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Hydrologic Base Period and Critical Period Analysis: 1978-2025 Reference Period Update

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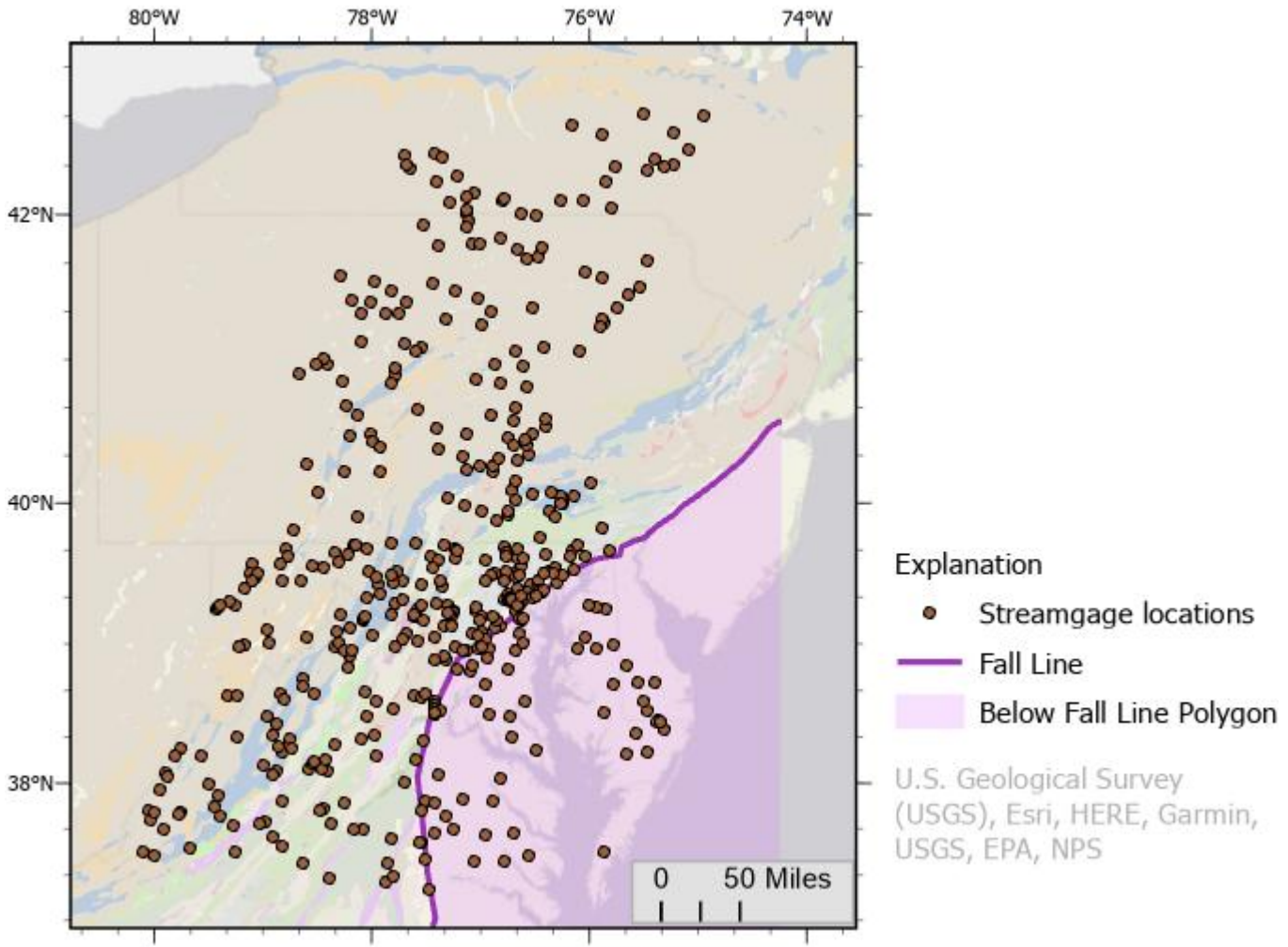
Reference period and scope

•Reference period locked at 1978-2025 (48 years), used consistently across MAPD, K-S, and critical period candidate selection

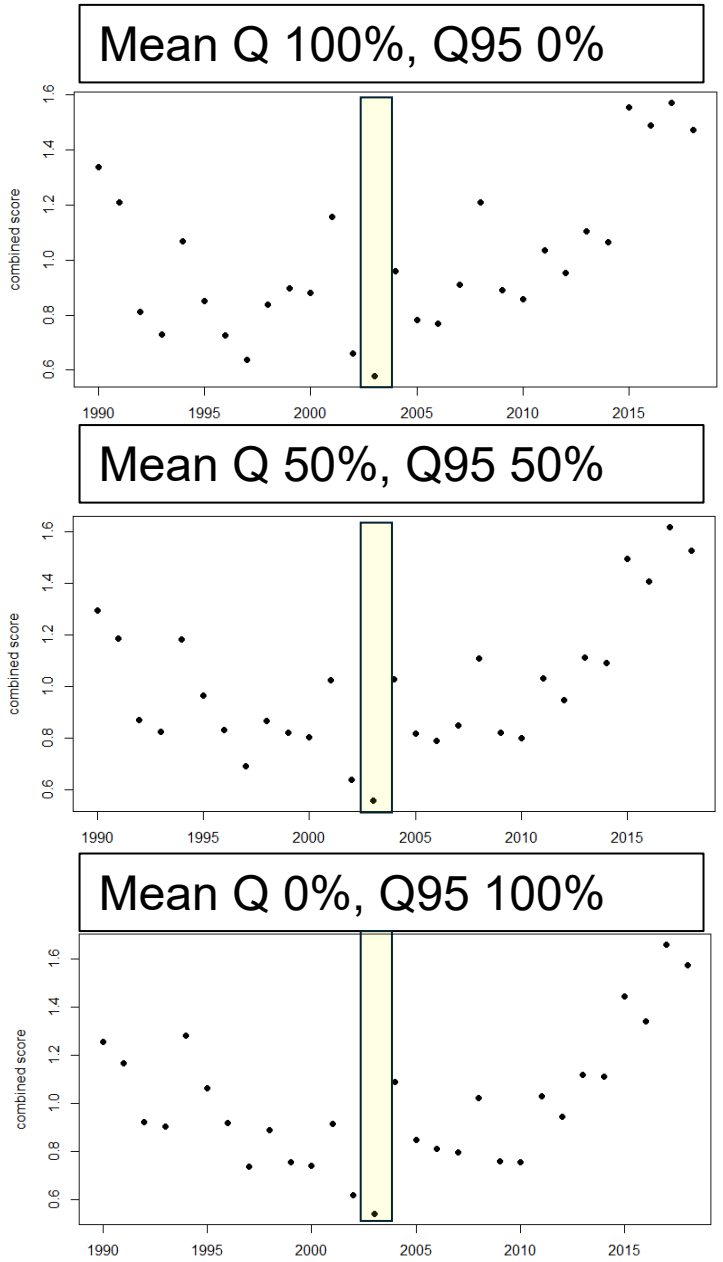
•Critical period calculation now uses full water year (all 12 months) instead of Oct-June only

•Tributary (non-RIM) stations filtered to below fall line only, using a hand-drawn polygon based on the published fall line boundary



Base period selection

- Ran three weighting scenarios varying the balance between mean flow and high flow (Q95): 100-0, 50-50, 0-100
- All three scenarios agreed on the same top-ranked base period: 1998-2007
- Result is robust to weighting choice, not an artifact of any single scoring assumption



Are recent decades a new regime?

Ran multiple trend tests: Mann-Kendall, Sen's slope, Pettitt change-point test, at both composite and individual-station level, on mean flow and high flow

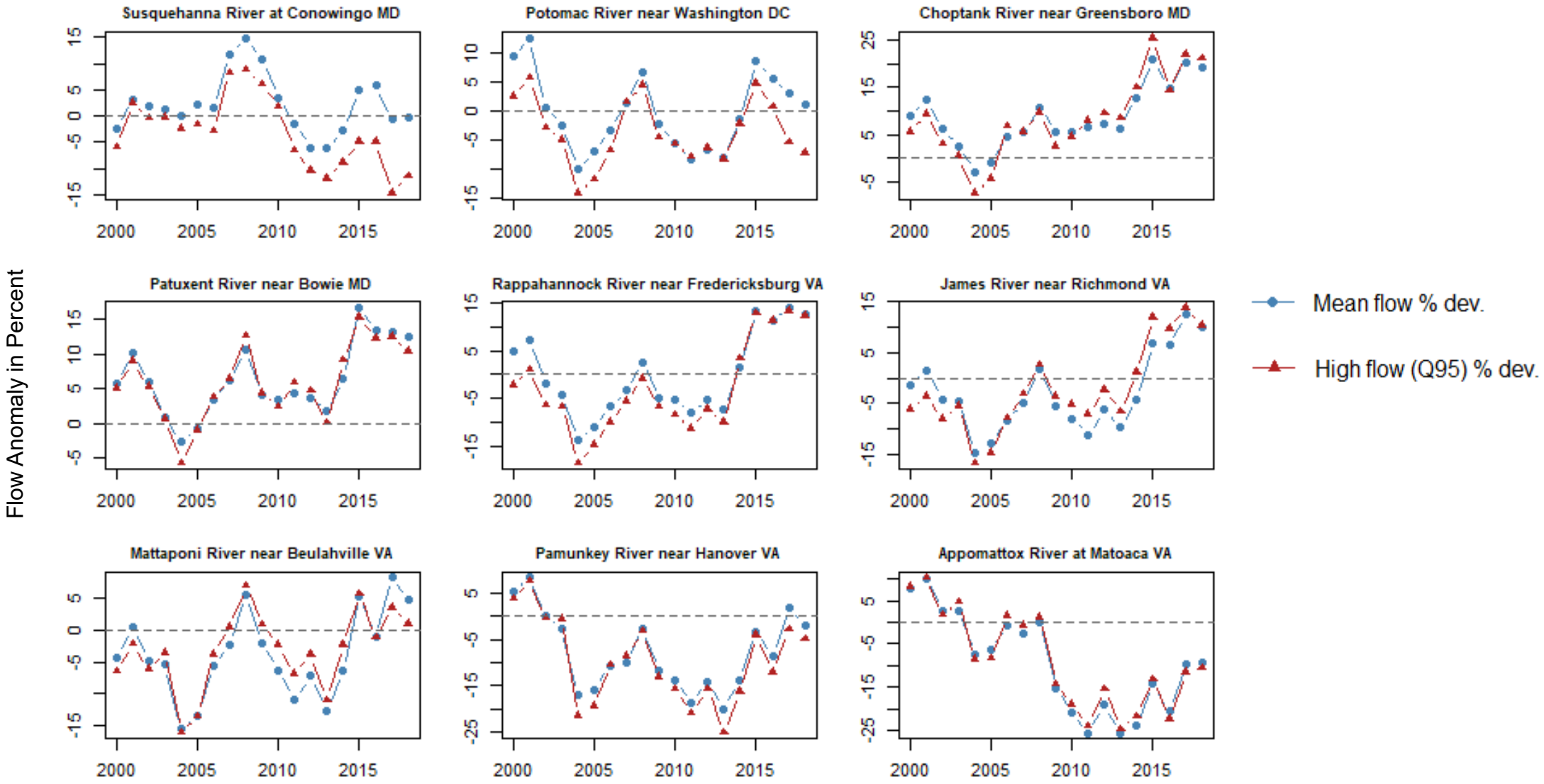
•No statistically significant trend or step change detected, at any station, under any test

•No evidence of a new hydrologic regime; recent variability reflects a complex, station-specific response rather than a uniform basin-wide shift

Trend test results

Station	Mean_Slope	Mean_p	Q95_Slope	Q95_p	Mean_Signif?	Q95_Signif?
Susquehanna River at Conowingo MD	37.91	0.783	-300.2	0.434	no	no
Potomac River near Washington DC	-50.24	0.333	-264.7	0.135	no	no
Choptank River near Greensboro MD	0.8	0.315	2.04	0.45	no	no
Patuxent River near Bowie MD	0.44	0.797	0.56	0.922	no	no
Rappahannock River near Fredericksburg VA	-2.92	0.638	-6.44	0.783	no	no
James River near Richmond VA	-13.82	0.625	-14.49	0.894	no	no
Mattaponi River near Beulahville VA	-2.09	0.419	-5.96	0.424	no	no
Pamunkey River near Hanover VA	-7.09	0.129	-24.01	0.138	no	no
Appomattox River at Matoaca VA	-9.81	0.066	-36.49	0.129	no	no

Ten-Year Window Flow Anomalies by Station: Mean and High Flow Relative to the Reference Period



Critical period result

•Within the 1998-2007 base period, one 3-year window meets the target return period criteria: 2004-2006 (return period approximately 12 years, within the target 10 plus or minus 2 window)

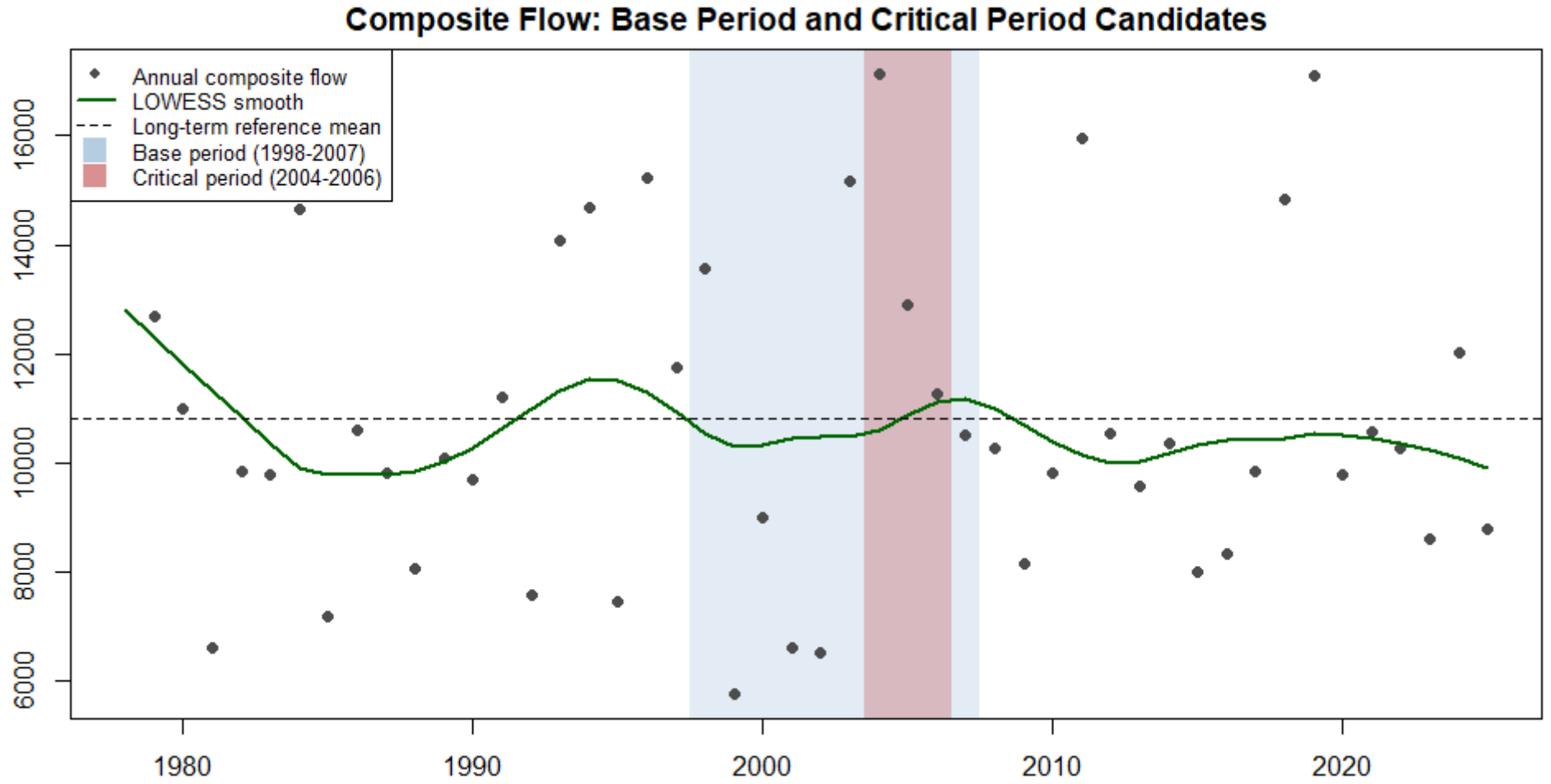
•This result is not a boundary artifact; it is well separated from the next-closest candidate windows

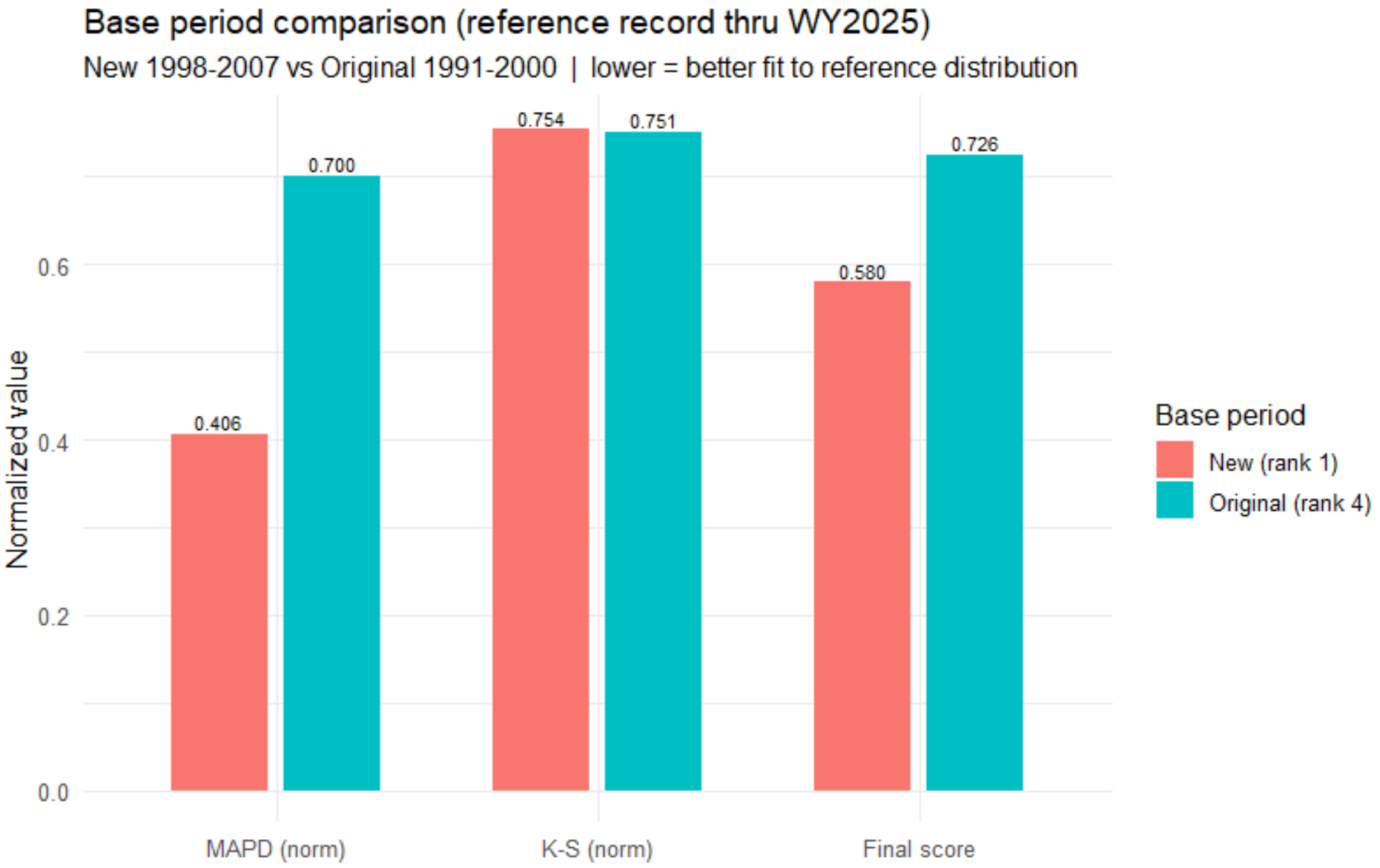
•Caveat: empirical Weibull return period estimation is sensitive to record length, particularly in the tails, where small differences in flow can produce large differences in estimated return period

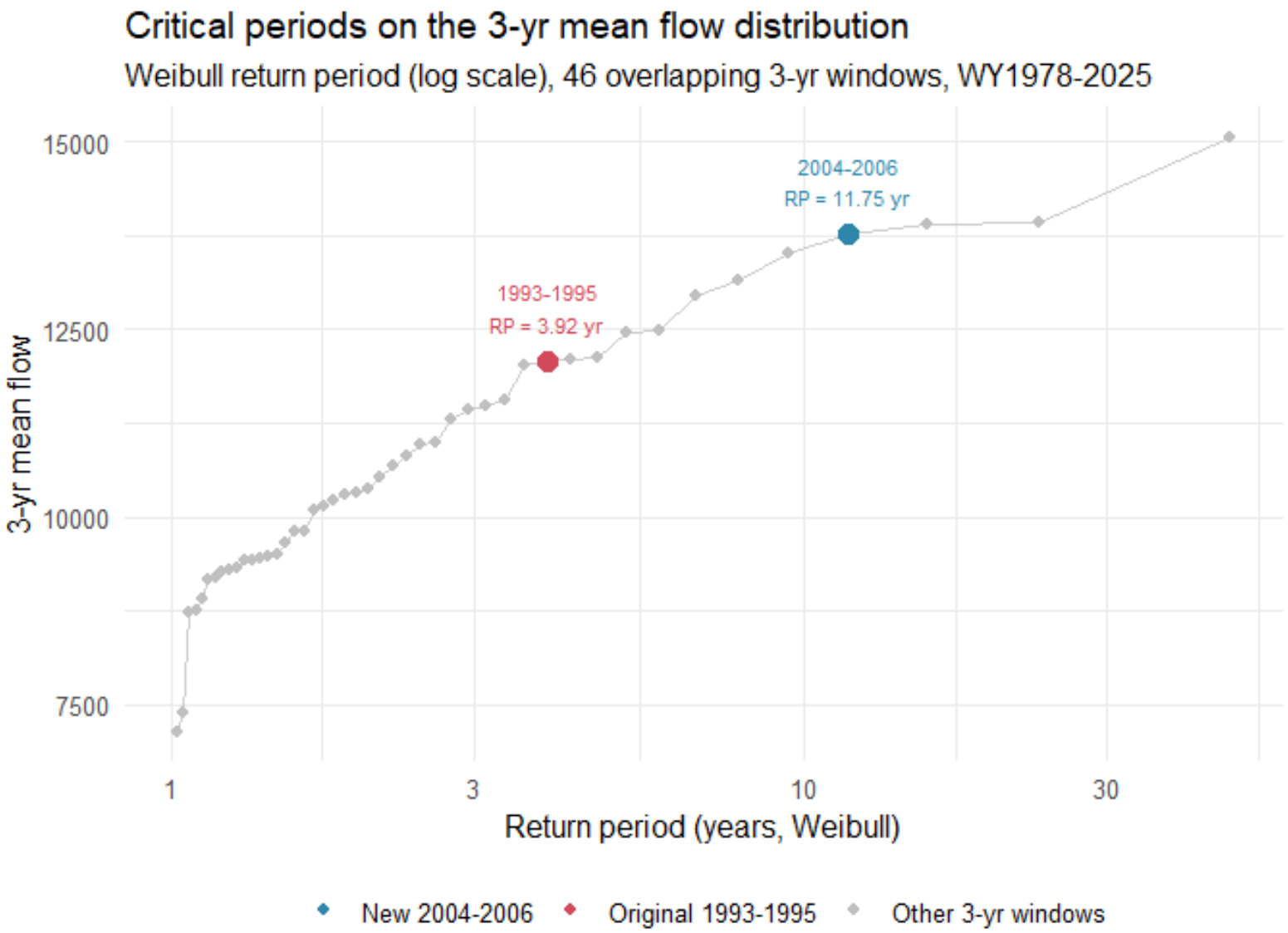
Critical period candidate table

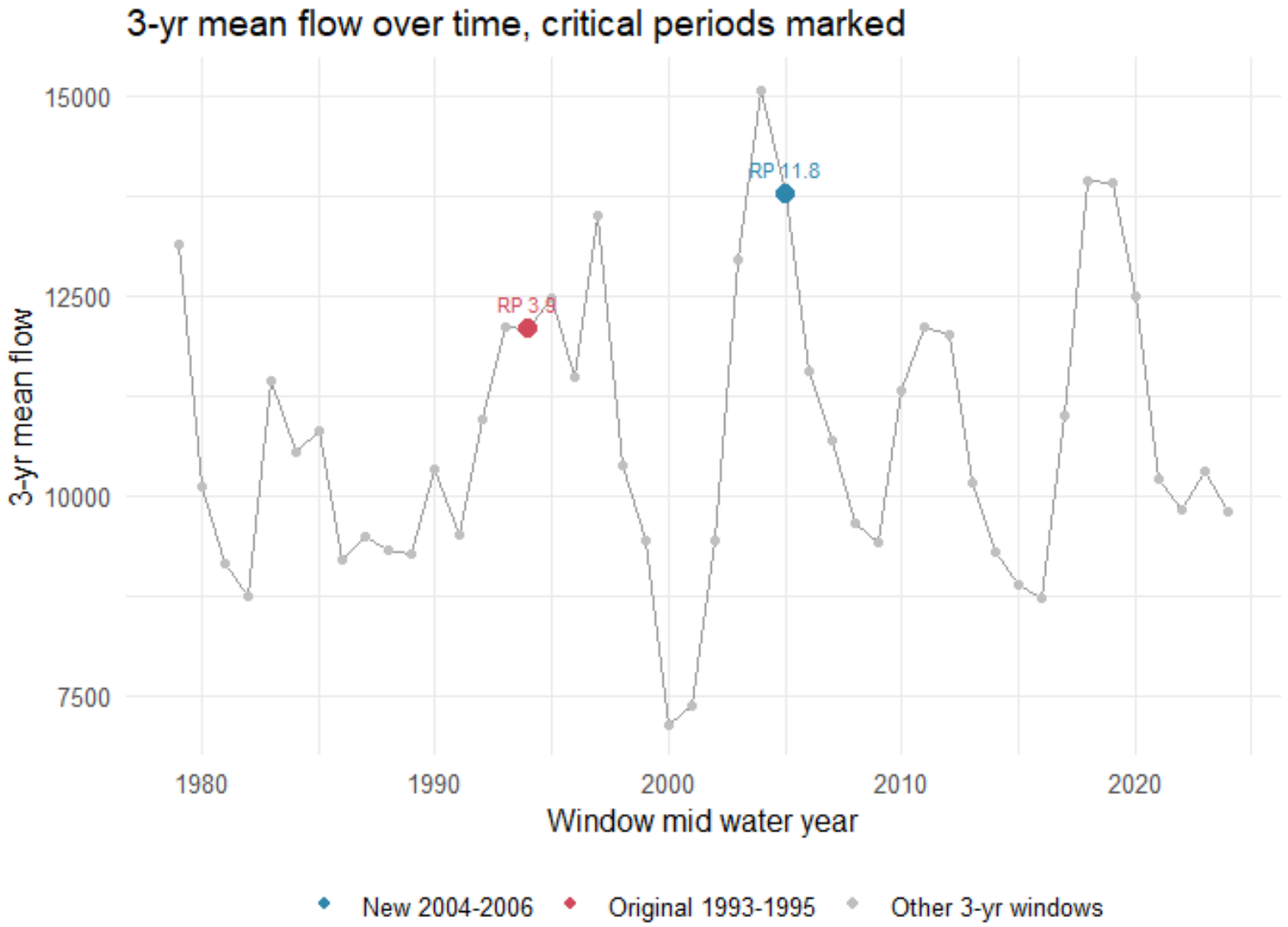
start	end	mid	window	mean_3yr_flow	near_target	return_p_weibull
1998	2000	1999	1998-2000	9446.2	FALSE	1.38
1999	2001	2000	1999-2001	7131.8	FALSE	1.02
2000	2002	2001	2000-2002	7382.6	FALSE	1.04
2001	2003	2002	2001-2003	9435.3	FALSE	1.34
2002	2004	2003	2002-2004	12940.7	FALSE	6.71
2003	2005	2004	2003-2005	15062.5	FALSE	47.00
2004	2006	2005	2004-2006	13767.3	TRUE	11.75
2005	2007	2006	2005-2007	11562.4	FALSE	3.36

Preliminary Results: 1998-2007 Base Period, 2004-2006 Critical Period




Base period comparison (reference record thru WY2025)
New 1998-2007 vs Original 1991-2000 | lower = better fit to reference distribution
Normalized value
0.0
0.2
0.4
0.6
0.406
0.700
0.754
0.751
0.580
0.726
MAPD (norm)
K-S (norm)
Final score
Base period
New (rank 1)
Original (rank 4)


Critical periods on the 3-yr mean flow distribution
Weibull return period (log scale), 46 overlapping 3-yr windows, WY1978-2025
15000
12500
10000
7500
3-yr mean flow
2004-2006
RP = 11.75 yr
1993-1995
RP = 3.92 yr
1
3
10
30
Return period (years, Weibull)
New 2004-2006
Original 1993-1995
Other 3-yr windows


3-yr mean flow over time, critical periods marked
15000
12500
10000
7500
3-yr mean flow
RP 11.8
RP 3.9
1980
1990
2000
2010
2020
Window mid water year
New 2004-2006
Original 1993-1995
Other 3-yr windows

Previous approach- 2010 TMDL critical period calculations

Table G-14. Summary of results for 1993–1995 and 1996–1998 periods

	All tributaries (1978–2009)		Potomac + Susquehanna (1930–2009)		
	Without multiplier	With multiplier	With multiplier	With multiplier	With multiplier
	No de-trending	No de-trending	No De-trending	De-trended (Linear regression)	De-trended (LOWESS)
Year	1993–1995				
Median (High r^2)	7.53	7.48	7.27	6.34	8.92
Mean (High r^2)	6.84	6.99	7.39	5.97	8.35
Median (All monthly spans)			9.31	6.62	9.07
Mean (All monthly spans)			11.28	8.05	11.26
Overall range 1993–1995	**5.97–11.28**				
Year	1996-1998				
Median (High r^2)	18.95	16.02	17.56	11.3	16.66
Mean (High r^2)	18.82	14.87	15.24	11.78	16.26
Median (All monthly spans)			19.26	14.35	18.26
Mean (All monthly spans)			21.63	15.57	21.05
Overall range 1996–1998	**11.30–21.63**				

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Summary

- Critical/base period selection rebuilt on the observed record (WY 1978–2025) using the weighted RIM aggregate inflow
- Trend analysis over the full observed record showed no significant trend, so flows were used as observed (no detrending applied)
- Deliberately did not extend the record to 1930: extension pulls in the 1930s and 1960s droughts, which introduces nonstationarity requiring detrending. Avoiding extension removes two stacked modeling layers (record-splicing + detrending) and the compounded uncertainty
- Single full-water-year integration replaces Appendix G's ~24 monthly-span combinations- one flow value, one ranking, one return period per window; no mean/median-across-spans smearing, no analyst-chosen month window
- Result: [1993-1995 ≈ RP 3.9; 2004-2006 ≈ RP 11.8
- Trade-off: a shorter series carries slightly more sampling variance in the extreme tail, accepted in exchange for eliminating two sources of model bias