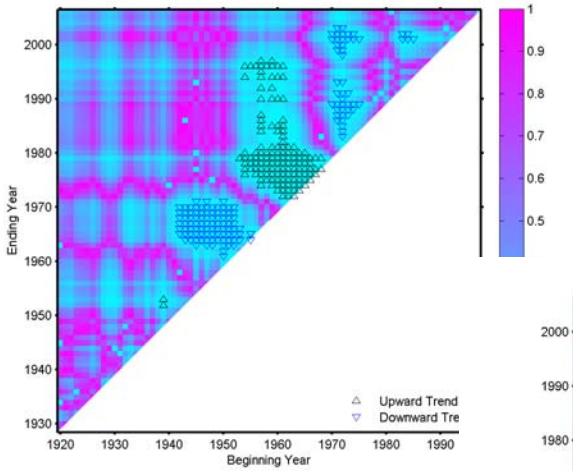


Results – Central Group

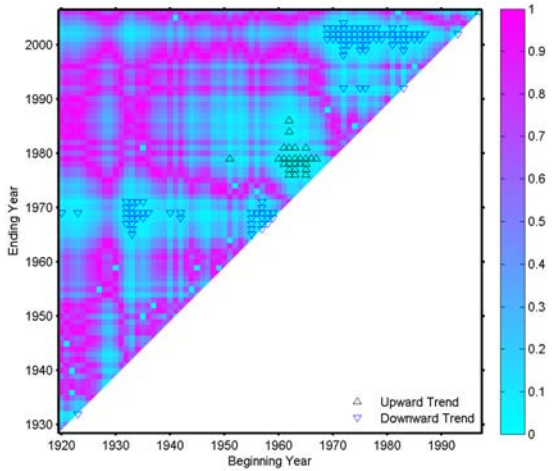
Annual Minimums



Annual Medians

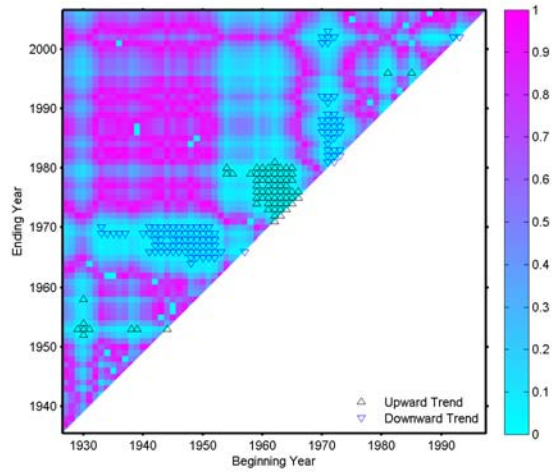


Annual Maximums

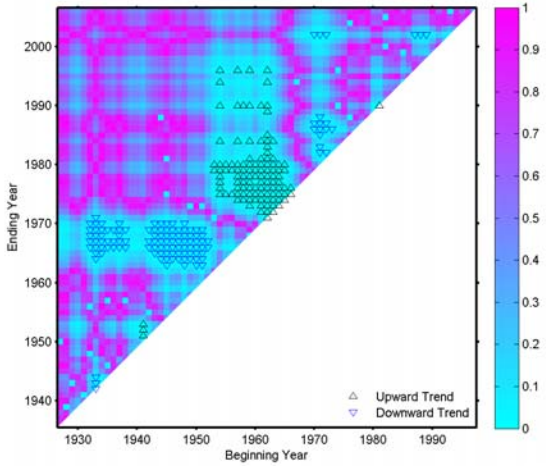


Results - Deer Creek

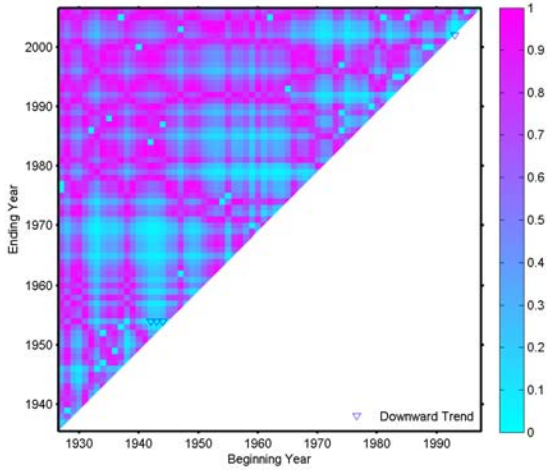
Annual Medians



Annual Minimums

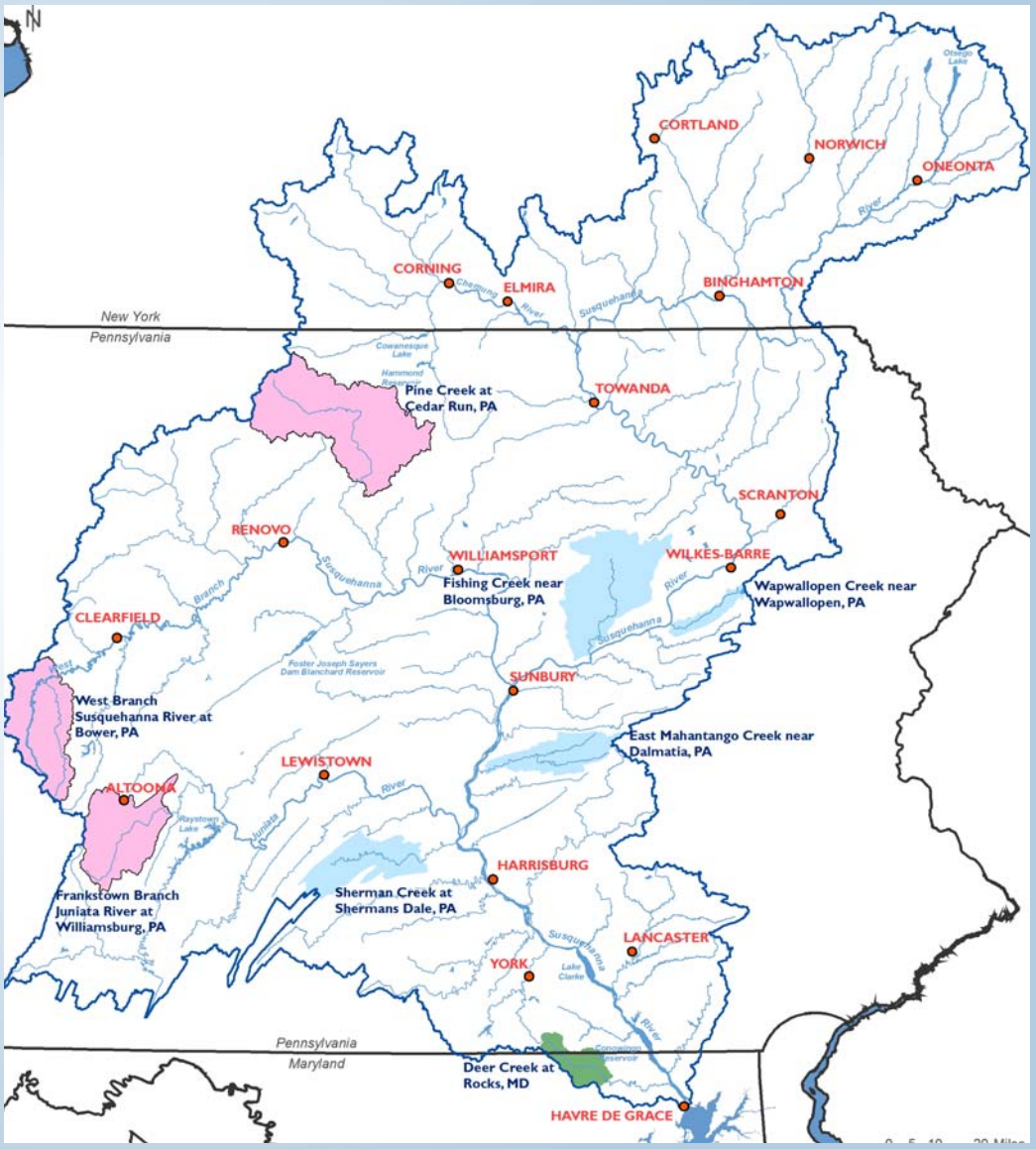


Annual Maximums



Findings – Annual flows

- Three watershed groupings
- Statistically significant increasing trends in annual flows

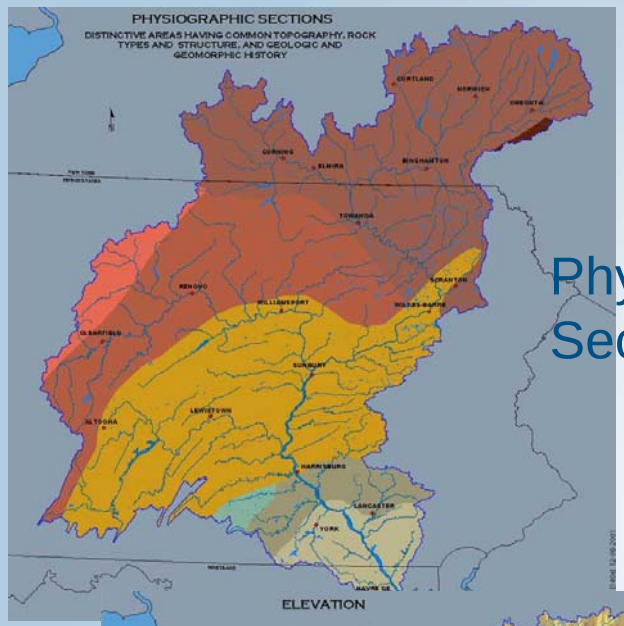


Monthly Flow Statistics

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Baseflow	0	0	0	0	0	0	2	2	3	2	1	3
Average Runoff	0	0	0	0	0	0	0	0	1	1	1	0
Average Total Flow	0	0	0	0	0	0	0	0	2	0	1	1
Minimum Total Flow	0	0	0	0	0	1	3	4	5	6	1	4

Conclusions

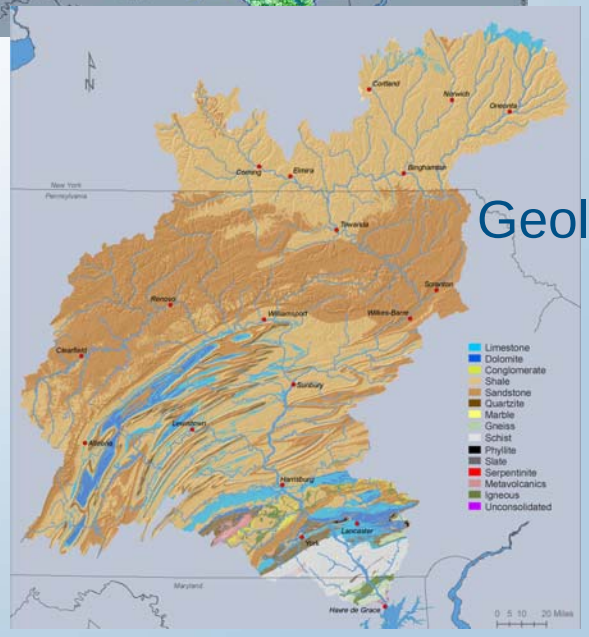
- 3 groupings of watersheds identified
- In general, SRB seems to have become wetter, especially in summer and fall seasons
- Shift was abrupt; no indication it is continuing
- More questions than answers



Physiographic Section

Land Cover

Elevation



Geology

Future Work and Implications

- What caused the change of streamflows?
- What does it mean to water resources management?

Management Implications of Climate Change

- Invalidates assumptions underlying core programs
  - Consumptive use mitigation
  - Flood and drought planning
  - TMDL development
  - Trends in nutrient and sediment loading from runoff
  - Aquatic habitat (instream flow) protection
  - Water availability studies
  - Regulatory policies

Regulatory Policy Considerations

- Use of streamflow characteristics for permitting decisions
- Application of groundwater and surface water withdrawal guidance
  - Aquifer recharge rates
  - Passby flows
- Development of ecosystem flow thresholds
- Compliance and enforcement

Questions and Discussion