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Evaluating the Role of Precipitation Pattern on the Temporal Changes in Streamflow and Baseflow

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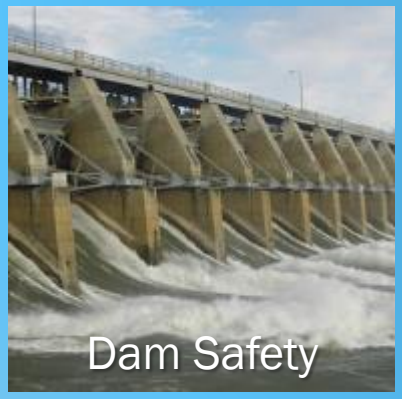

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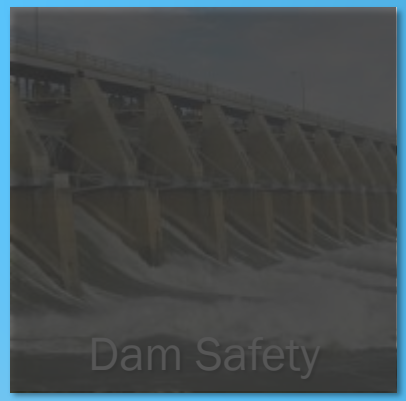

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Changes in Precipitation Pattern

- Evaluating the presence of precipitation pattern changes
  - Period
  - Quantity
  - Type
  - Intensity
- Precipitation pattern changes can impact:
  - Infiltration (runoff, groundwater, and baseflow)
  - Recharge (groundwater, baseflow)
  - Surface runoff (streamflow)

Objective

- Are there any long term temporal trends
  - Total streamflow
  - Baseflow
  - Runoff
- Do the changes in precipitation pattern contribute to these trends?

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Background

- Nebraska legally recognized hydrological connection
- The statute tasks:
  - DNR administer surface water
  - Natural Resources Districts administer groundwater
  - Integrated management to protect water users
- The DNR evaluates:
  - Streamflow trends
  - Trends in components impacting streamflow

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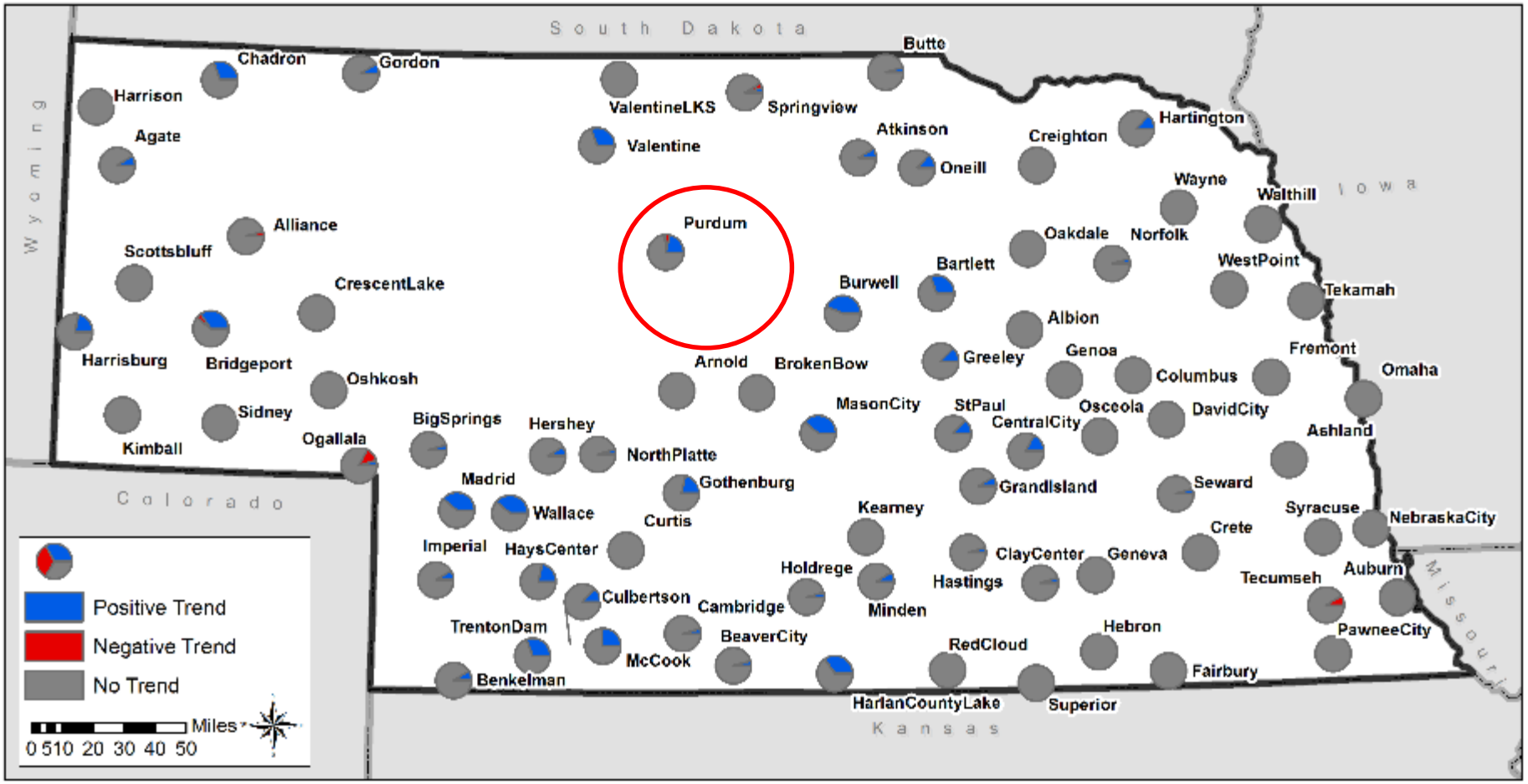
Nebraska Precipitation Trend Distribution



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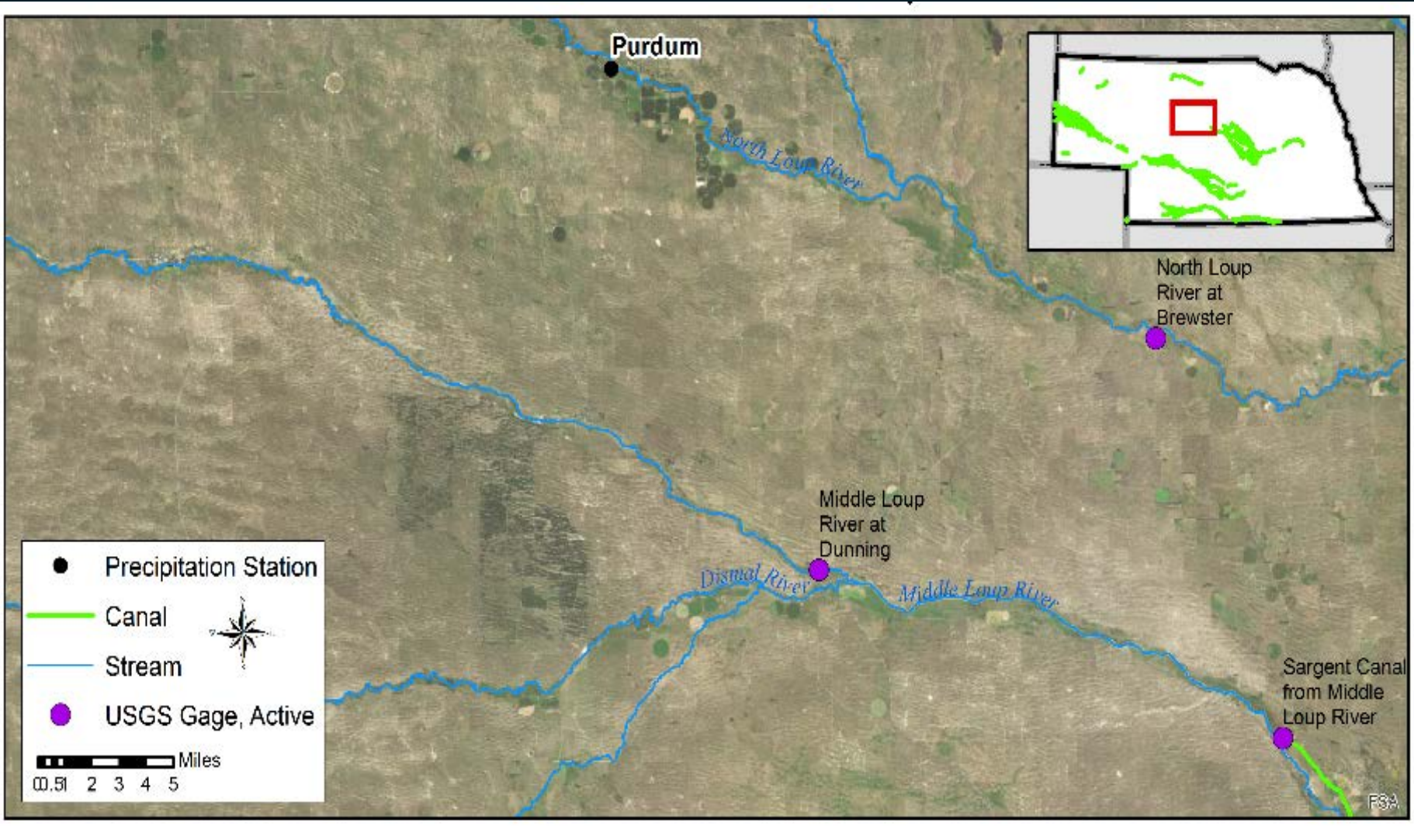

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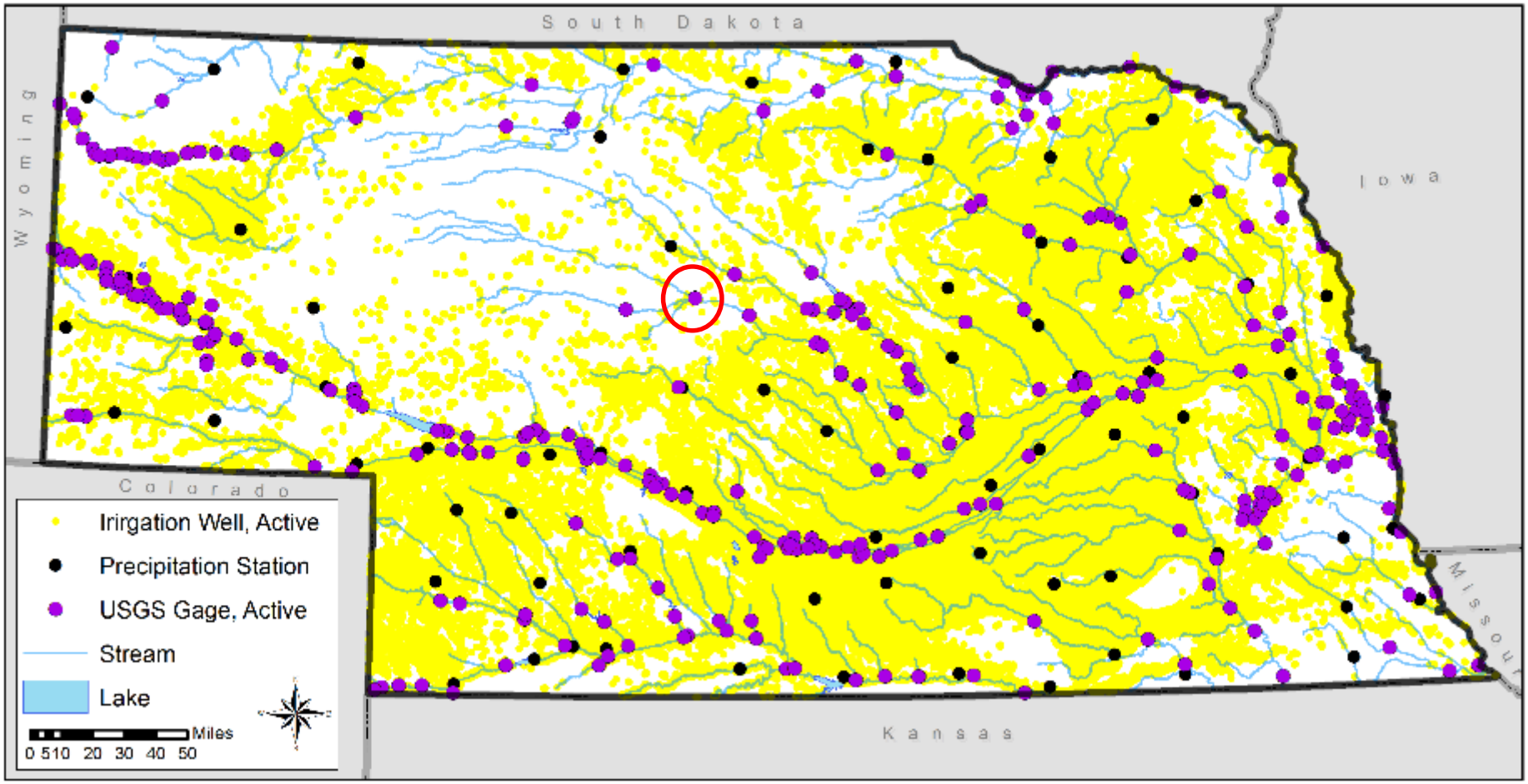
Nebraska Active Irrigation Wells



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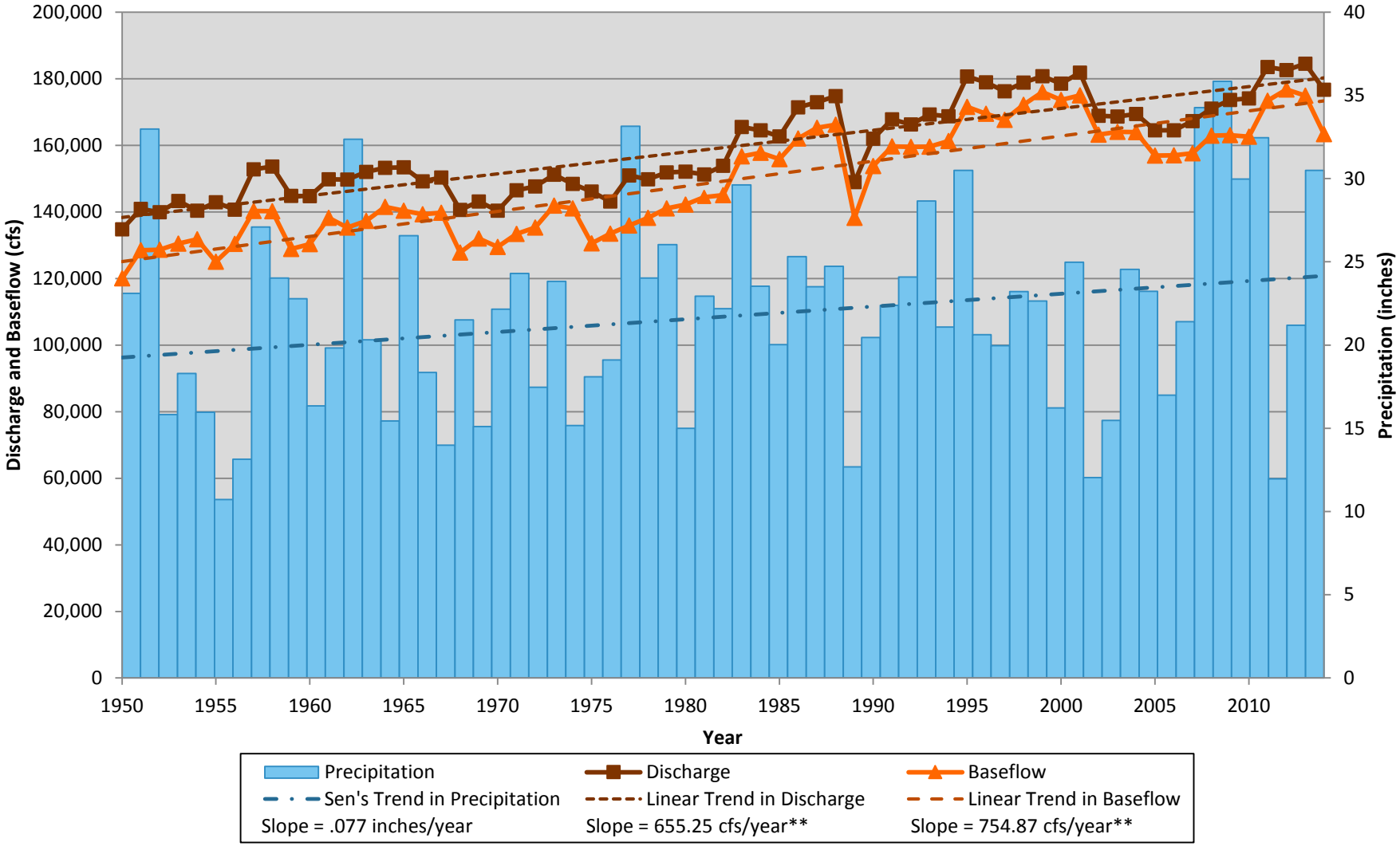
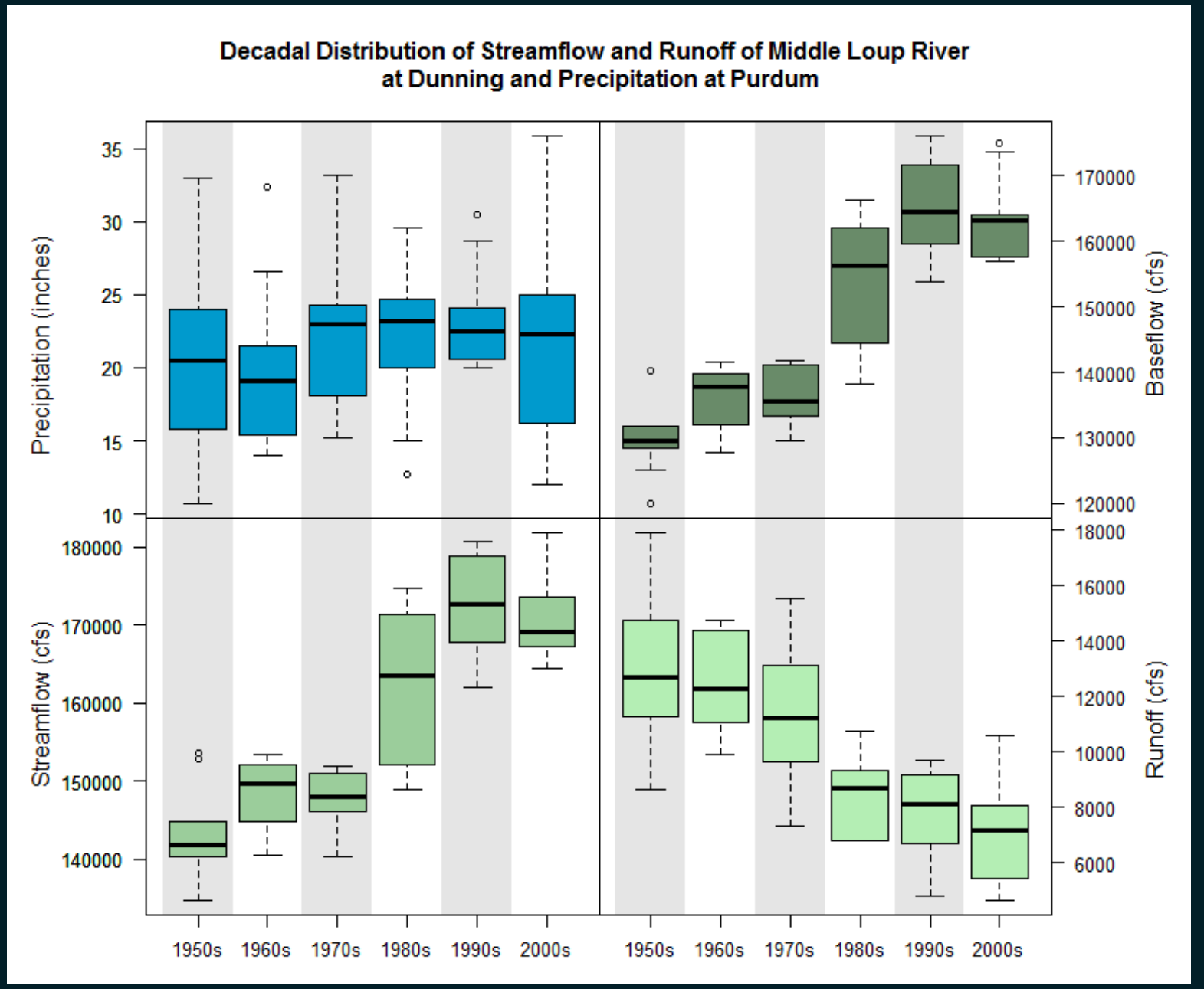
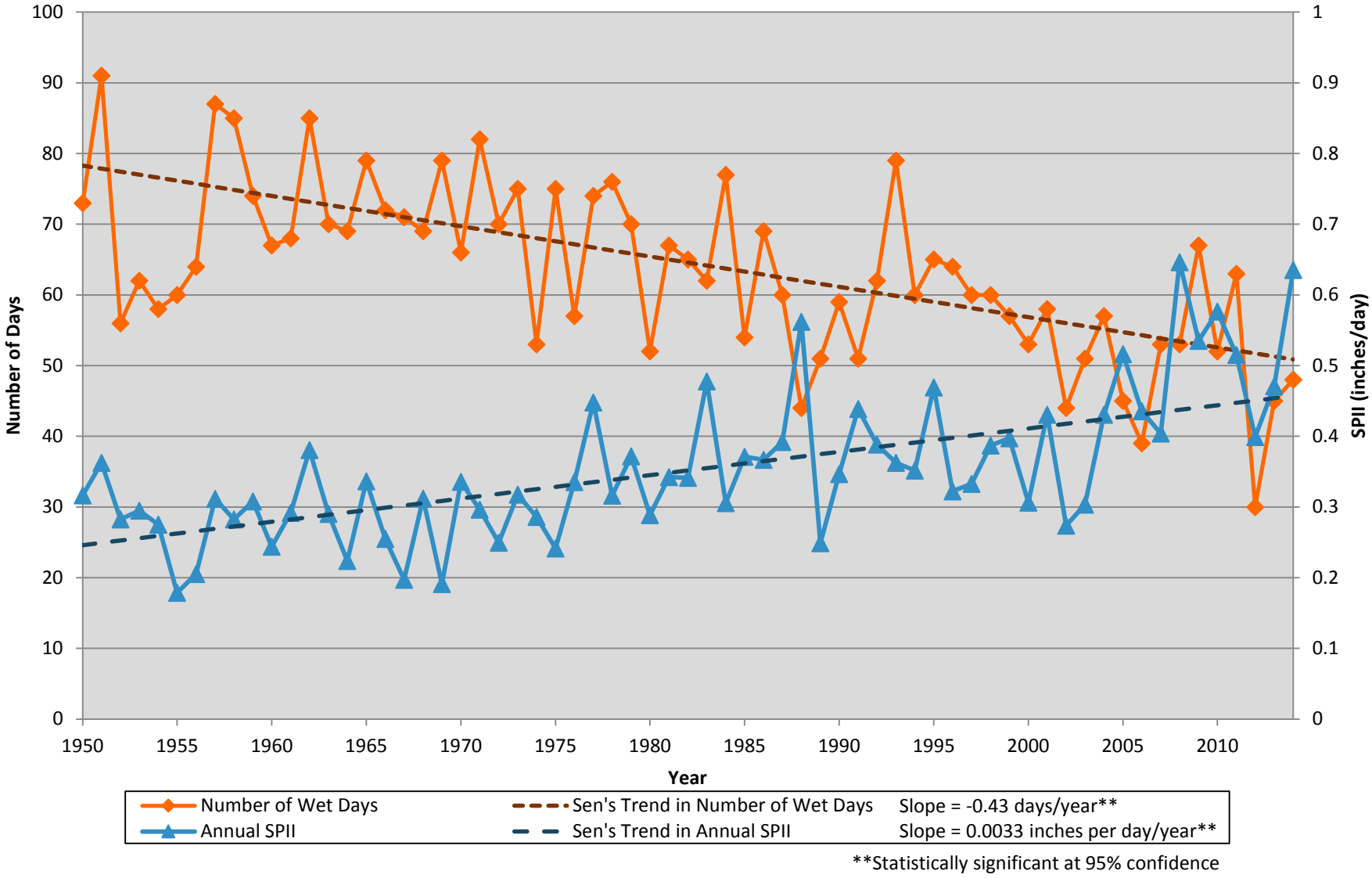
Annual Total Discharge and Baseflow of the Middle Loup River at Dunning and Precipitation at Purdum, Nebraska



**Statistically significant at 95% confidence

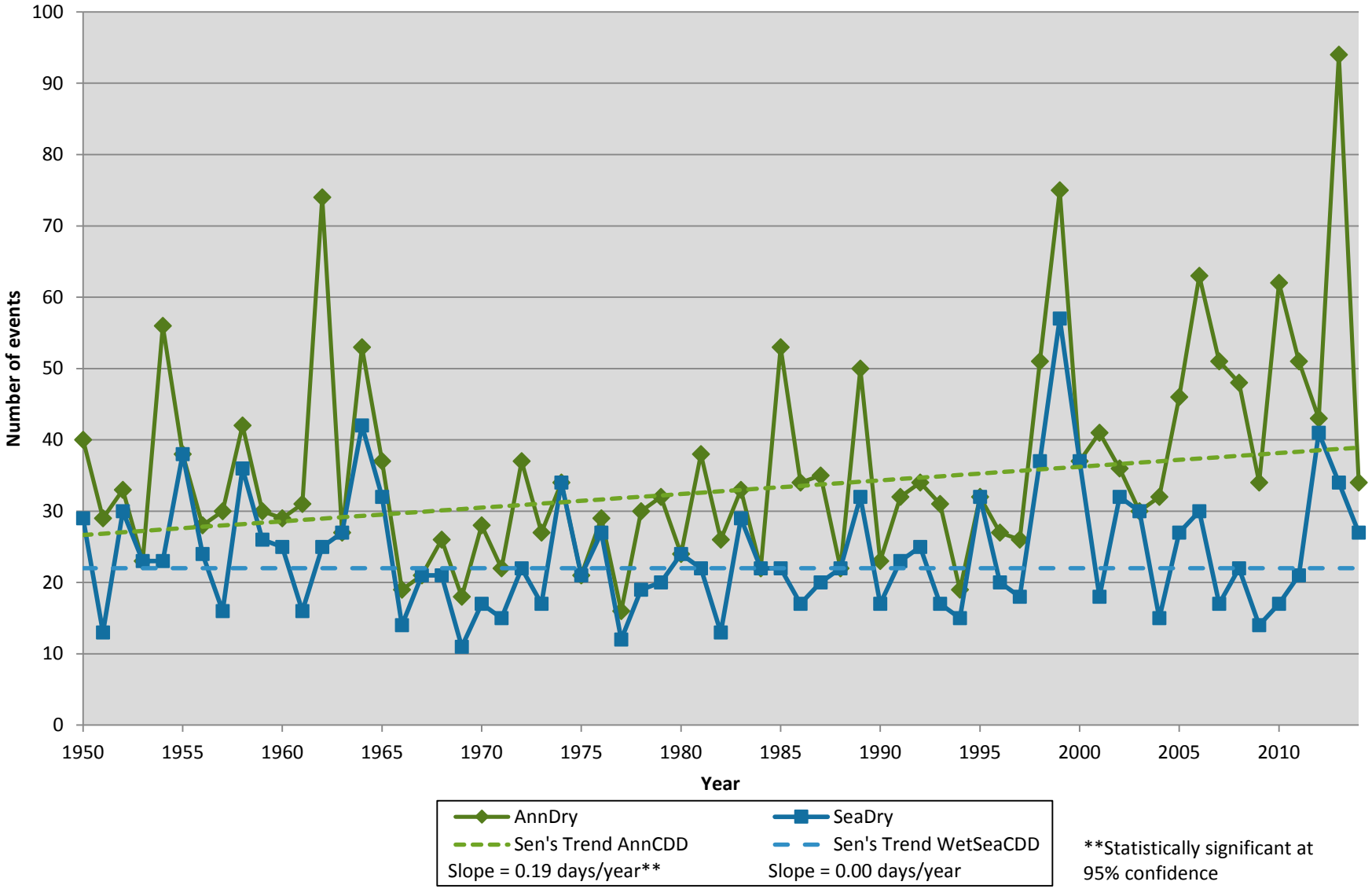

Decadal Distribution of Streamflow and Runoff of Middle Loup River
at Dunning and Precipitation at Purdum
Precipitation (inches)
Baseflow (cfs)
Streamflow (cfs)
Runoff (cfs)
1950s
1960s
1970s
1980s
1990s
2000s

Annual Number of Days with Precipitation and the Simplified Precipitation Index (Annual Total Precipitation/Number of Precipitation Days)

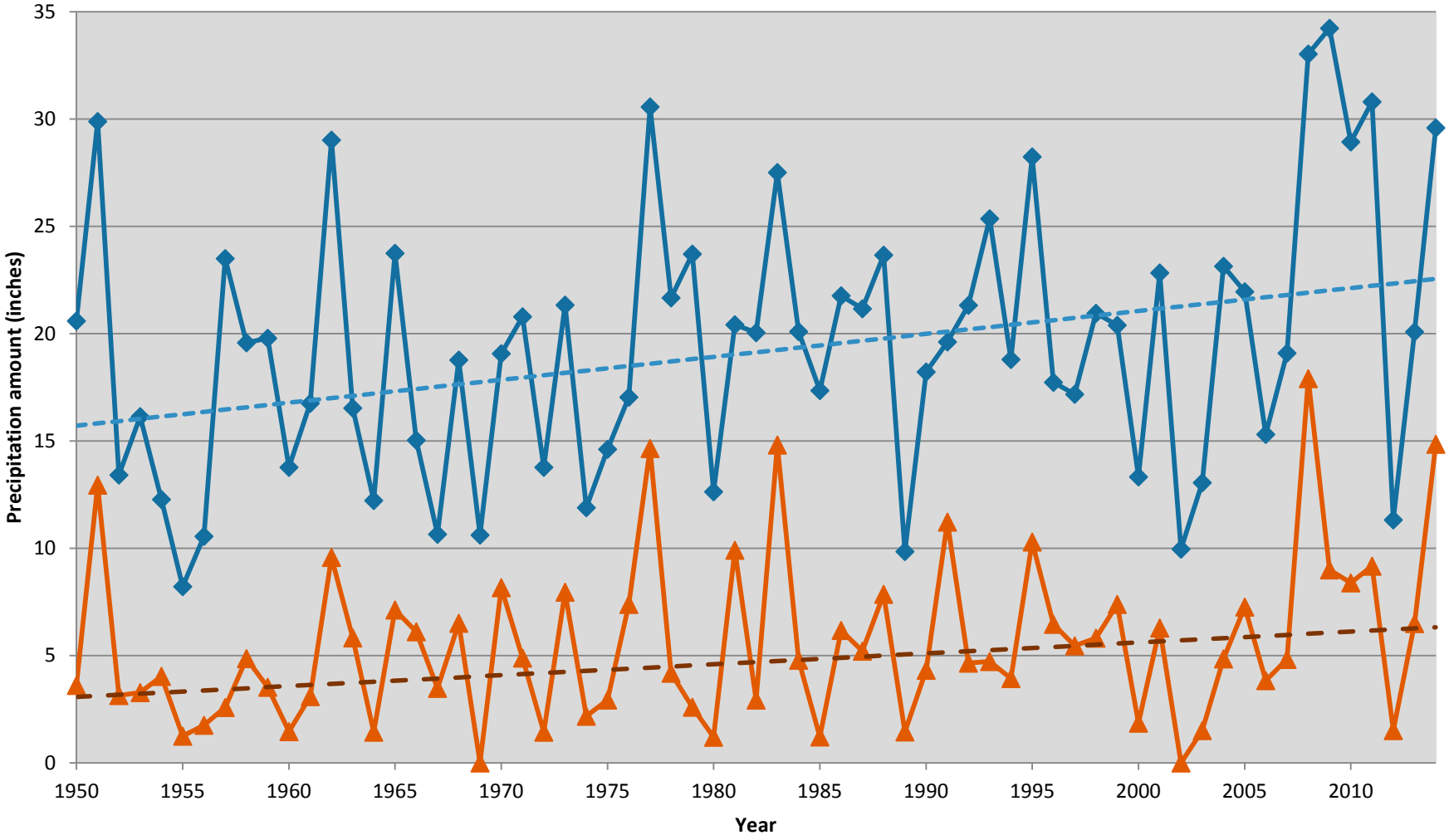


**Statistically significant at 95% confidence

Annual and Wet Season Maximum Lengths of Consecutive Days without Precipitation



Annual Total Precipitation Amounts from Events in the Greatest 50th and 95th Percentiles



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Summary

- Slight increasing trend in annual precipitation
- Declining precipitation events per year
  - Precipitation decrease in the dry season
- Increasing total streamflow and baseflow
- Decreasing trend in runoff

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Conclusions

- Possible explanations for increased streamflow and baseflow
  - Increasing intensity of rainfall may result in greater recharge rates
  - Greater recharge rates can elevate groundwater table and baseflow
  - Increased baseflow can surge total streamflow

- Possible explanations to decreased runoff
  - Decreased events in the dry season (dry soils) reduces runoff
  - Rainfall interception by a manmade forest (Halsey National Forest)
  - Changes to snowfall and snowmelt timing
  - Distance between weather station and gage

Acknowledgments

- Kari Burgert
- Rick Vollertsen
- Elise Jared

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THANK YOU

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Correlation Coefficients	Stream flow	Base flow	Runoff	Total Prcp	Total Prcp ≥ 0.2 in/day	Total Prcp ≥ 1.2 in/day	Annual Max Wet Spell	Annual Max Dry Spell	Wet Season Max Wet Spell	Wet Season Max Dry Spell
Streamflow	1	0.99	-0.60	0.29	0.35	0.26	0.04	0.34	0.02	0.19
Baseflow	0.99	1	-0.72	0.23	0.30	0.22	0.00	0.33	-0.03	0.20
Runoff	-0.60	-0.72	1	0.11	0.07	0.04	0.22	-0.17	0.23	-0.15
Total Prcp	0.29	0.23	0.11	1	0.99	0.79	0.28	0.08	0.27	-0.34
Total Prcp ≥ 0.2 in	0.35	0.30	0.07	0.99	1	0.80	0.27	0.12	0.26	-0.31
Total Prcp ≥ 1.2 in	0.26	0.22	0.04	0.79	0.80	1	0.10	0.09	0.10	-0.16
Annual Max Wet Spell	0.04	0.00	0.22	0.28	0.27	0.10	1	0.10	0.98	-0.08
Annual Max Dry Spell	0.34	0.33	-0.17	0.08	0.12	0.09	0.10	1	0.10	0.52
Wet Season Max Wet Spell	0.02	-0.03	0.23	0.27	0.26	0.10	0.98	0.10	1	-0.06
Wet Season Max Dry Spell	0.19	0.20	-0.15	-0.34	-0.31	-0.16	-0.08	0.52	-0.06	1

Baseflow Extraction

- Sens test
  - A non-parametric test
  - Similar to Mann-Kendal test or Kendal Tau
  - Appropriate when the data contains cycles or seasonality
  - It models how the “median” changes with time rather than the “mean”
  - Much less sensitive to outliers
- Baseflow extraction – USGS and USBR program
  - Calculate 5-day minimas
  - Find turning points in these 5-day minimas
  - Connect the turning points to obtain the baseflow hydrograph
  - The graph is contained to equal the observed data
  - Baseflow Index is the baseflow percent of the total streamflow