

Status of the Chesapeake Regional Hydrologic Model – 2020 Version (CRHM 2020)

Modeling Workgroup Quarterly Meeting – April 2020

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Presentation Outline

- 1. Overview – CRHM 2020, CRHM 2023**
- 2. Streamflow Monitoring Data**
- 3. Methods and Results – CRHM 2020 Version 1**
- 4. Summary and Next Steps**

1. Overview – Chesapeake Regional Hydrologic Model

- CBP Watershed Modeling Team is developing a fine-scale regional hydrology model at the National Hydrography Dataset Plus (NHDPlus V2) 1:100,000 scale stream network catchments
 - on the direction of the Chesapeake Bay Program (CBP) Partnership
 - with significant inputs from CRHM collaborators
 - guidance from the CBP Modeling Workgroup and the CBP Scientific and Technical Advisory Committee's (STAC) recommendations ^{[1][2]}
- The importance of small-scale processes of landscape and streams
 - supported by findings of monitoring and modeling research
 - provides critical information necessary for supporting
 - water supply management
 - living resource and habitat prediction models
 - targeted implementation of management practices for controlling nutrient and sediment runoff

[1] CBP Modeling in 2025 and Beyond: A Proactive Visioning Workshop - http://www.chesapeake.org/pubs/401_Hood2019.pdf

[2] https://www.chesapeakebay.net/channel_files/16174/review_chesapeake_bay_watershed_modeling_effort_2008.pdf

1. Overview – Chesapeake Regional Hydrologic Model

- Chesapeake Regional Hydrologic Model planning workshop ^[3]
- The workshop brought together CBP Partnership stakeholders, experts, and developers to outline management needs and available resources (data as well as knowledge) for fine-scale hydrology modeling.
 - Management: TMDL/targeting, water supply, and living resources
 - Scale: spatial and temporal scales for land, stream, and river simulations
 - Scenarios: sensitivity to management relevant drivers
- Workshop participants helped in drafting important details for the near (2020), intermediate (2023), long term (beyond 2025) plans.
- Collaborations – CRHM 2020, CRHM 2023
 - Water supply
 - SRBC (John Balay, Can Liu, et al.); VADEQ (Rob Burgholzer and team); ICPRB (Cheri Schultz, Sarah Ahmed, et al.)
 - USGS living resources (Jen Rapp, Jeff Chanut, Kelly Maloney, et al.)
 - CBPO Watershed Modeling and Land/GIS Data teams

Elements of CRHM 2020 Version

- CBP Phase 6 (county scale) land simulation for finer NHDplus V2 1:100,000 scale stream hydrology
- Refinements throughout 2020 – *2 to 3 Versions*
 - Version 1 updates (today)
- Better understanding of data needs and operational details

Scale – Phase 6 vs. CRHM 2020

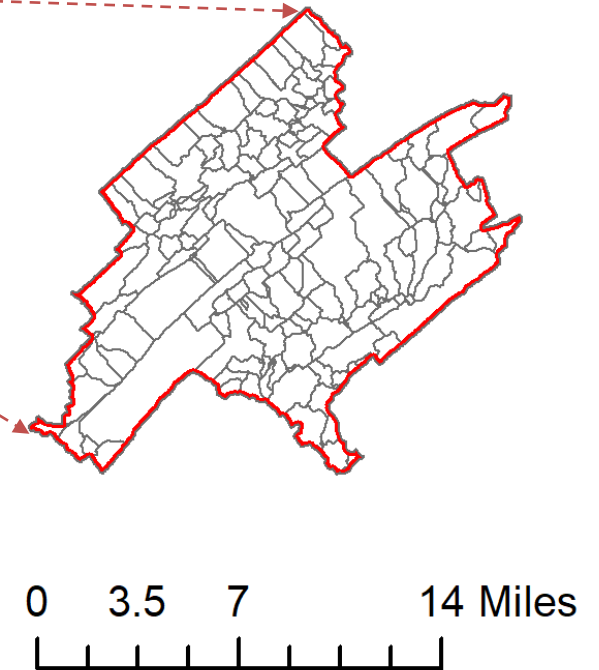
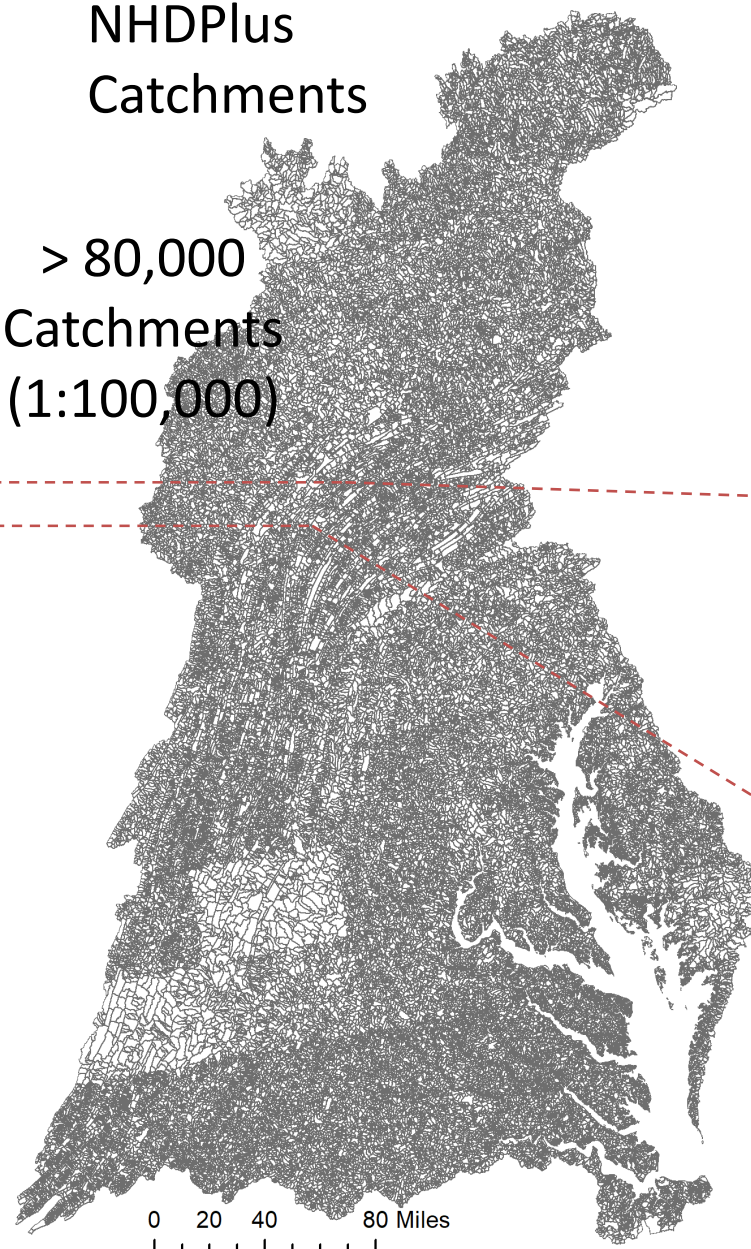
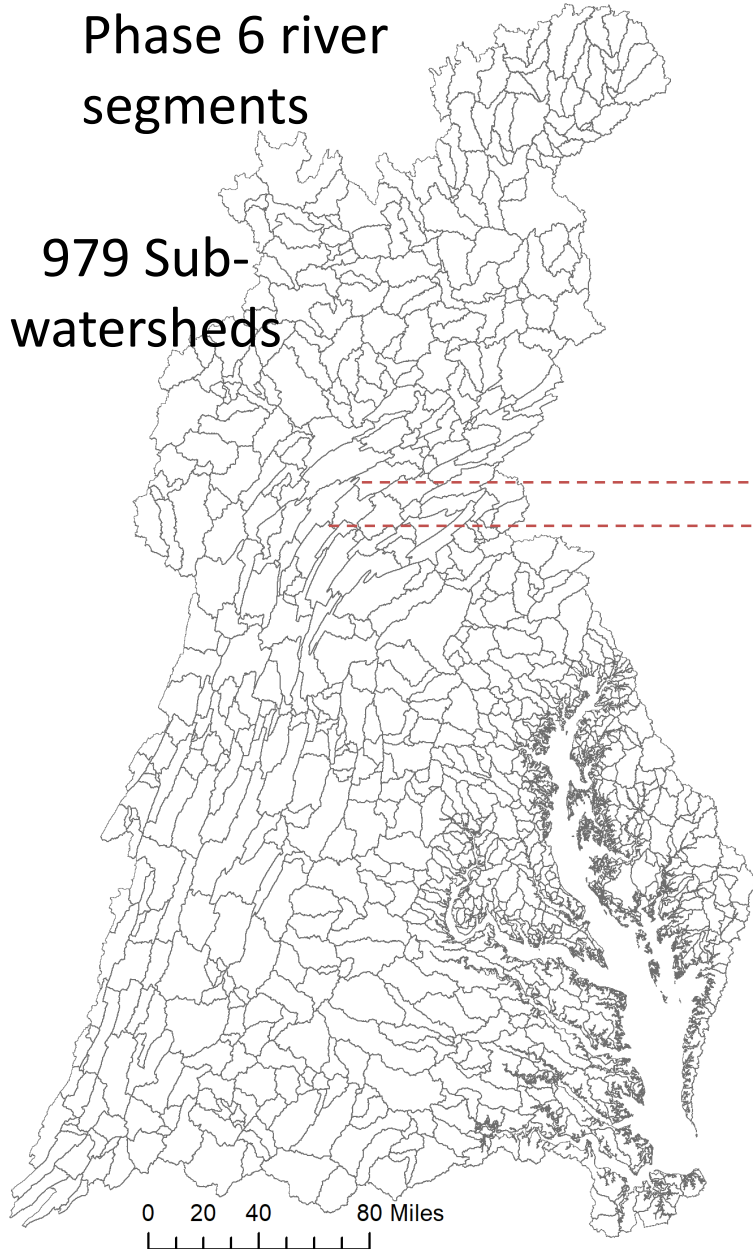
Phase 6 river
segments

NHDPlus
Catchments

- Simulation at NHD catchments would be considerably finer scale than that of Phase 6 (approx. 80x)
- Ability to represent watershed characteristics at finer scale

979 Sub-
watersheds

> 80,000
Catchments
(1:100,000)



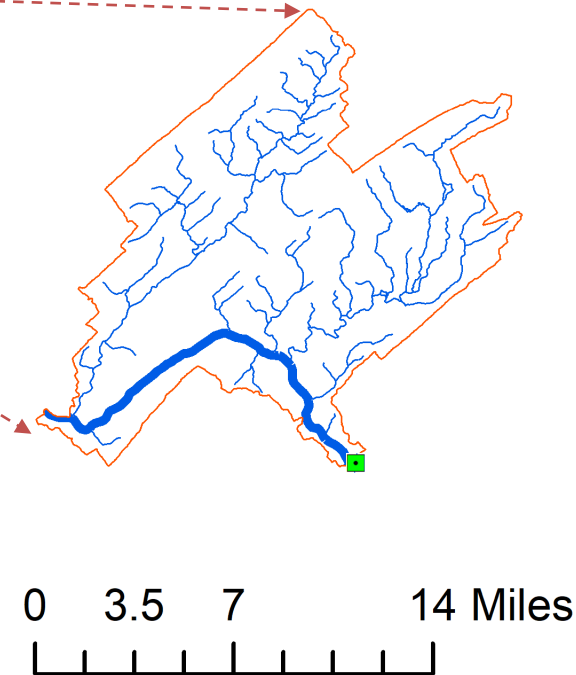
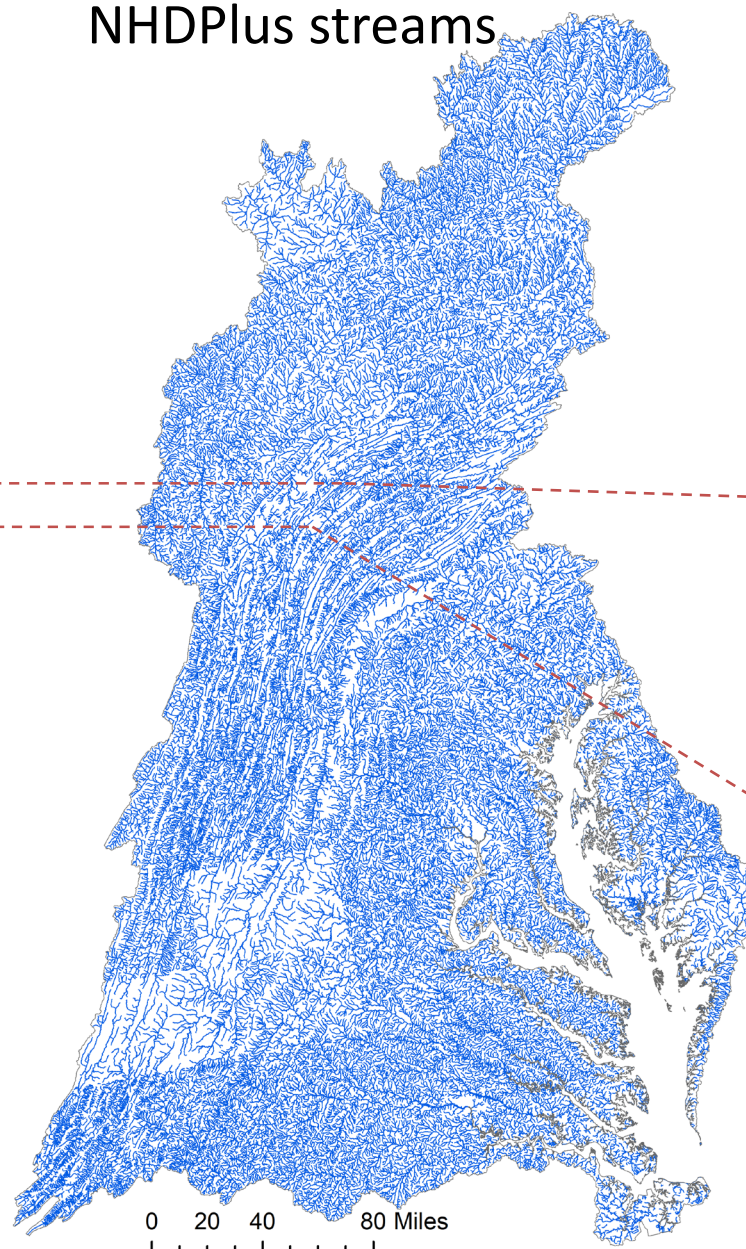
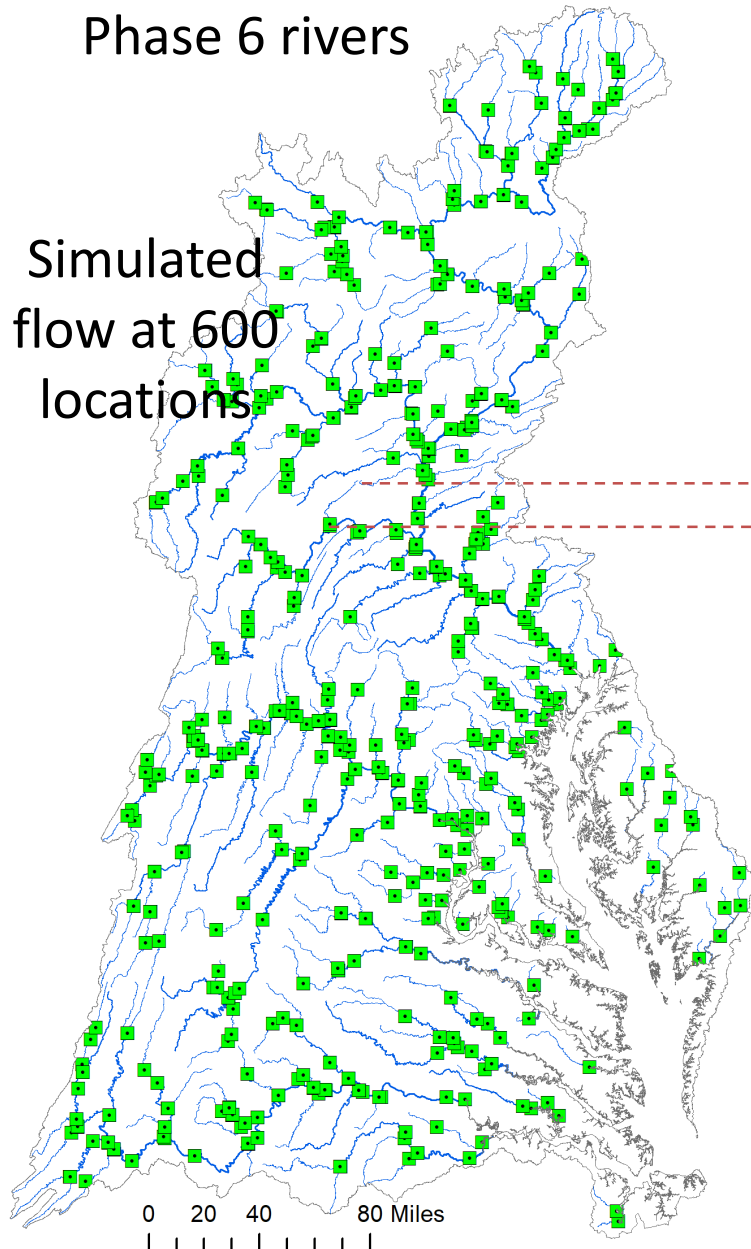
Scale – Phase 6 vs. CRHM 2020

Phase 6 rivers

NHDPlus streams

Simulated
flow at 600
locations

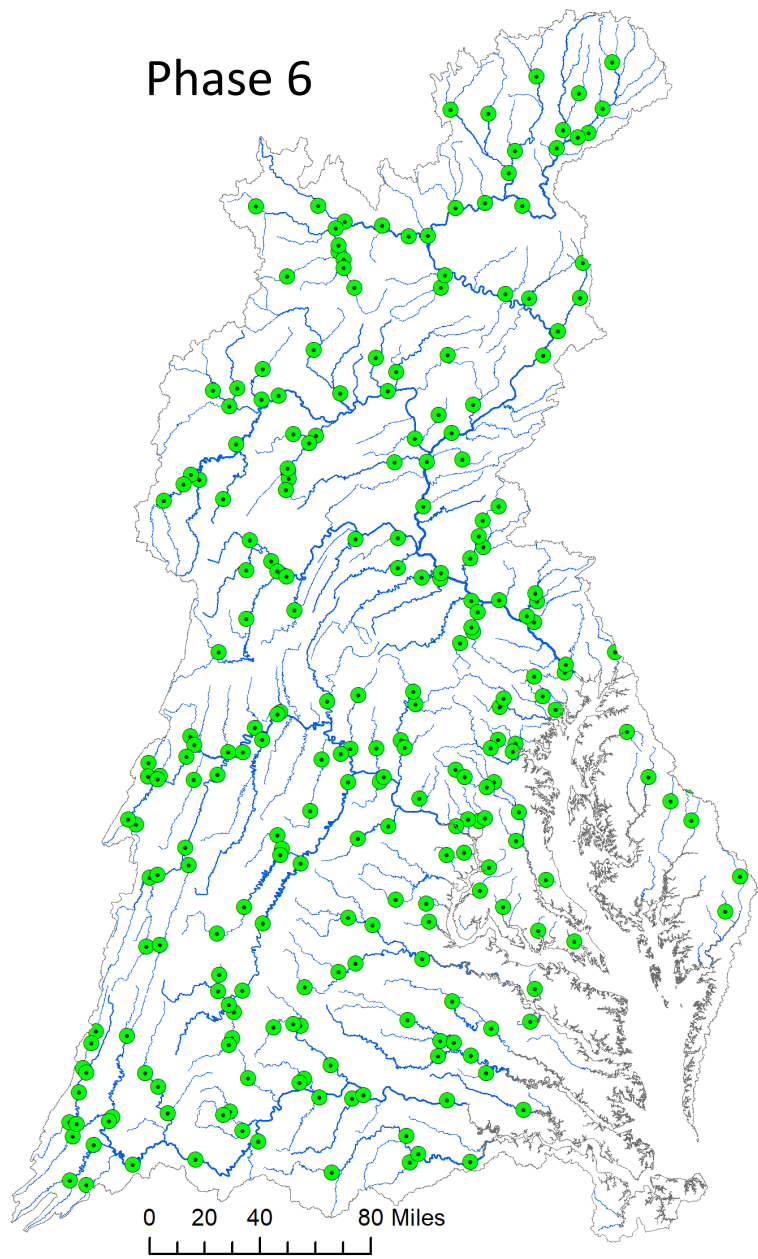
- Model outputs of riverine fluxes (streamflow timeseries) at finer scales



2. Streamflow Monitoring Data – Model Calibration and Evaluation

Cuiyin Wu, CRC | CBPO

Phase 6



NHDPlus

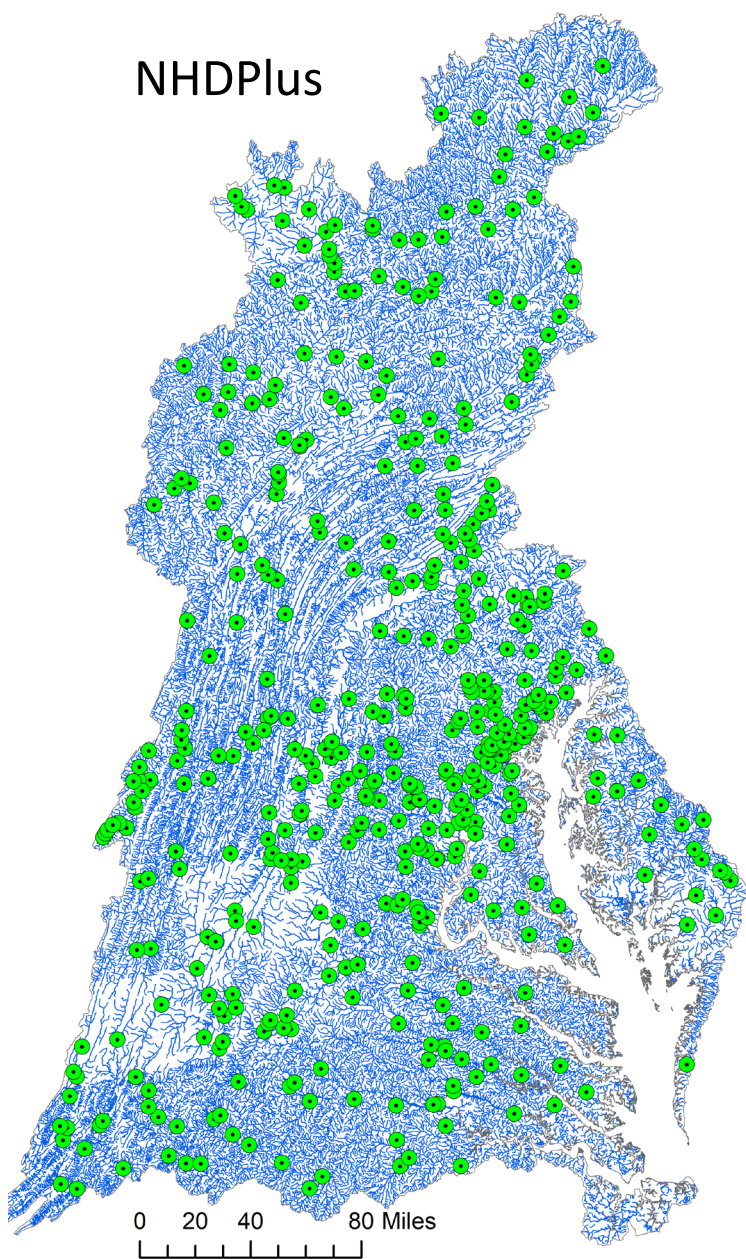
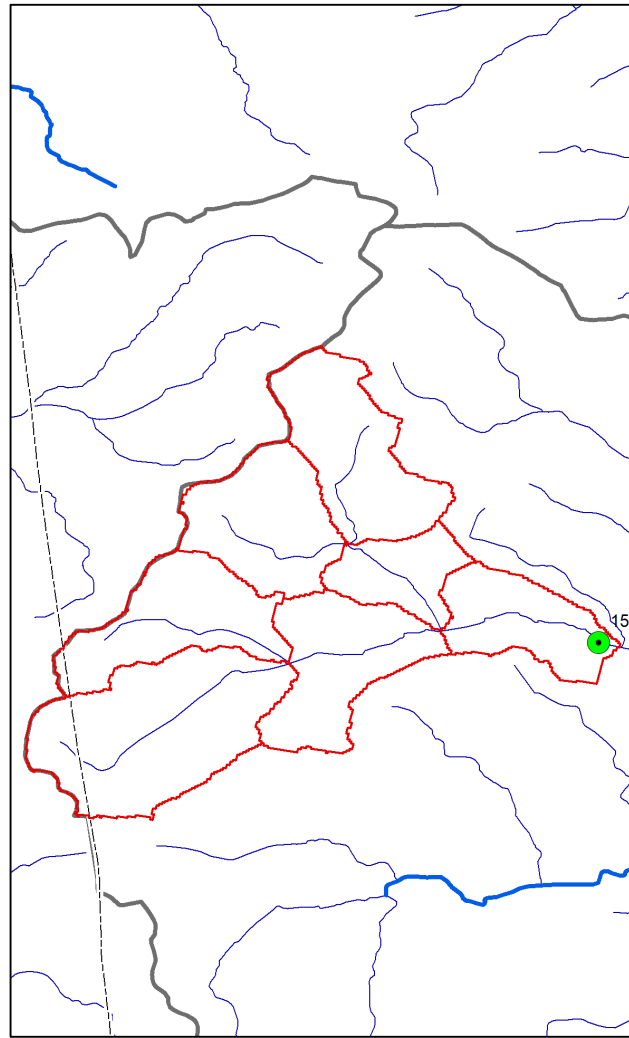


Table: Feasible flow calibration stations

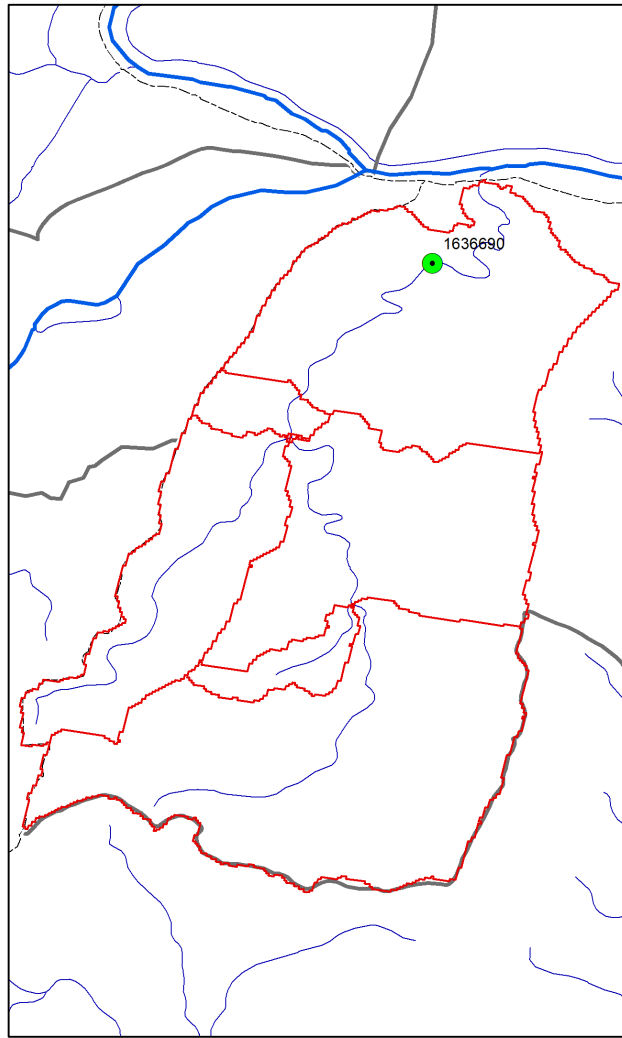
Major Basins	Phase 6	NHD
Eastern Shore	7	23
James	40	52
Patuxent	7	14
Potomac	68	141
Rappahannock	8	12
Susquehanna	101	159
Western Shore	7	49
York River	8	17
Total	247	467

Stations with flow data during 1985 to 2019

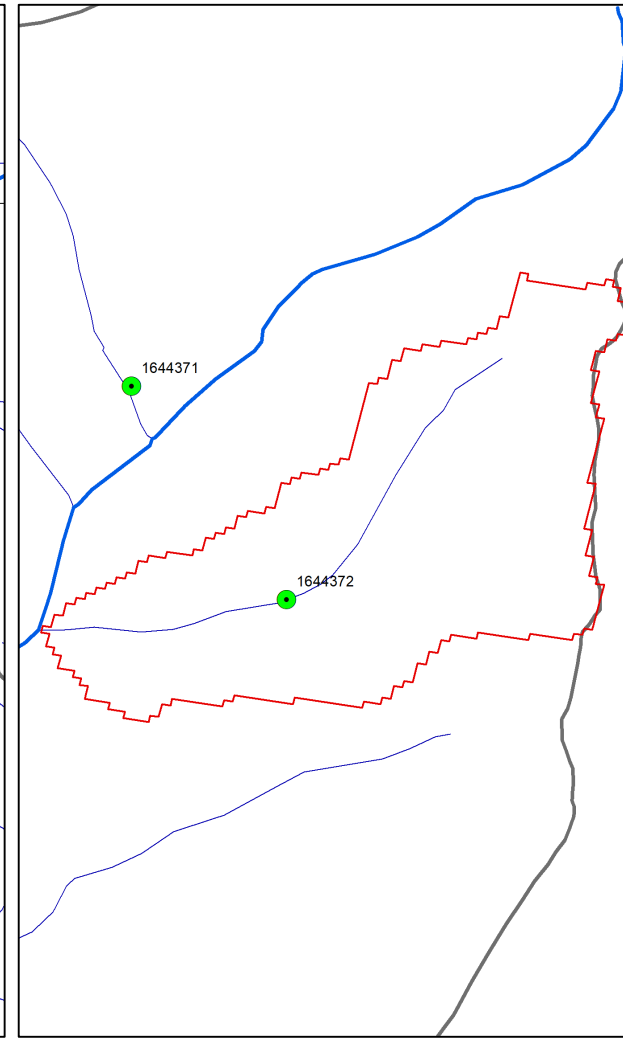
Alignment of the streamflow station with the NHD catchments



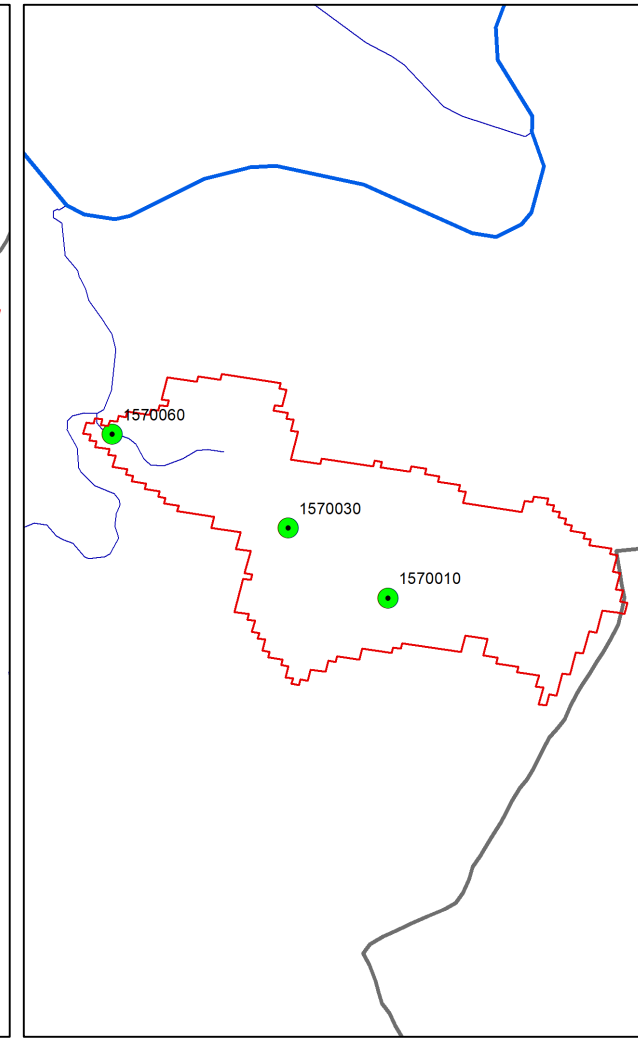
Good Alignment
 $CA = 1.01 \times DA$



Not So Good Alignment
 $CA = 1.10 \times DA$



Poor Alignment
 $CA = 2.17 \times DA$

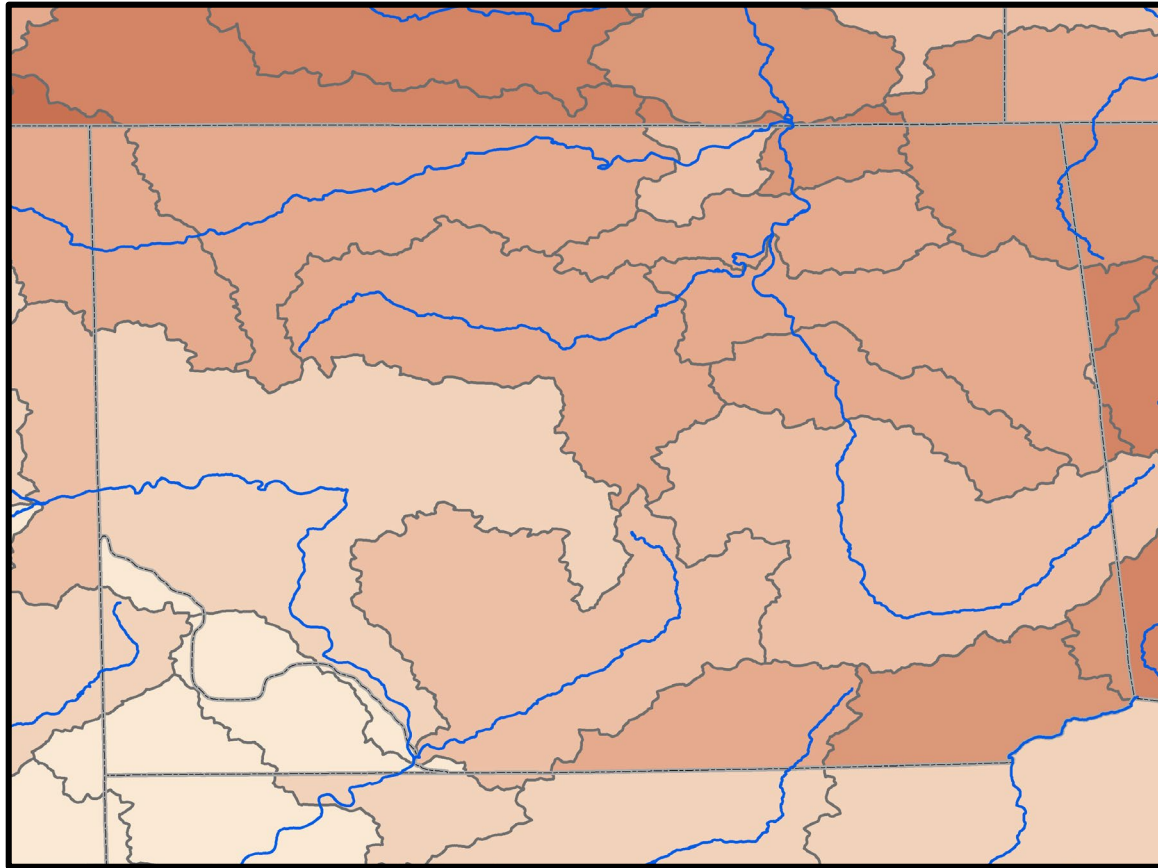


Unresolved Issue
 $CA = 0.43 \times DA$

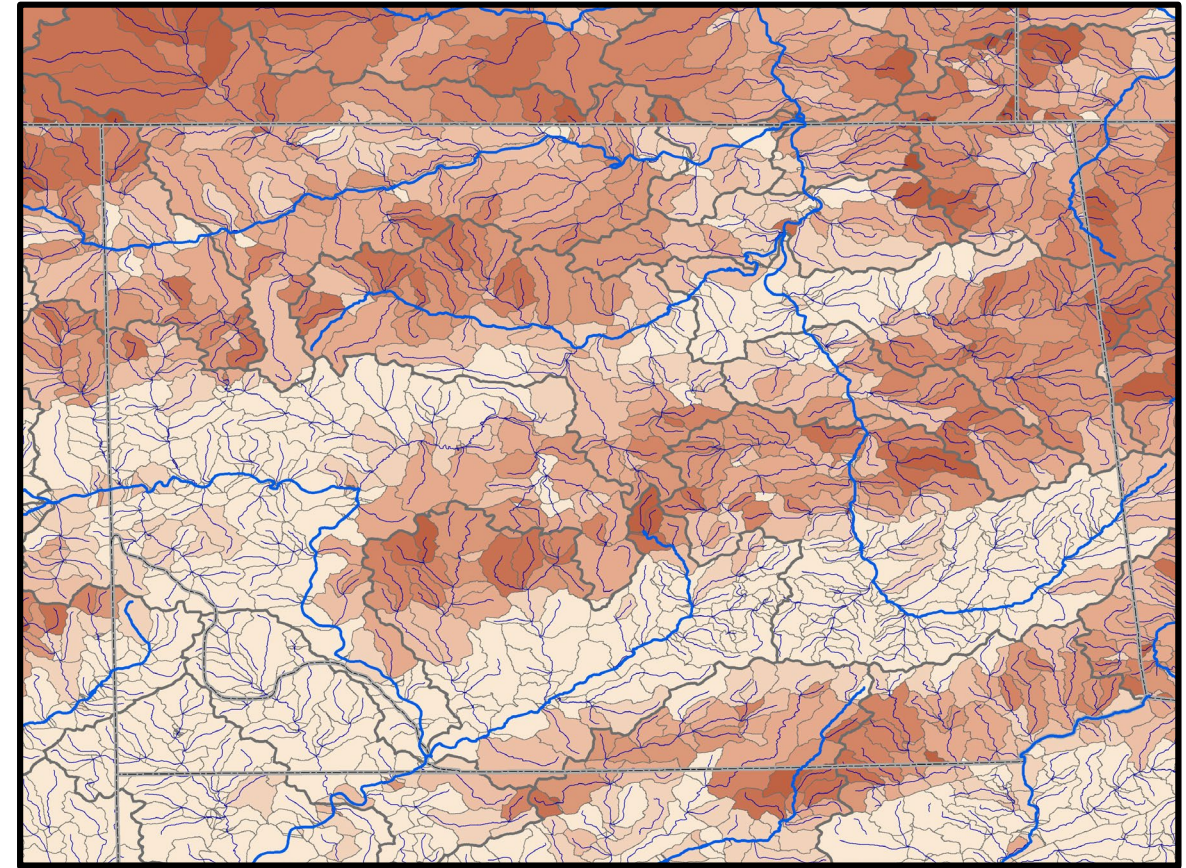
3. Methods and Results – CRHM 2020 Version 1

Downscaling of Phase 6 hydrology based on the composition of land cover data

Land Segment → River Segments



Land Segment → NHDplus Catchments



County/Land Segment



Percent Cropland

0% - 3%

10% - 17%

27% - 35%

46% - 55%

67% - 80%

4% - 9%

18% - 26%

36% - 45%

56% - 66%

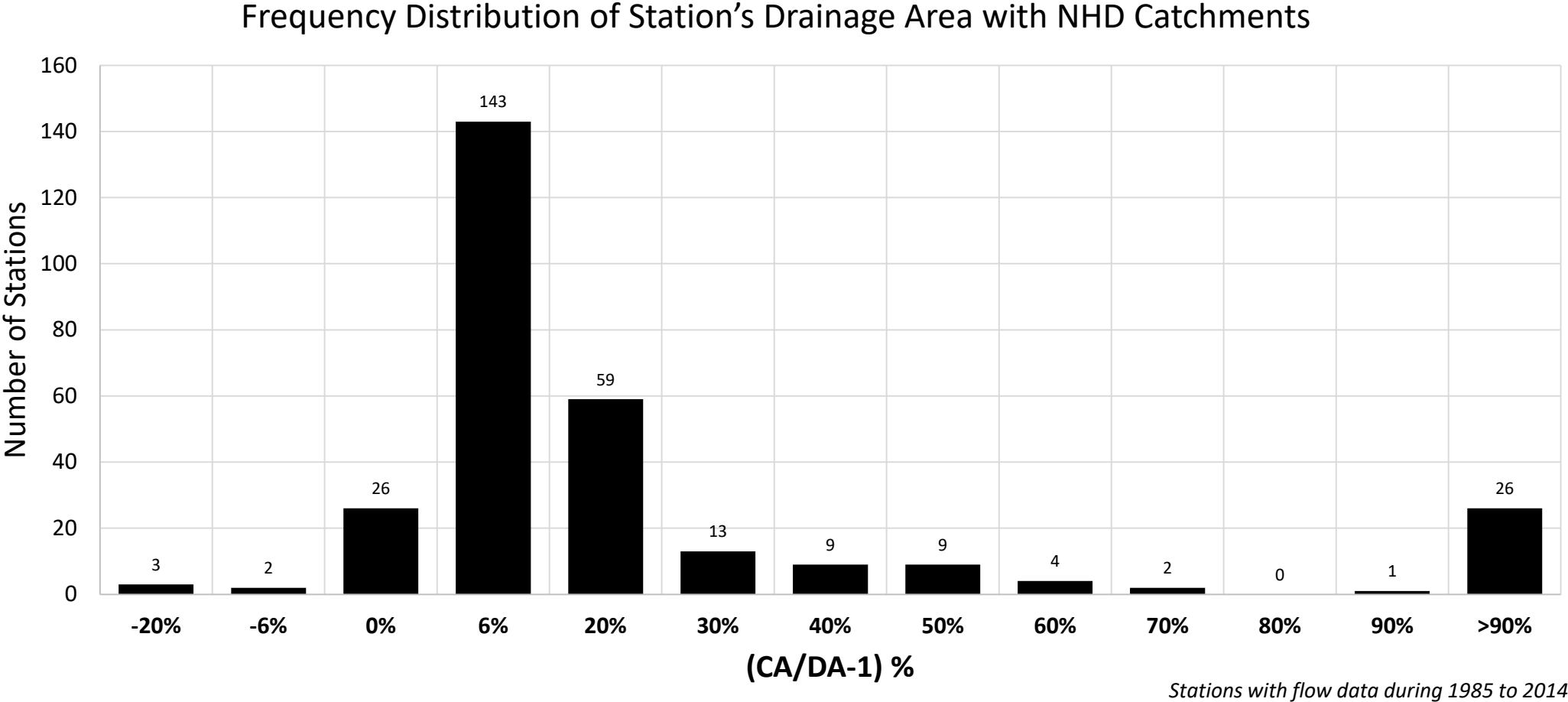
81% - 100%

3. Methods and Results – CRHM 2020 Version 1

- Limitations of the current approach
 - Point-source (Wastewater & CSO) discharges
 - Surface water withdrawals (water supply and irrigation)
 - Spatial variability in rainfall and meteorology
 - Flow routing through small streams
 - Spatial variability in watershed properties

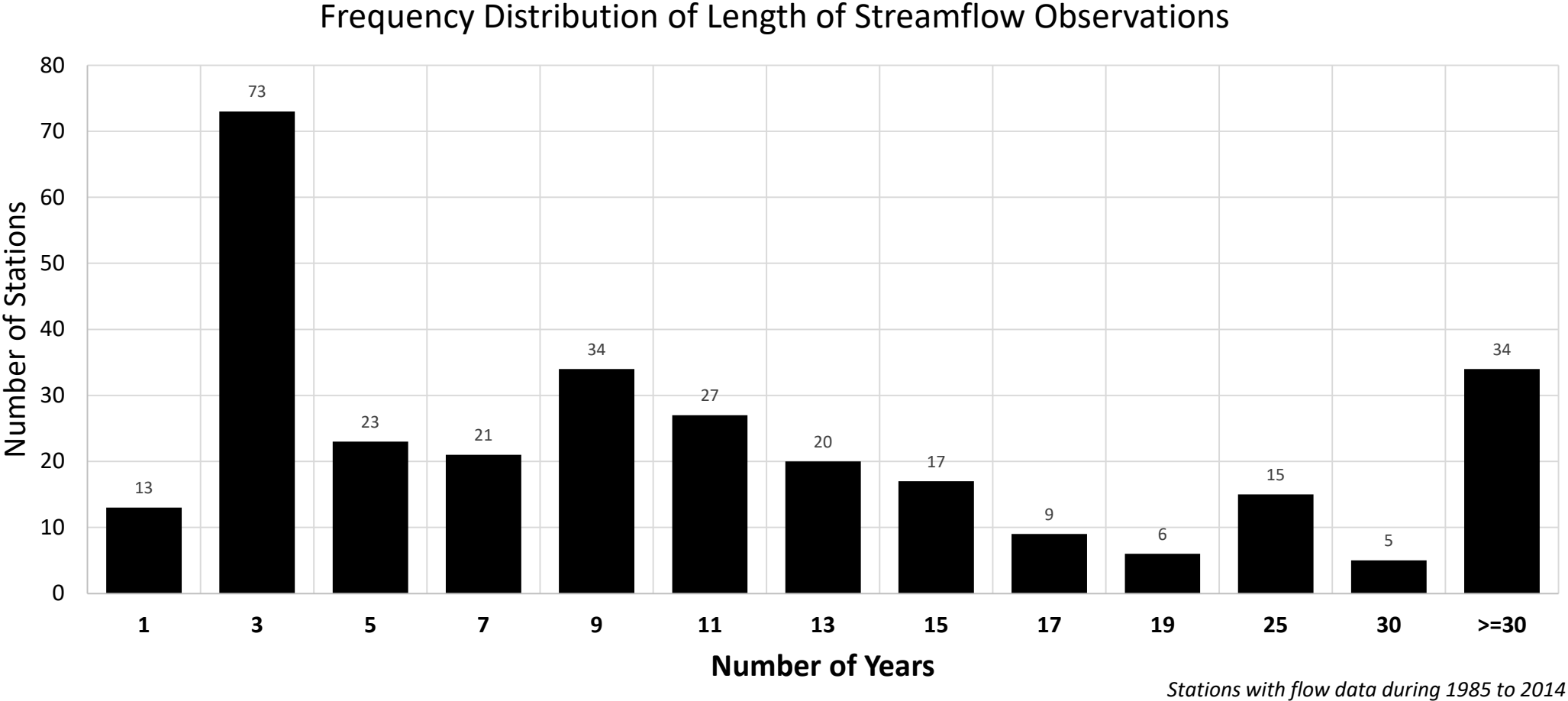
Other minor issues such as static land cover, exclusion of water land use, etc.

Alignment of NHD Catchments and USGS Stations (not used in calibration)



169 out of 297 new stations have Catchment Area (CA) within $\pm 06\%$ of the station's Drainage Area (DA)
193 out of 297 new stations have Catchment Area (CA) within $\pm 10\%$ of the station's Drainage Area (DA)

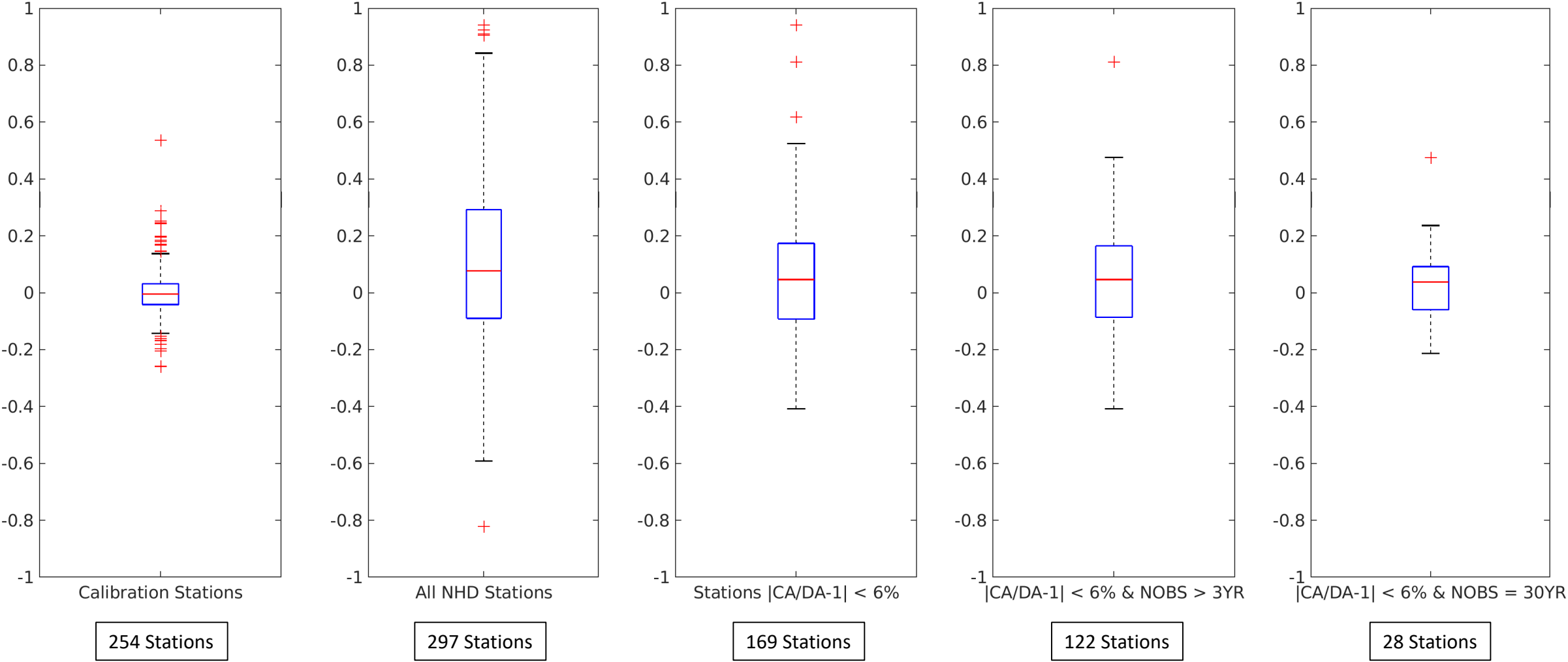
Length of Streamflow Observation for USGS Stations (not used in calibration)



86 out of 297 new stations have less than 3-years of streamflow observations
34 out of 297 new stations have complete 30-years (1985-2014) of streamflow observations

Bias in simulated streamflow

Bias closer to 0 is better

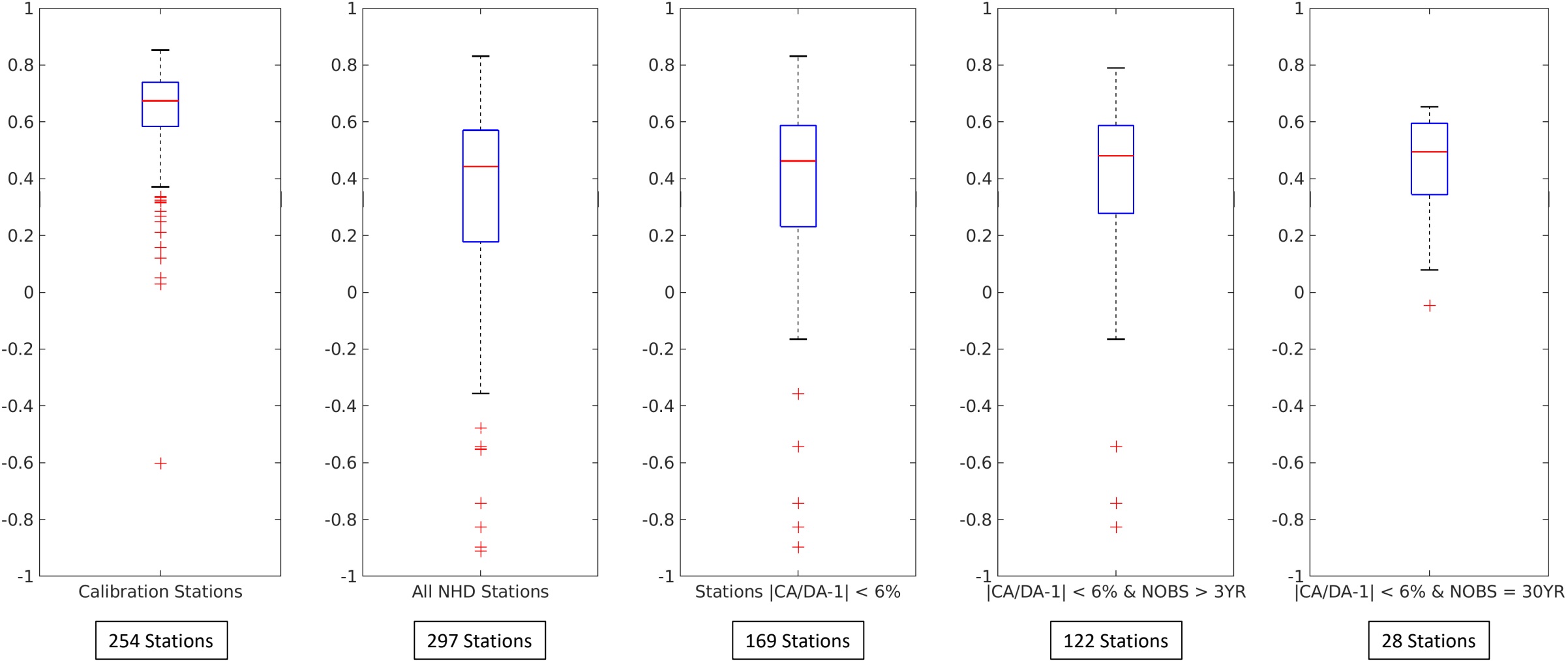


Phase 6 Calibration

Not used in Phase 6 Calibration

Nash Sutcliffe Efficiency (NSE) of simulated daily streamflow

NSE closer to 1 is better



Phase 6 Calibration

Not used in Phase 6 Calibration

4. Summary and next steps

- CBPO Watershed Modeling Team with collaborators all over the watershed is working on developing a finer-scale hydrology model.
- Initial plans and important collaborations have been developed for CRHM 2020 and CRHM 2023 versions.
- CBPO Watershed Modeling Team has started working on CRHM 2020 at NHDplus (1:100,000) scale
 - early results were presented
 - team will work on refinements (data, methods, and simulation system)

