CalCAST Updates

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Modeling Workgroup Quarterly Review

10/17/2023

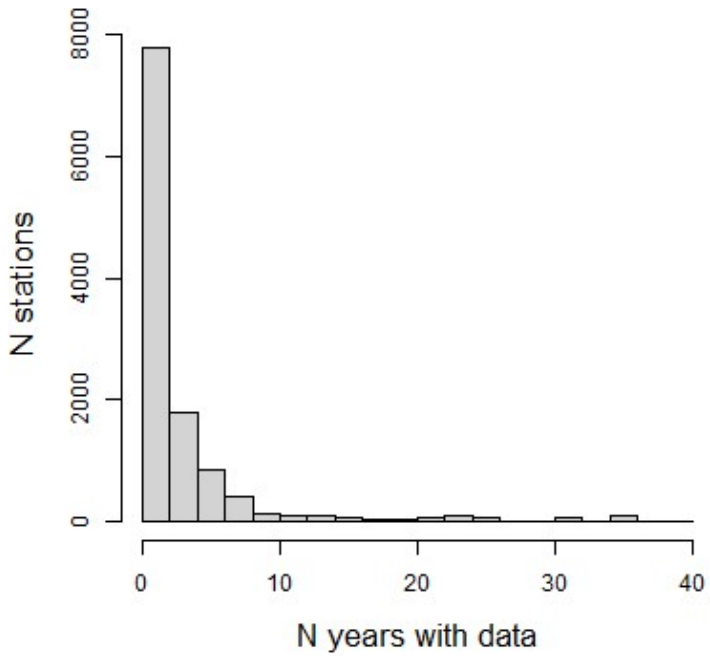
Developing a reproducible workflow to download water quality data from EPA's Water Quality Portal (WQP)

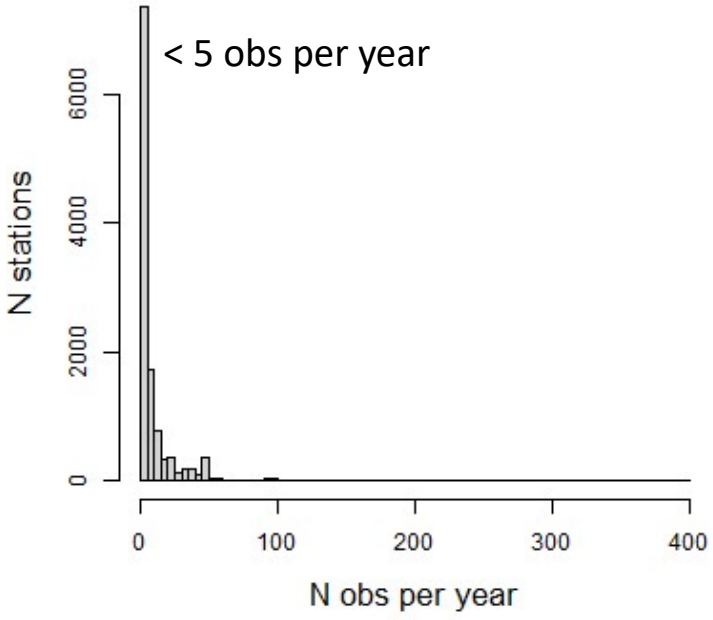
JUNE QUARTERLY RECAP

Motivation

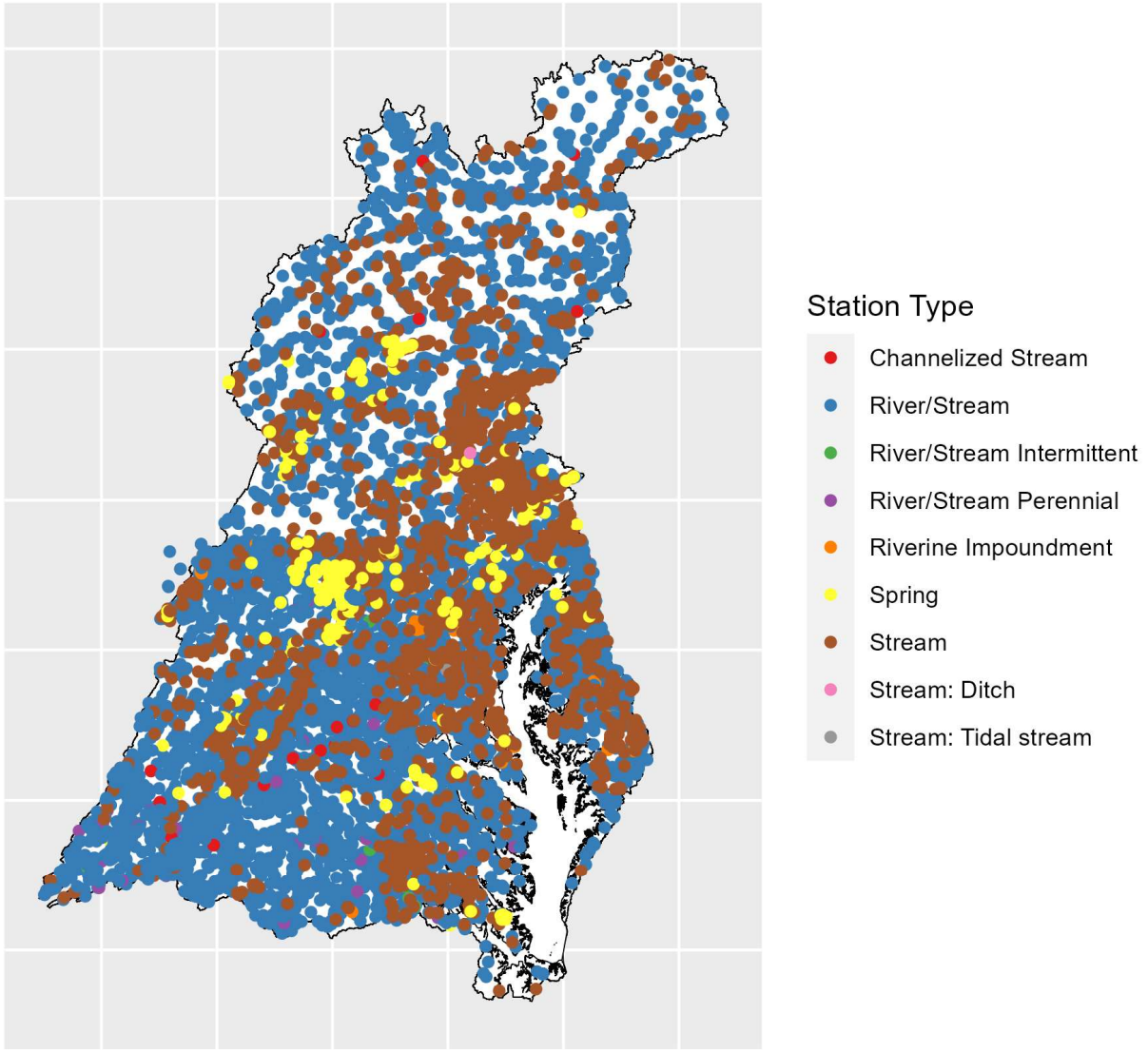
- We need to update the watershed model calibration dataset for P7
- The P6 calibration dataset was obtained through an ad-hoc process that is not easily reproducible
- We would like to develop an automated workflow that allows us to regularly update and expand our calibration dataset without major efforts
- March 2023: STAC Workshop "Using Local Monitoring Results to Inform CBP's Watershed model":
  - It is very important to local monitoring agencies that their stations are used to calibrate the CBP watershed model if possible
  - Need for a transparent and streamlined process to submit monitoring data for use in watershed model calibration

Monitoring stations with N data in the WQP





~11000 stations in Bay watershed



Three purposes for WQP dataset

Each purpose has different data requirements and different criteria for station/data inclusion

- **Dynamic watershed model** calibration and verification
    - Raw constituent concentrations (for calibration)
    - Load estimation (for verification)

- **CalCAST** calibration
    - Load estimation

- **Other forthcoming applications** (e.g., Machine Learning RFP)
    - Not sure yet, retain as much data as possible (while flagging/fixing issues)

Workflow

1. Raw WQP data processing/cleanup
2. Raw USGS streamflow data processing/cleanup
3. WQP station – USGS streamflow gage matching for load estimation
4. Application of screening criteria for load estimation

References we heavily relied on

1. **Oelsner et al., 2017** - **Water-quality trends** in the **Nation's rivers and streams**, 1972–2012—**Data preparation**, **statistical methods**, and trend results (ver. 2.0, October 2017): *U.S. Geological Survey Scientific Investigations Report 2017–5006*.

2. **Shoda et al., 2022** - **Water-quality trends** in the **Delaware River Basin** calculated using multisource data and two methods for trend periods ending in 2018: *U.S. Geological Survey Scientific Investigations Report 2022–5097*.

3. **Saad et al., 2019** - Estimates of long-term mean daily streamflow and annual nutrient and suspended-sediment loads considered for use in regional **SPARROW** models of the conterminous United States, 2012 base year: *U.S. Geological Survey Scientific Investigations Report 2019–5069*.

4. **Hirsch and DeCicco, 2015** - User guide to Exploration and Graphics for RivEr Trends (EGRET) and dataRetrieval—**R packages for hydrologic data** (version 2.0, February 2015): *U.S. Geological Survey Techniques and Methods book 4, chap. A10*.

5. **CBP's Nontidal Network**

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Raw WQP data processing/cleanup

- Flag/remove samples in wrong **media** (e.g., «biological tissue» or «bed sediment»)
- Standardize/flag **sample fraction** (e.g., «dissolved» vs. «total» vs. «suspended»)
- Standardize/flag **sample type** (e.g., «lab replicate», «reagent blank», «field obs»)
- Standardize/flag **censoring** information (e.g., «Present Below Quantification Limit»)
- Standardize/flag **qualifying issues** that affect results (e.g., «No Result, lab accident»)
- Standardize **parameter names** and assign appropriate USGSPCode
- Standardize/fix **units of measure**
- Resolve **duplicate** samples
- Flag «**suspicious»** values
- Aggregate constituents to obtain **surrogate TN** measurements

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USGS streamflow data processing/cleanup

1. Retrieved daily flow data for 1984-present at >500 USGS streamflow gages originally assessed for inclusion in DM/CalCAST calibration dataset

Calculation of loads requires continuous record of daily flow (no NAs, zeros, or negatives). Following Oelsner et al. 2017 and Shoda et al. 2022:

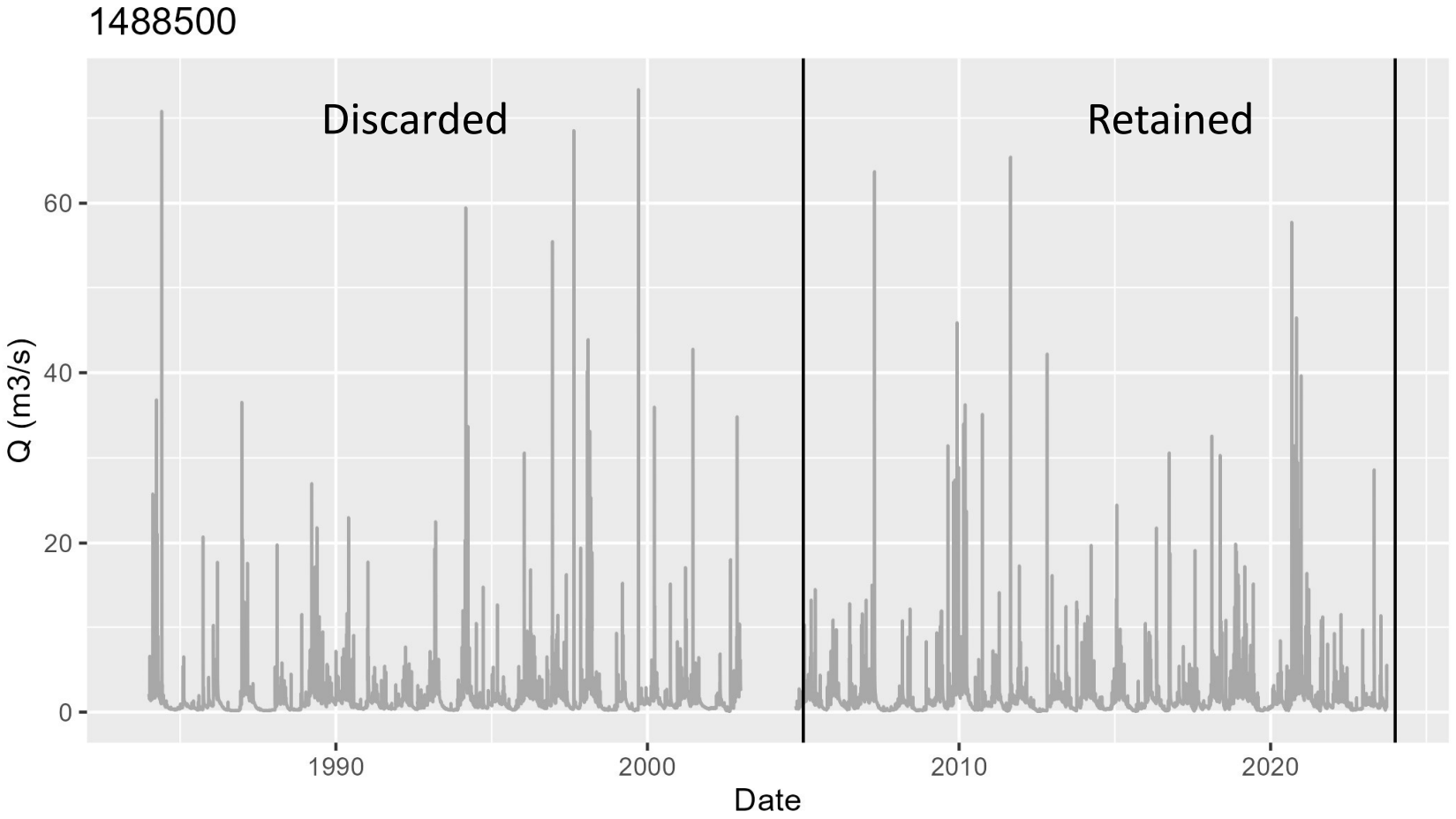
2. Each streamflow record was required to meet the following criteria:
   - No more than 30 days with **missing streamflow** per year
   - No more than 3 consecutive days with **missing streamflow** per year
   - No days with **negative streamflow**
   - No more than 30 days with **zero streamflow** per year

3. Added small constant to zero streamflow values

4. Filled in missing streamflow using the R function “fillMiss” from the R package “waterData” (Ryberg and Vecchia, 2012)

USGS streamflow data processing/cleanup

In some cases, a streamflow record failed to meet all criteria; whenever possible, we deleted parts of the period of record that did not meet criteria and retained the longest period of record that met criteria.



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WQP Station – USGS Streamflow gage matching

Calculation of loads requires to match streamflow gages and water quality stations:

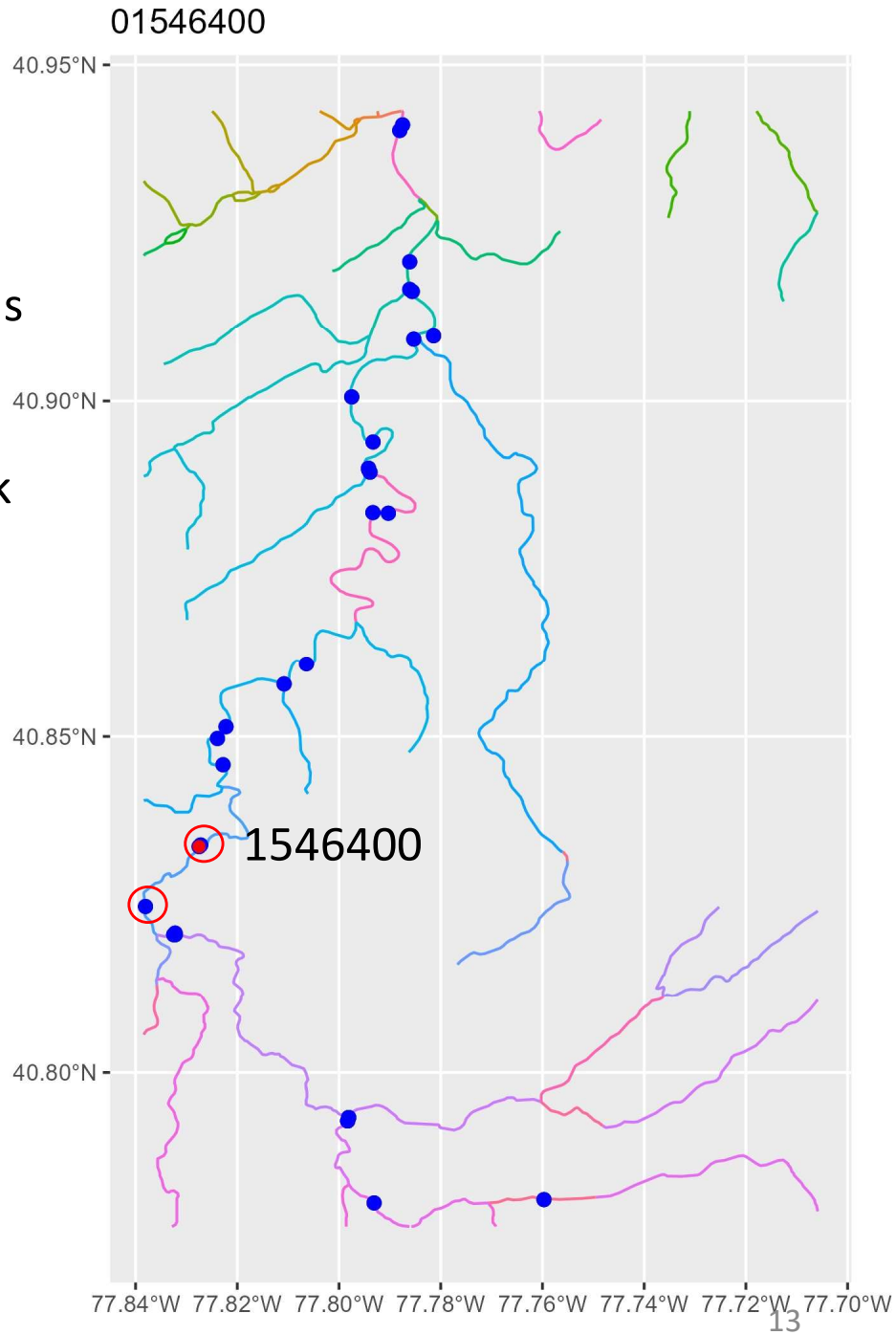
1. Assign NHDPlus Flowline (ComID) to WQP stations and some USGS streamflow gages (most USGS streamflow gages already have ComID information) – Combination of NLDI and GIS work

2. For each USGS streamflow gage, identify WQP stations on same LevelPathID (Oelsner et al., 2017)

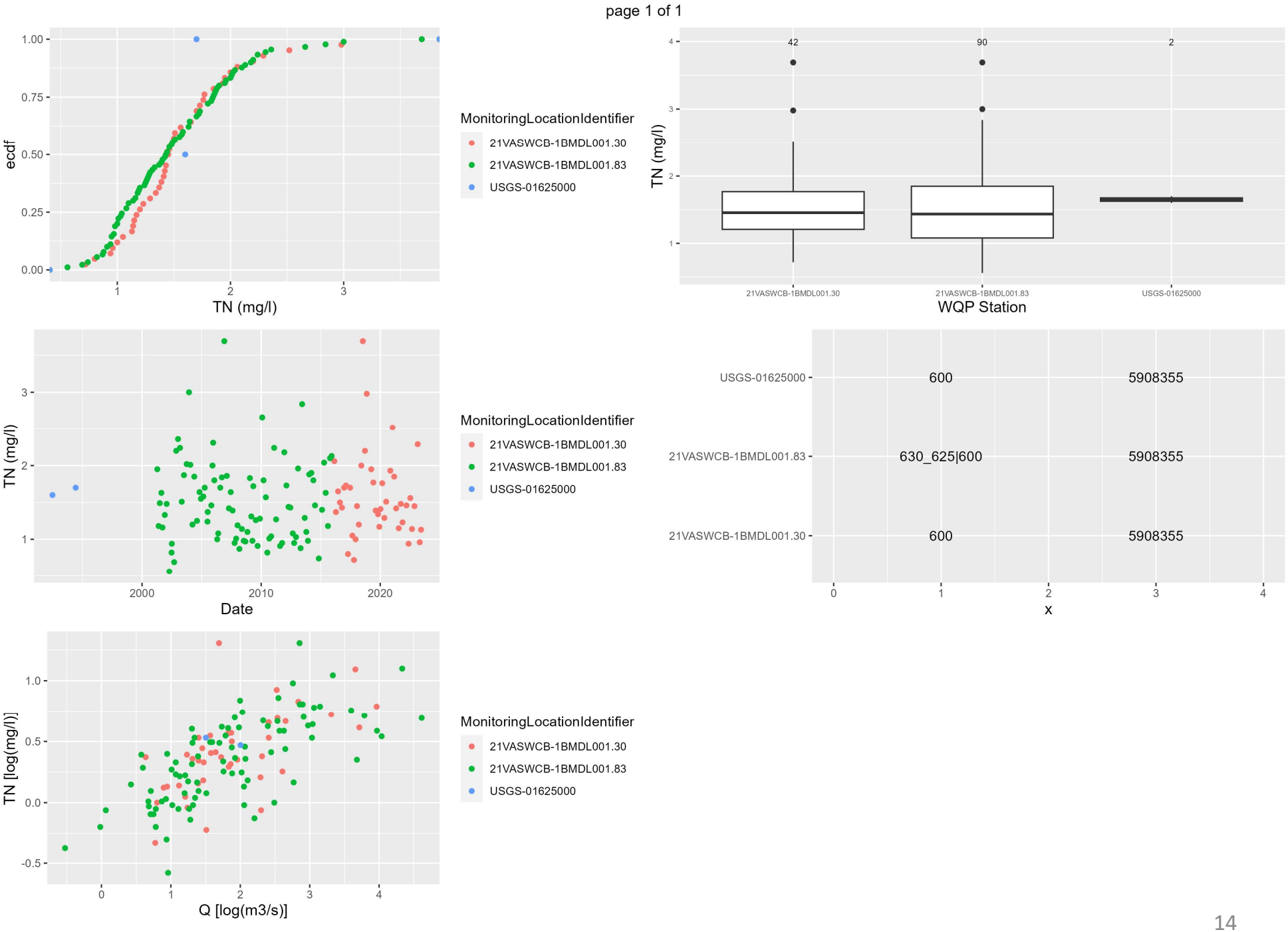
3. Retain only WQP stations within ~2 km (linear distance) of each streamflow gage and without intervening tributaries

4. Double check that we obtain same matches as NTN sites – Verified

5. Visually assess the combined water-quality data



WQP Station – USGS Streamflow gage matching



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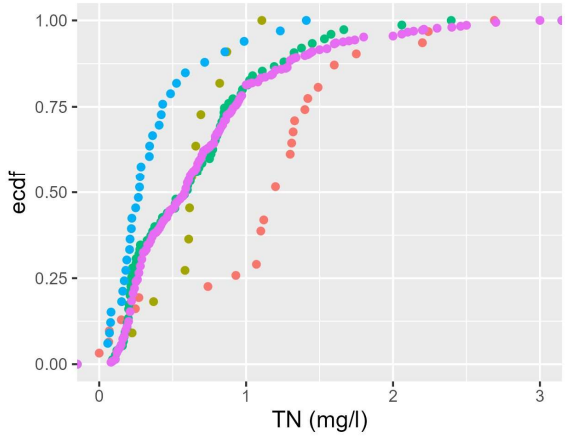

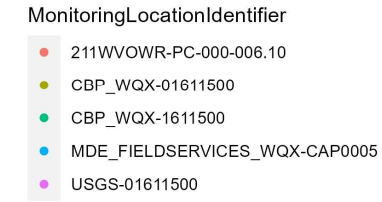

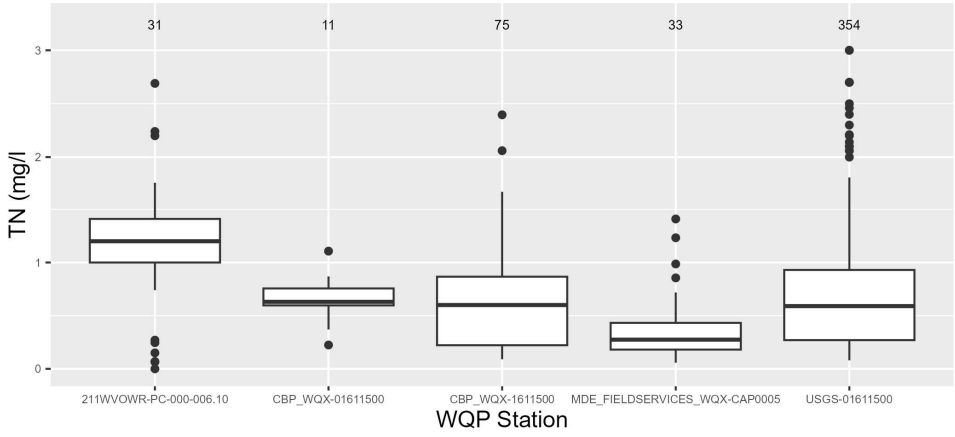

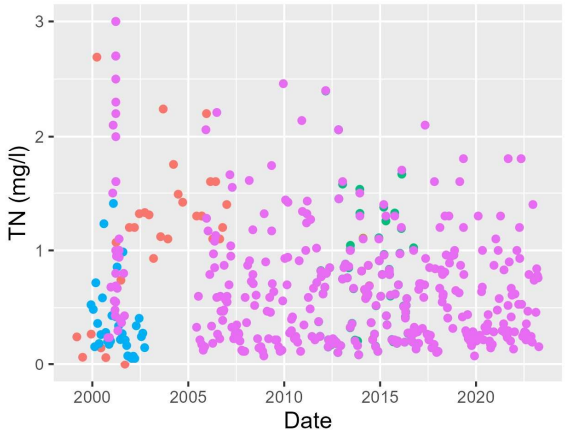

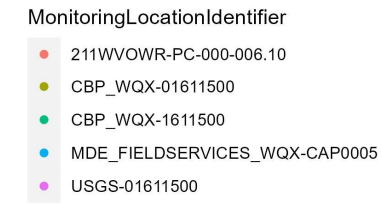

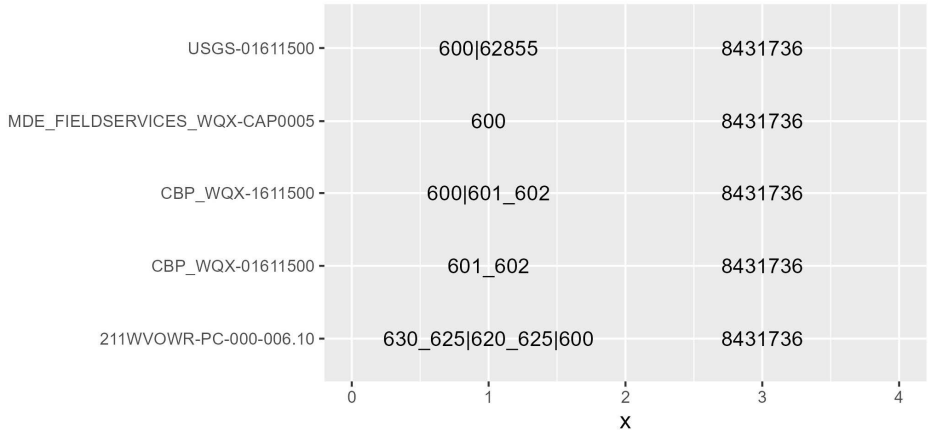

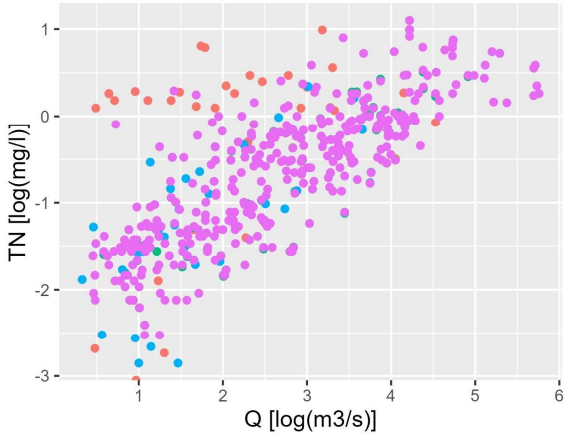

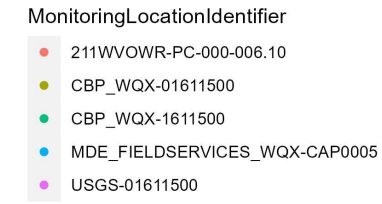

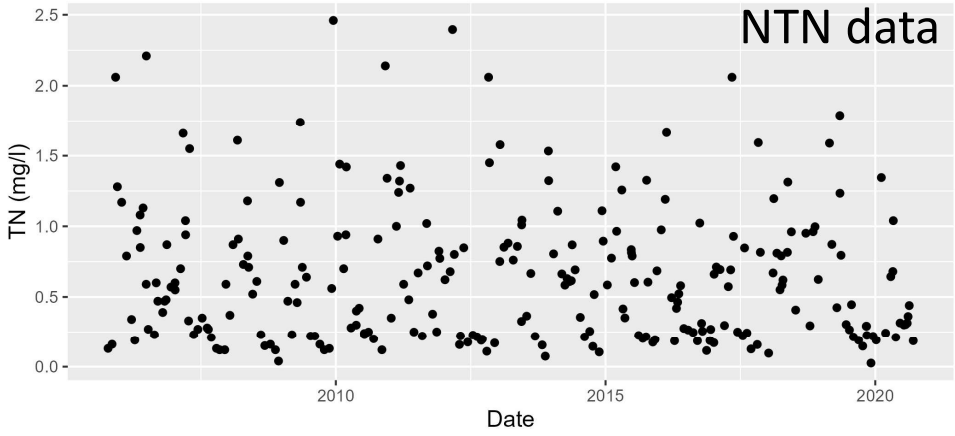

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Application of screening criteria for load estimation

Screening criteria to estimate loads using **FluxMaster** (Saad et al., 2019/SPARROW):

a) At least 2 years of overlap between water quality and streamflow data
b) Minimum of 5 years of daily streamflow (originally 10 years)
c) Minimum of 3 years of water quality data
d) At least 24 samples
e) At least 3 samples in each season

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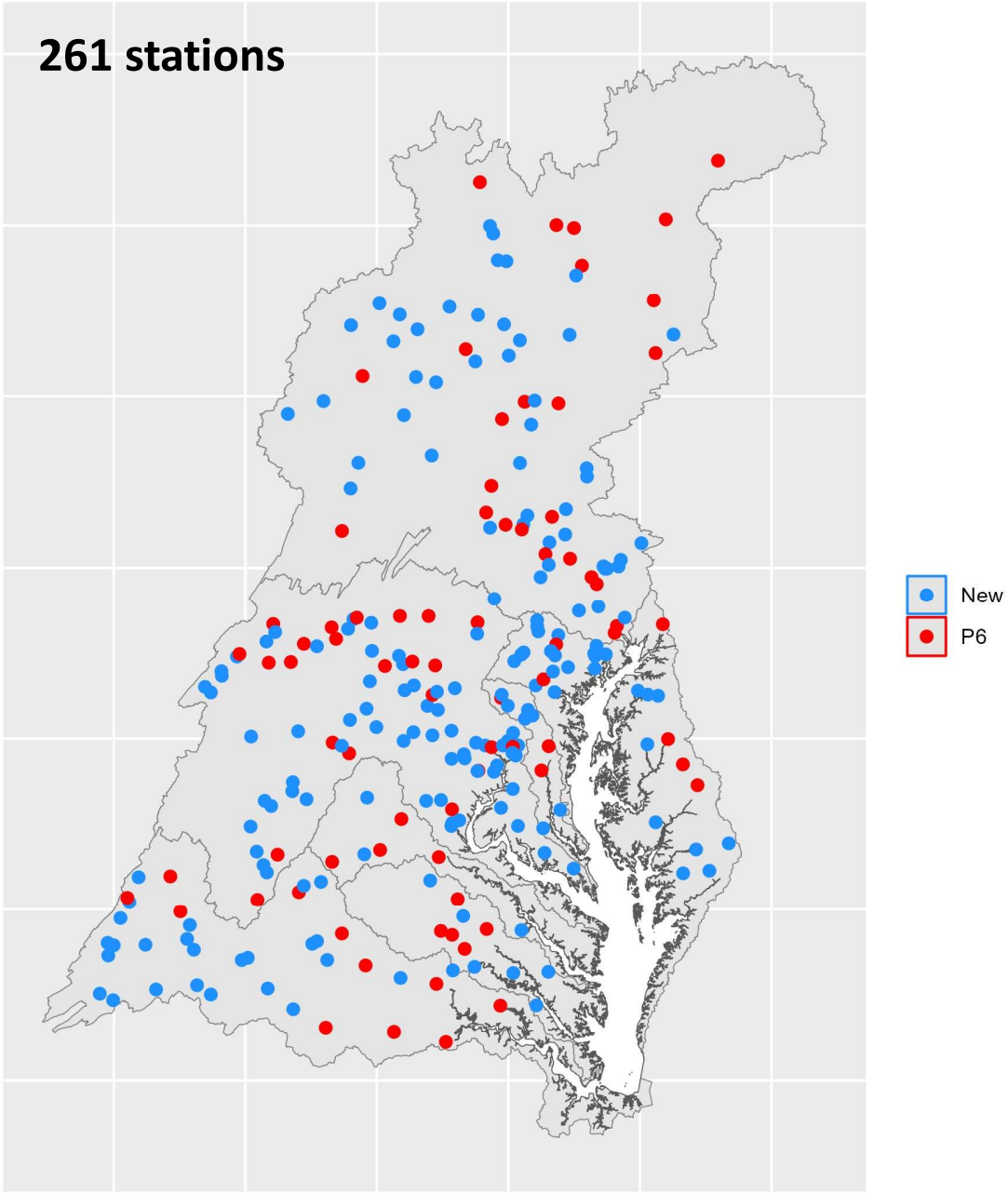

Application of screening criteria for load estimation

Screening criteria to estimate loads using **WRTDS** (Oelsner et al., 2017; Shoda et al., 2022; Hirsch and DeCicco, 2015):

a) At least 3 years of water quality (WQ) data
b) If one or more gaps of >2 years in WQ data is present, retain longest period of record without such gaps (gaps <3 years are allowed)
c) Coverage of seasons: 70% of years must have at least quarterly samples (relaxed criterion to retain stations with > 60 samples)
d) At least 3 consecutive years with quarterly WQ samples (relaxed criterion to retain stations with > 60 samples)
e) Coverage of streamflow: At least half of the decades must have at least 14% high-flow samples, or 20 high-flow samples, and the other decades must have at least 10% high-flow samples
f) Minimum 5 years of daily streamflow (originally 10 years)

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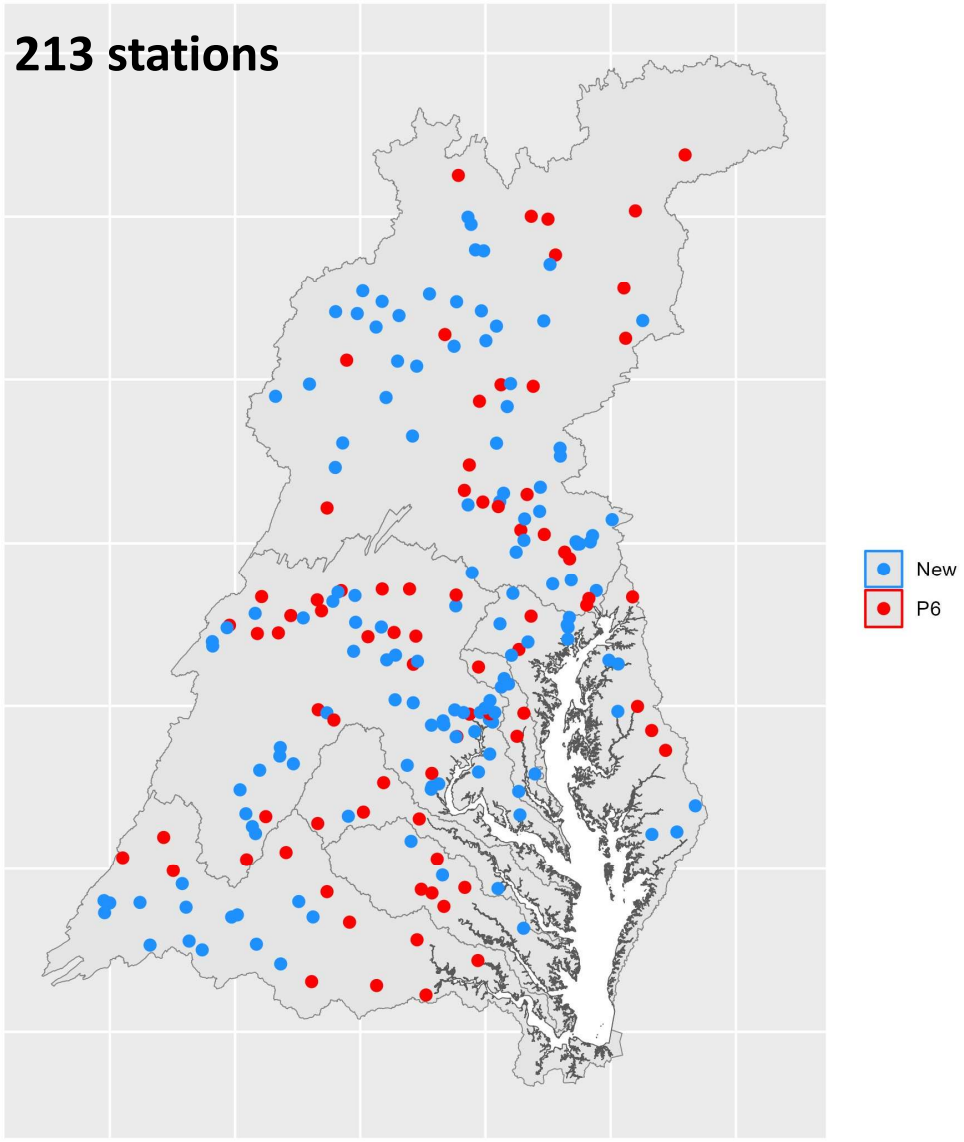
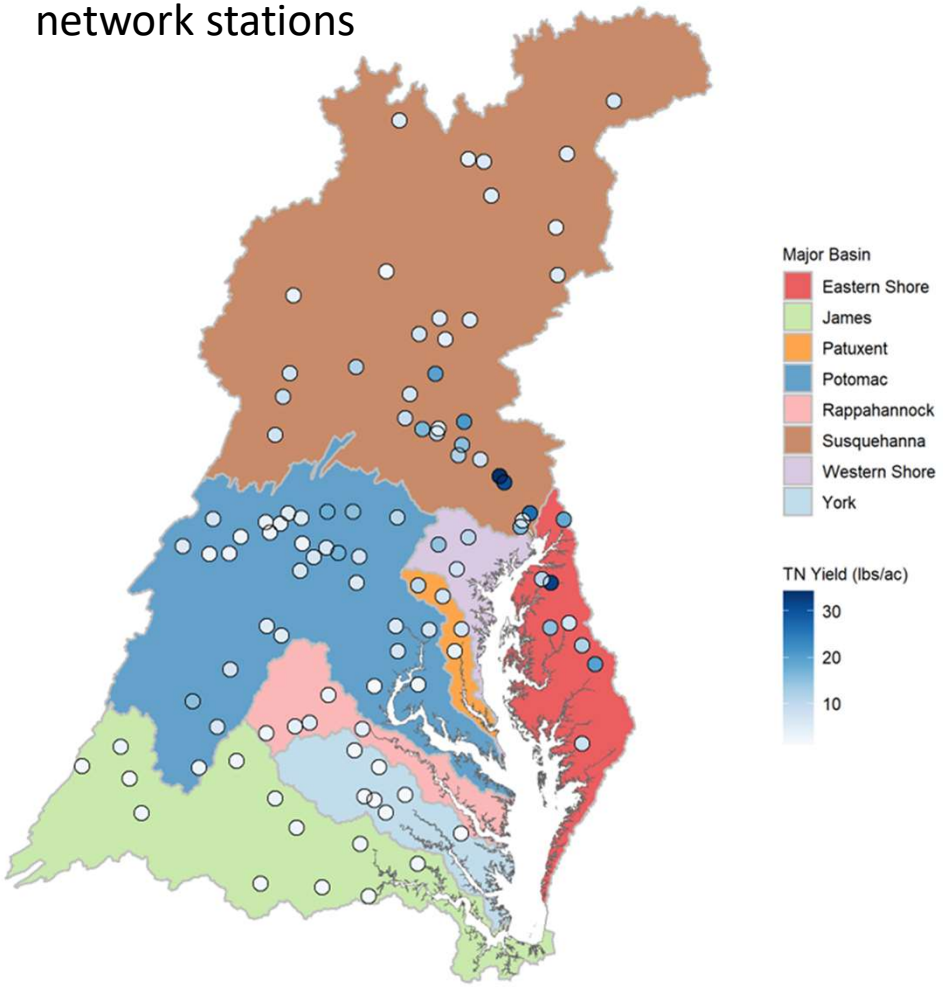
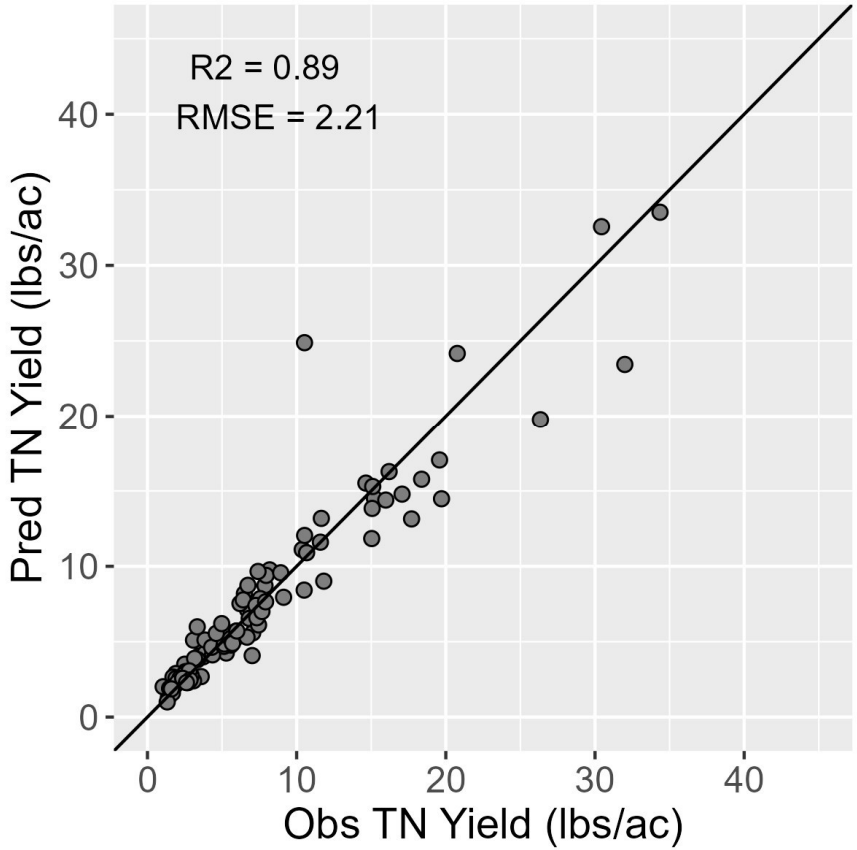


CalCAST average annual TN predictions at current calibration stations

- **Calibration target**: WRTDS flow-normalized TN load at **123** non-tidal network stations





Land to water factors

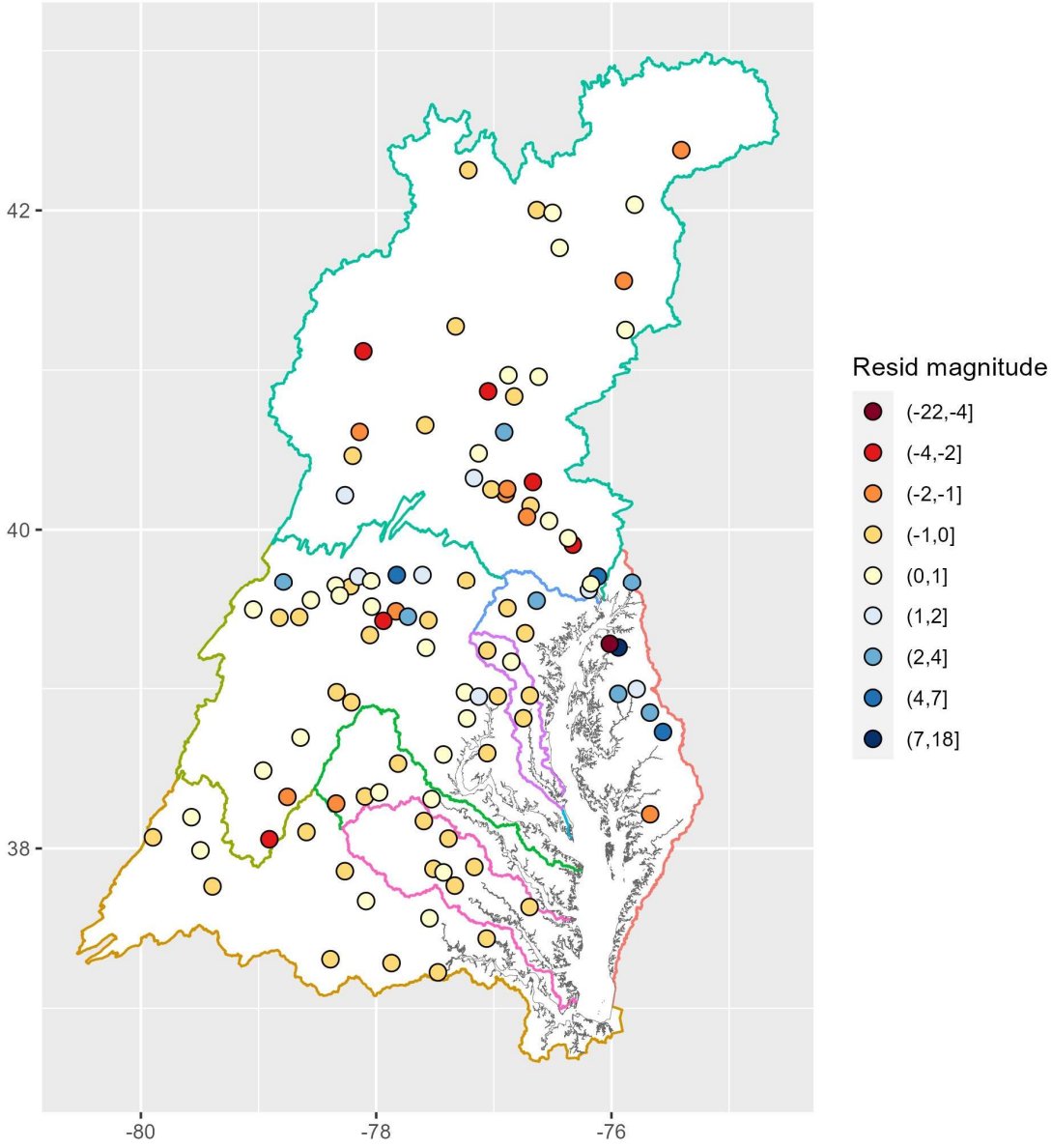
Groundwater recharge (mm)

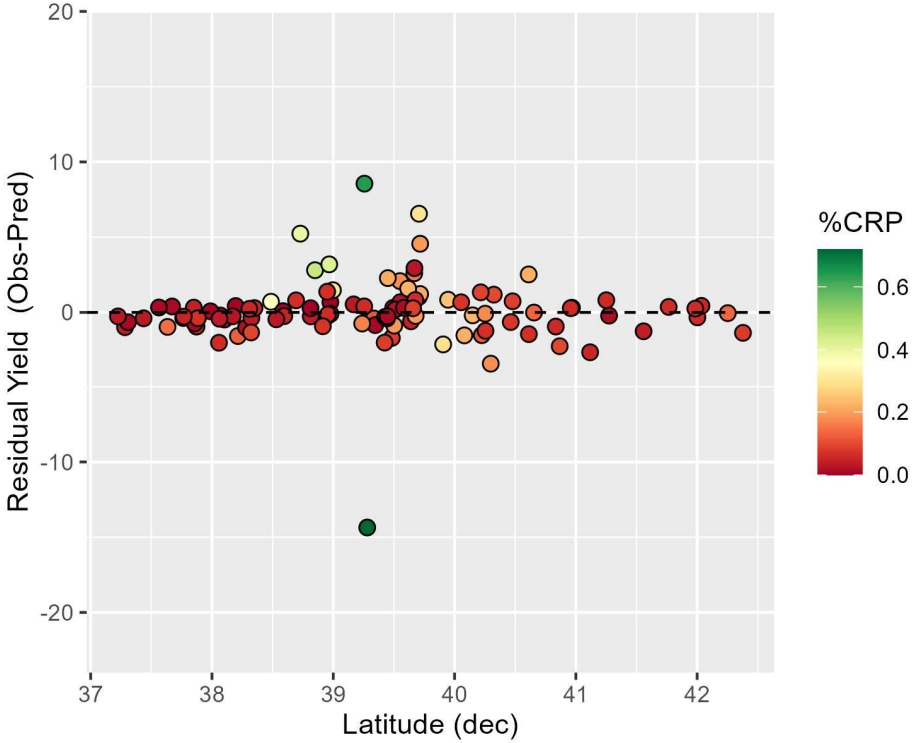
Hydrogeomorphic unit: Coastal Plain Upland (%)

Hydrogeomorphic unit: Piedmont Carbonate (%)

CalCAST average annual TN predictions at current calibration stations

Map of residual yield (Obs – Pred)





Next Steps

- Finalize data processing workflow
- Calculate constituent loads and compare to P6/NTN/SPARROW wherever possible
- Ask Monitoring Agencies to provide feedback and fill in data gaps
- Update CalCAST and DM calibration datasets
- Re-do data pull and processing in 2025