CHESAPEAKE BAY NONTIDAL NETWORK: EXTENSION OF LOADS AND TRENDS THROUGH WY2012

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CB NTN Data Analysis through WY2012

- This is a unique year for determining nutrient and sediment loads and trends because this is the first time that we have two sets of models to perform our analyses across the CB NTN (ESTIMATOR and WRTDS)
- We have decided to use:
  - WRTDS as the primary approach for computing N, P, and S loads across the NTN
  - ESTIMATOR as the primary approach for determining changes in water-quality conditions (i.e. flow-adjusted concentration trends)
- By selecting WRTDS as our primary load determination tool, we are truly pioneering new applications in areas that have not been carefully researched (i.e. state-run ambient water-quality stations)

CB NTN Data Analysis through WY2012: Cont.

- A fortunate unintended consequence of computing load and trend results using both WRTDS and ESTIMATOR is that differences in model results have led us to unprecedented scrutiny of both model performance and quality of the input water-quality record.

- Data concerns identified (will discuss with NTN in future meetings)
  - The addition of targeted storm samples to the long-term “Monthly” monitoring data sets
  - Total phosphorus and orthophosphorus data quality issues (i.e. changing censoring level and potential bias)
  - Suspended sediment – Comingled TSS and SSC results
  - Quality and density of water-quality results associated with the highest 10% of discharges
  - First three concerns have potential to bias “Flow-Normalized” Load trends produced using WRTDS – (top priority for investigation this year)

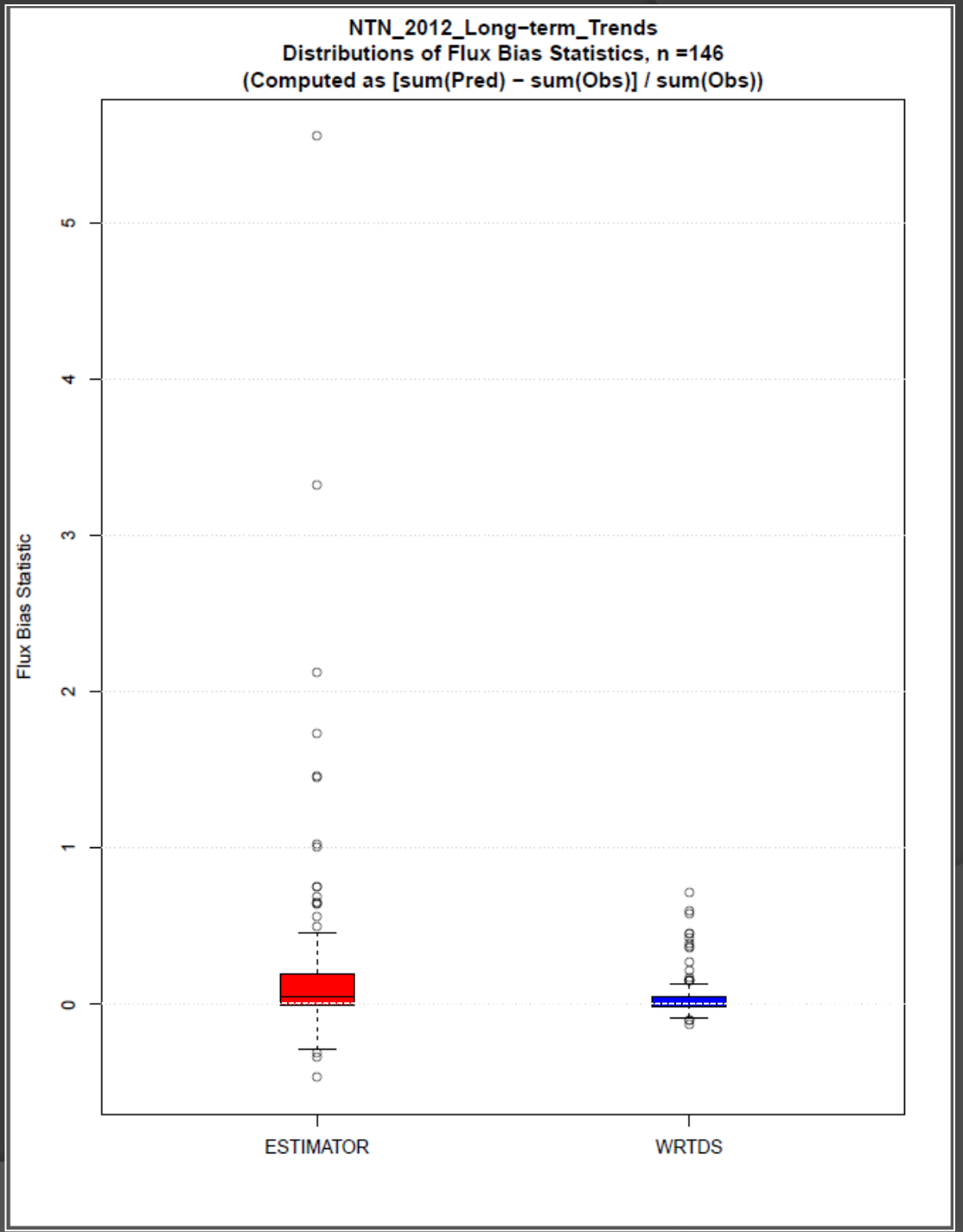
What led us to decide to use WRTDS this year for load computations across the NTN?

Why Use WRTDS?

- Moyer and others (2012) – found that WRTDS produced estimates of flux that were less biased than flux estimates obtained using ESTIMATOR (using high-quality, data-rich datasets)
- Hirsch, in review, *"Evaluating potential bias of regression-based flux estimates"*
  - Most detailed scientific study available addressing model selection, sample size, model diagnostics

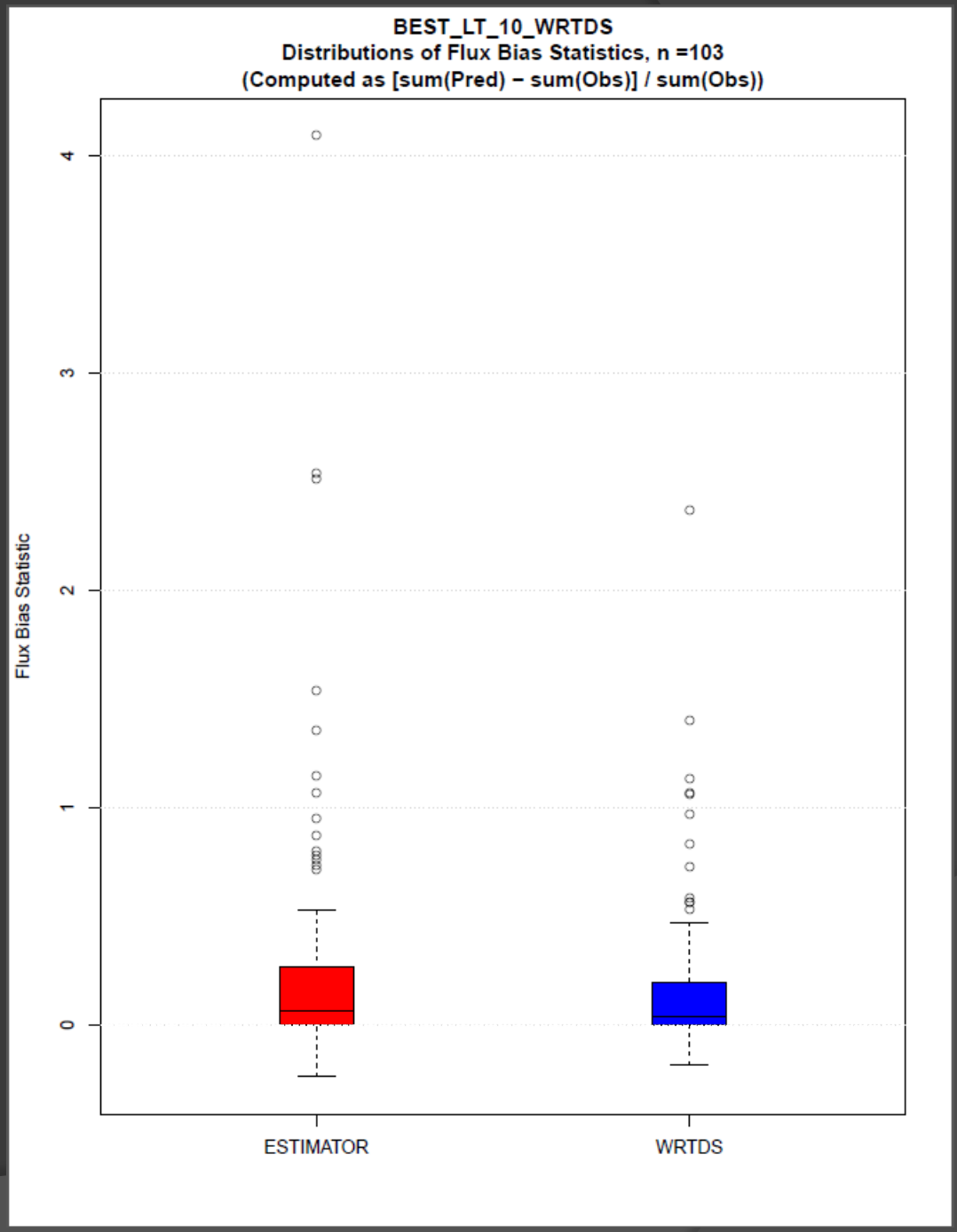
What do our WRTDS vs. ESTIMATOR FB Results look like?

NTN Long-Term Stations



What do our WRTDS vs. ESTIMATOR FB Results look like?

NTN BEST scenario *(stations have greater than 120 observations)*



Model Estimation Categories

- Long-Term Estimation (~1985-2012)
  - Model → WRTDS for loads and ESTIMATOR for FAC Trends
  - Stations = 30 (9 RIM and 21 NTN)

- 10-Year Estimation (2003 – 2012)
  - Model → WRTDS for loads and ESTIMATOR for FAC Trends
  - Stations = 31 (9 RIM and 22 NTN)

- Products
  - Annual and monthly loads for period (WRTDS) (Using longest estimation period)
  - 5-year mean yield (WRTDS)
  - Flow-adjusted concentration trend (ESTIMATOR)

Model Estimation Categories Cont.

- "Best" Less Than 10 years (Stations with greater than 120 samples)
  - Model → WRTDS for loads
  - Stations = 24 NTN
  - Time period – starting year varies depending on data quality/availability (i.e. 2004,2005, 2006, 2007 or 2008)
  - Products
    - Annual and monthly loads for period (WRTDS)
    - 5-year mean yield (WRTDS)

- "Best" Less Than 10 years (Stations with less than 120 samples)
  - Model → ESTIMATOR for loads
  - Stations = 10 NTN
  - Time period – starting year varies depending on data quality/availability (i.e. 2004,2005, 2006, 2007 or 2008)
  - Products
    - Annual and monthly loads for period (ESTIMATOR)
    - 5-year mean yield (ESTIMATOR)

- Secondary Stations (10-Year Simulation)
  - Model → ESTIMATOR for FAC Trends only
  - Stations = 15 NTN
  - Products
    - Flow-adjusted concentration trends (ESTIMATOR)

Total Number of NTN Stations Represented in Load and Trend Analysis

- Load Stations = 65
  - 30 Long-term
  - 1 10-year
  - 34 Best (24 WRTDS + 10 ESTIMATOR)
- Trend Stations = 46
  - 31 (Long-term + 10-year)
  - 15 Secondary
- Total NTN Stations = 80
  - 65 Load
  - 15 Secondary

Changes in scenarios from last year

- Long-Term Estimation
  - Do Not Report
    - Susquehanna Danville Ortho-P (censoring amount and threshold)
    - West Branch Susquehanna Lewisburg (censoring amount and threshold)
    - Removed Susquehanna Wilkes-Barre TSS (BEST WRTDS – SSC)
  - Removed from NTN
    - Patuxent River at Laurel, Md.
- Secondary Stations
  - Do not report
    - Calfpasture River at Goshen, Va. (TP and Ortho-P, censoring)
    - Bullpasture River at Williamsville, Va. (TP and Ortho-P, censoring)
    - Appomattox River at Farmville, Va. (Ortho-P, censoring)
  - Removed from NTN
    - Piney River at Piney River, Va.

Changes in scenarios from last year

- Best Less Than 10-Years (WRTDS)
  - Do Not Report
    - Raystown Branch Juniata Ortho-P (censoring amount and threshold)
- Best Less Than 10-Years (ESTIMATOR)
  - Do not report
    - Cacapon River near Great Cacapon Ortho-P (censoring amount)
  - Removed from NTN
    - Piney River at Piney River

Model Review Process and Tools

Review Objectives

- Obtain data from DUET and produce new Q and QW files
- Demonstrate that we can produce last year's results using the new Q and QW files
- Compare ESTIMATOR and WRTDS input files for consistency
- Evaluate input data files
- Ensure that "all" WY2012 data are present for each NTN station
- Categorize and review flux biases
- Identify sample outliers and percent censoring issues
- Compare FAC, FNC, and FNL (have raw data that will need to be fully interrogated in WY2014)

Data from DUET

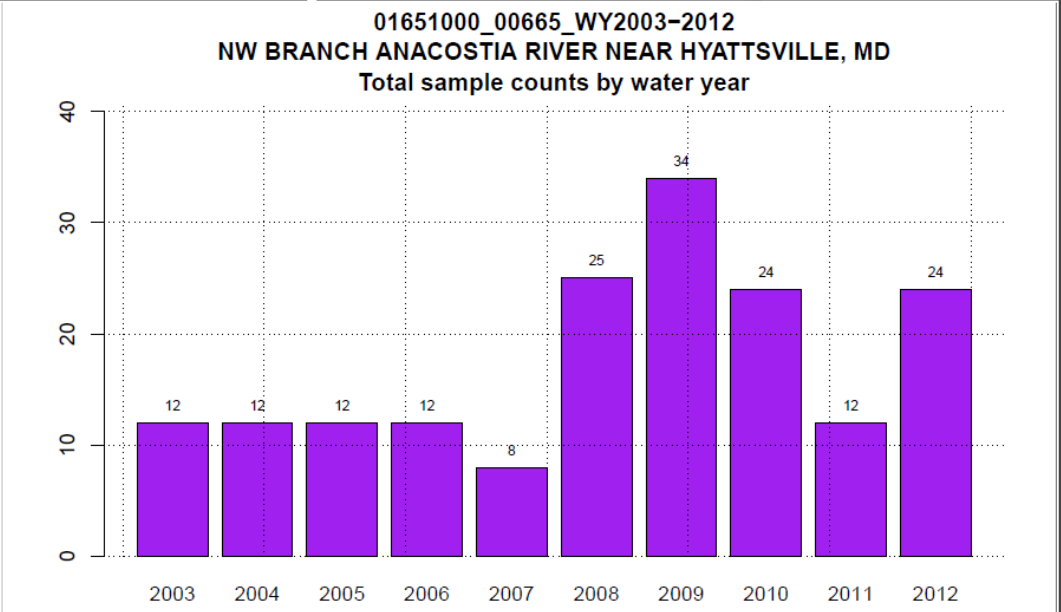
- Mike L. worked extensively with Mike Mallonee to resolve:
  - Parameter code issues *(e.g. missing codes or codes needing translation)*
  - The format of the DUET output file required for uploding into SAS
- Date of final data transfer from DUET was July 17, 2013
- Investigated missing WY2011 and WY2012 data in VA and PA

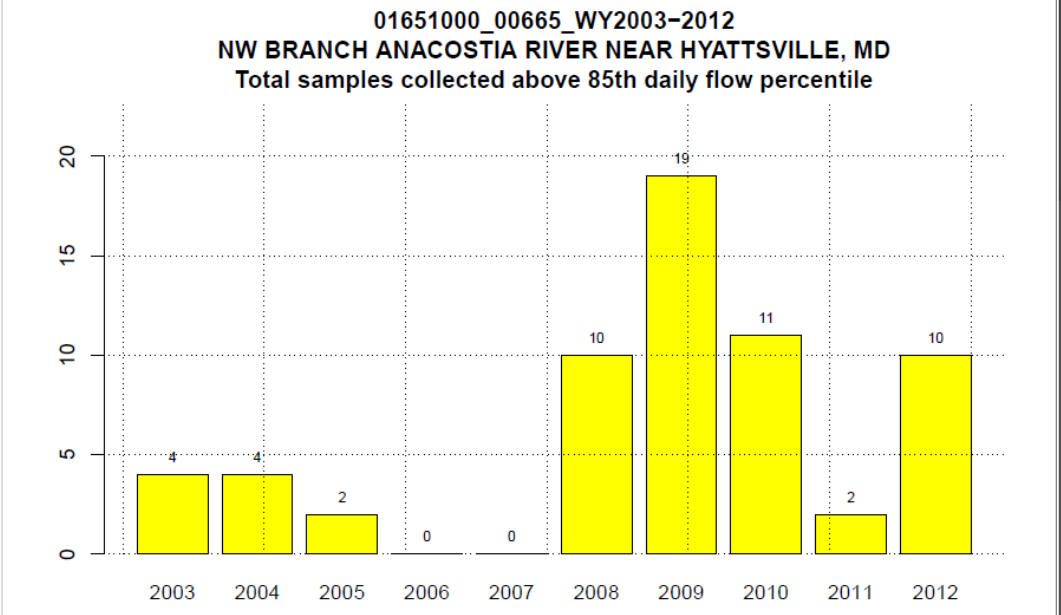
Produce Q and QW files and Reproduce Last Year's Results

- Q-files were recreated fresh this year
- QW-files – WY2012 data from DUET were appended to the QW file used for the WY2011 loads and trends
- Reproduce last year's results (based on FAC)
  - The majority of the FAC results from last year were successfully reproduced
  - Discrepancies were all related to Q-file issues (i.e. missing data or applying shifts to the historical record)

Review for data completeness

- Reviewed each station to ensure data "completeness" for WY2012
- Investigate anomalously low sample count years
- Documented number of samples collected above the 85 and 95 percentile Q
- Approx. 8-10 NTN stations had missing or incomplete data in WY2012 and 2-3 had missing or incomplete data for WY2011





Model Review Process: FLUX

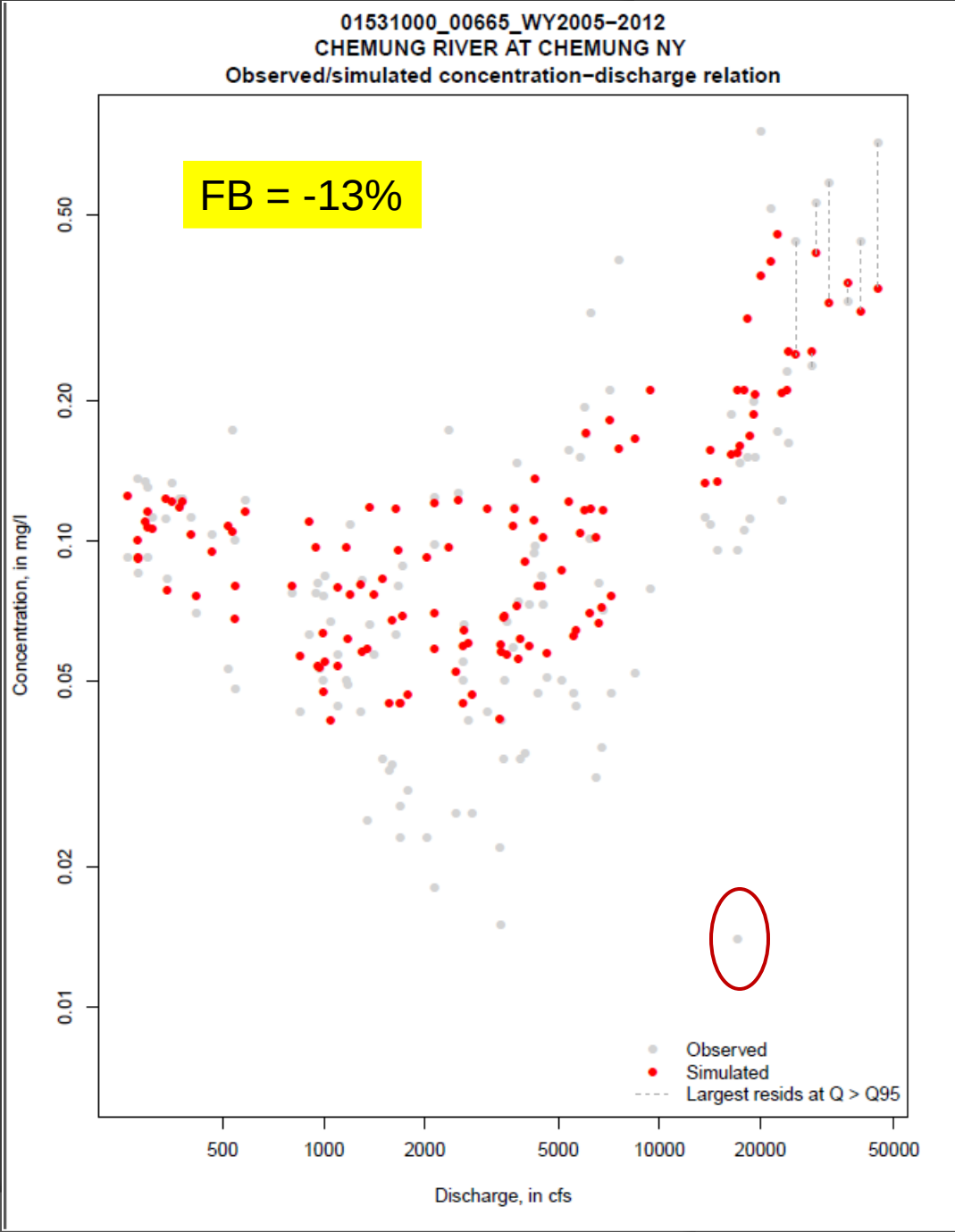
- Determine Flux Bias
  - Calculated as

$$FB = \frac{\sum Flux_{Pred} - \sum Flux_{obs}}{\sum Flux_{obs}}$$

  - Three categories of Flux Bias have been established:
    - Category 1 = +/- <10%
    - Category 2 = +/- 10 to 40%
    - Category 3 = > 40%

Model Review Process: FLUX

- Review CQ plot to evaluate model performance and ID sources of bias
- CQ plots also are used as the initial screening tool to identify potential outliers



RESULTS

- Completed Simulations for all Scenarios
- Reviewed all model diagnostics and results
- Generated input files required to update the NTN web page and produce indicator maps
- Currently updating and reviewing NTN web page and indicator maps

Indicators Produced and Source of Information

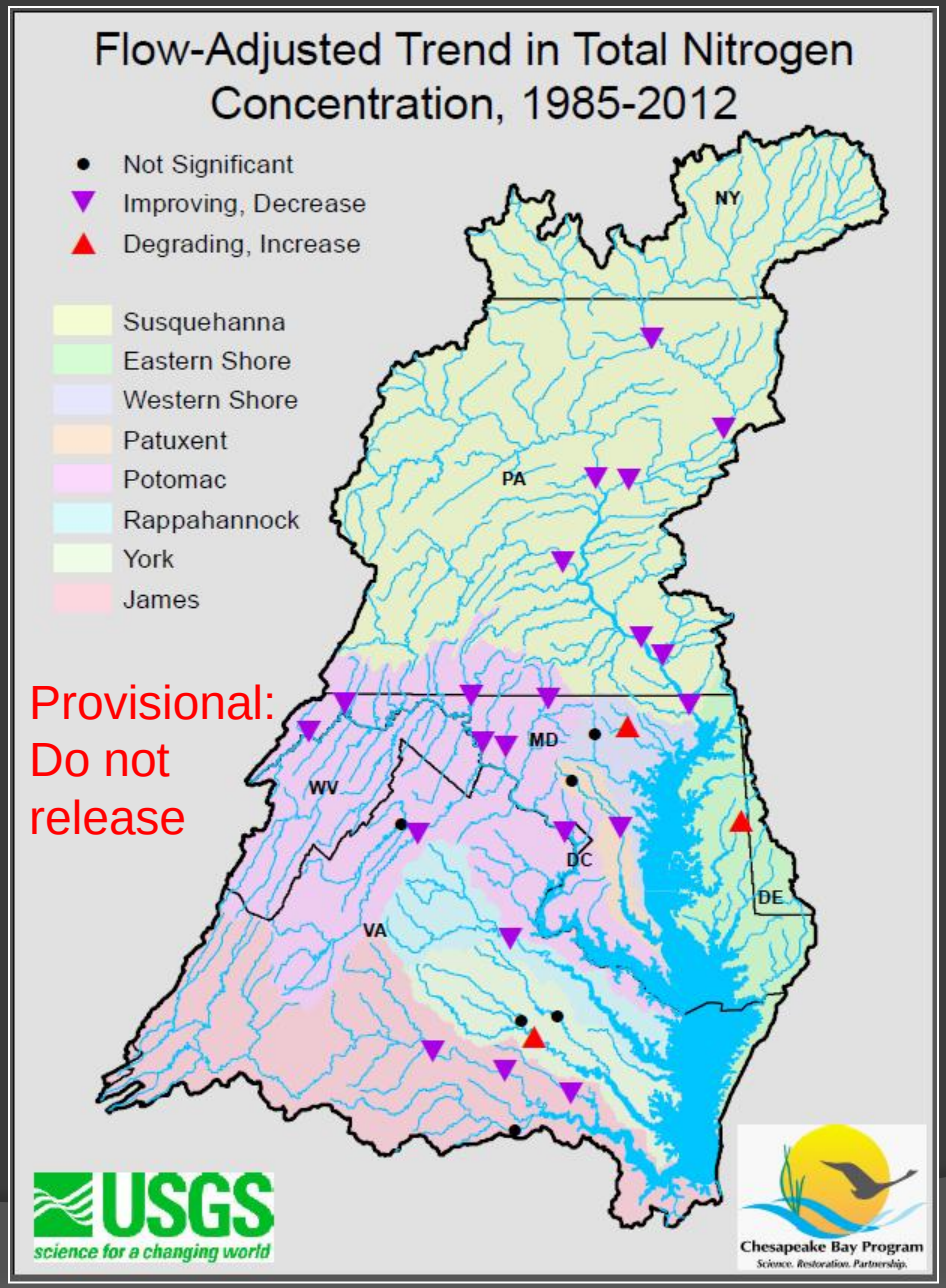
- Flow-Adjusted Trend in Concentration
  - Long-term – ESTIMATOR
  - Short- Term – ESTIMATOR
- 5-Year Average Yields
  - WRTDS
    - Long-term
    - 10-year (If not represented in long-term estimation)
    - Stations with <10years and >120 observations*
  - ESTIMATOR
    - Stations with <10 years and <120 observations*

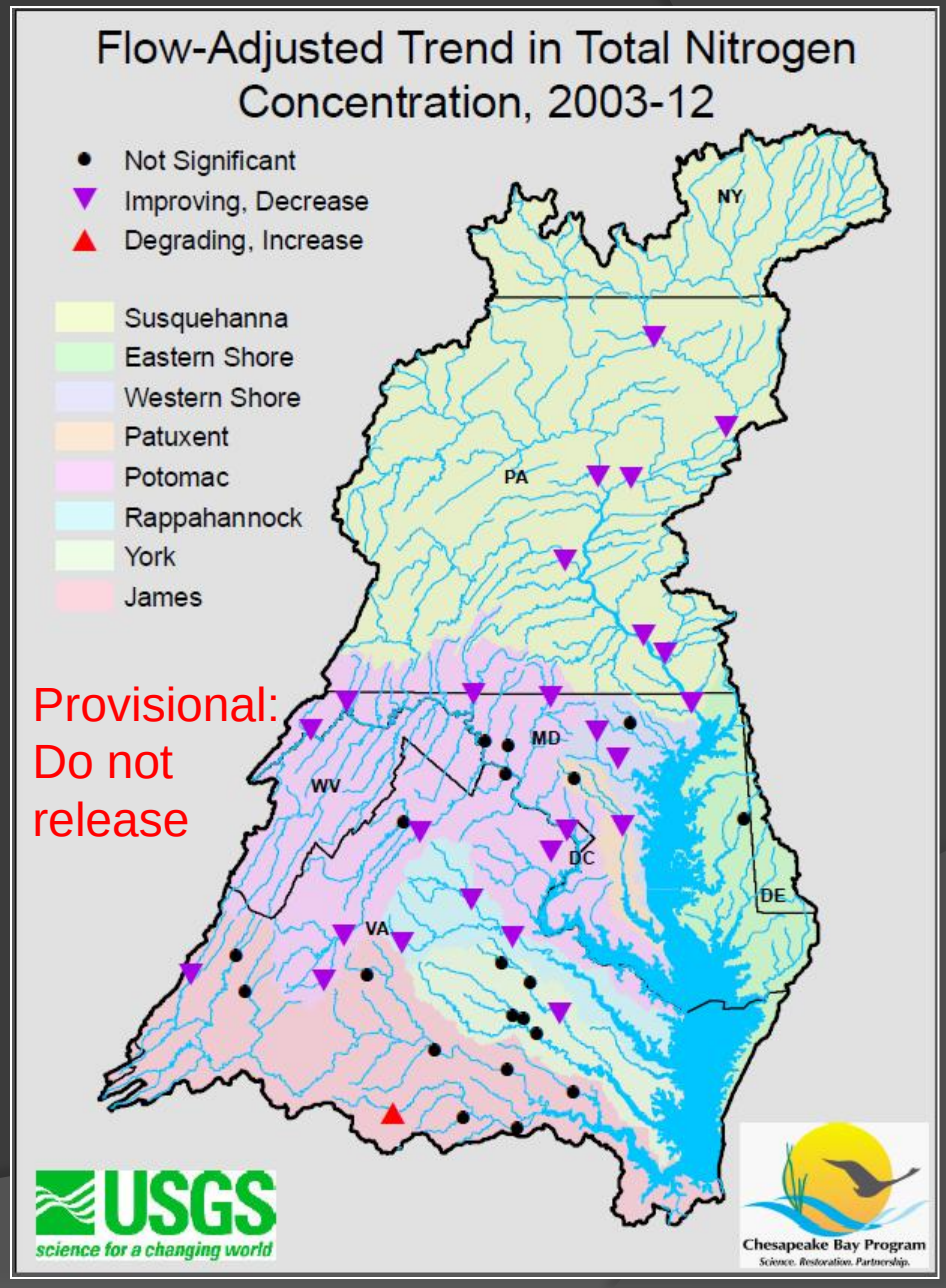
* Based on Hirsch (In Review)

Summary of Nitrogen Flow-Adjusted Concentration Trend Results

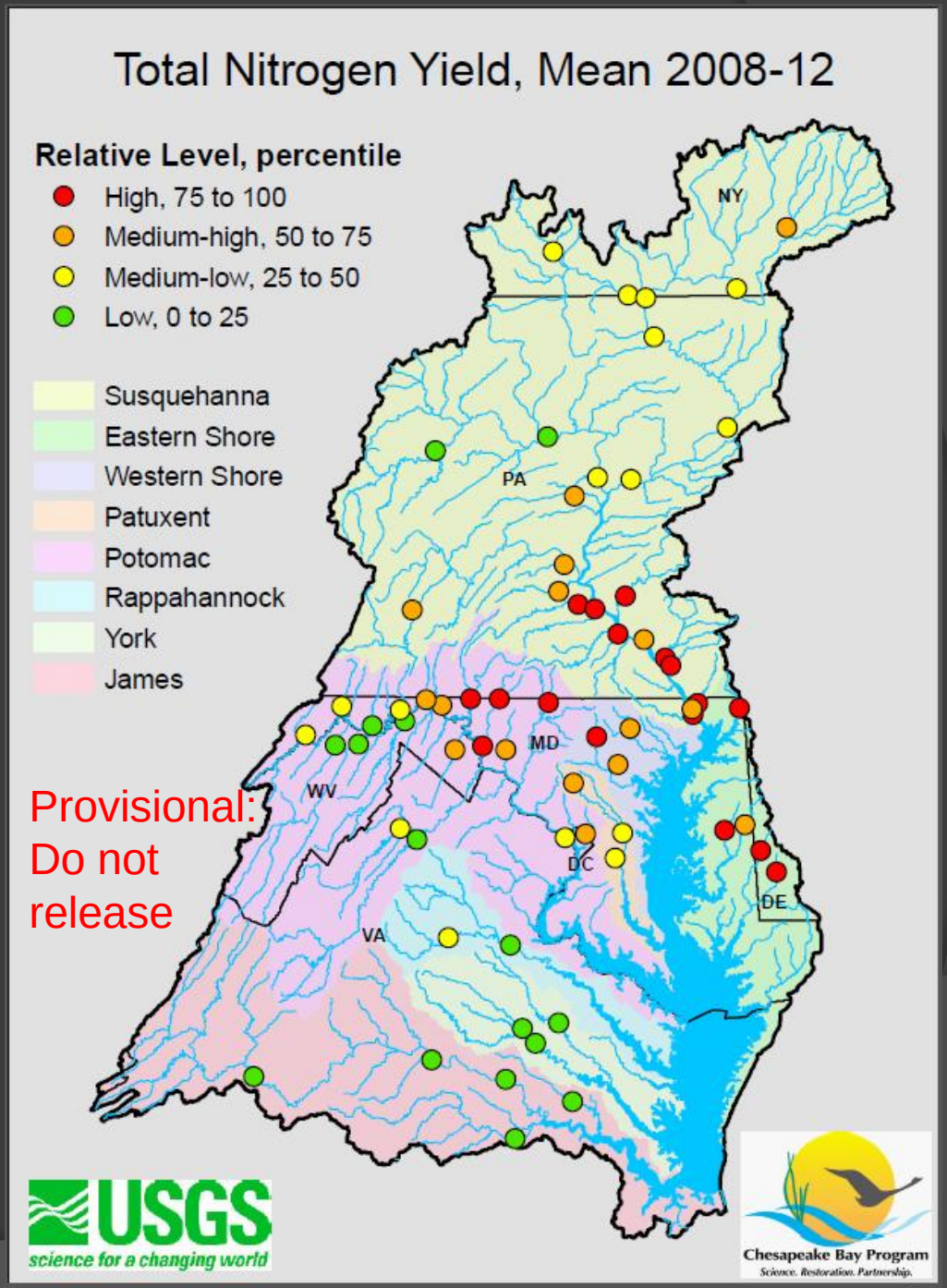
Constituent	Long-term trends				10-year trends		
	Not sig.	Degrading	Improving		Not sig.	Degrading	Improving
Total Nitrogen	6	3	21		20	1	25
(%)	20	10	70		43	2	54
Nitrate	6	5	19		13	0	33
(%)	20	17	63		28	0	72

TOTAL NITROGEN: Flow Adjusted Concentration Trends





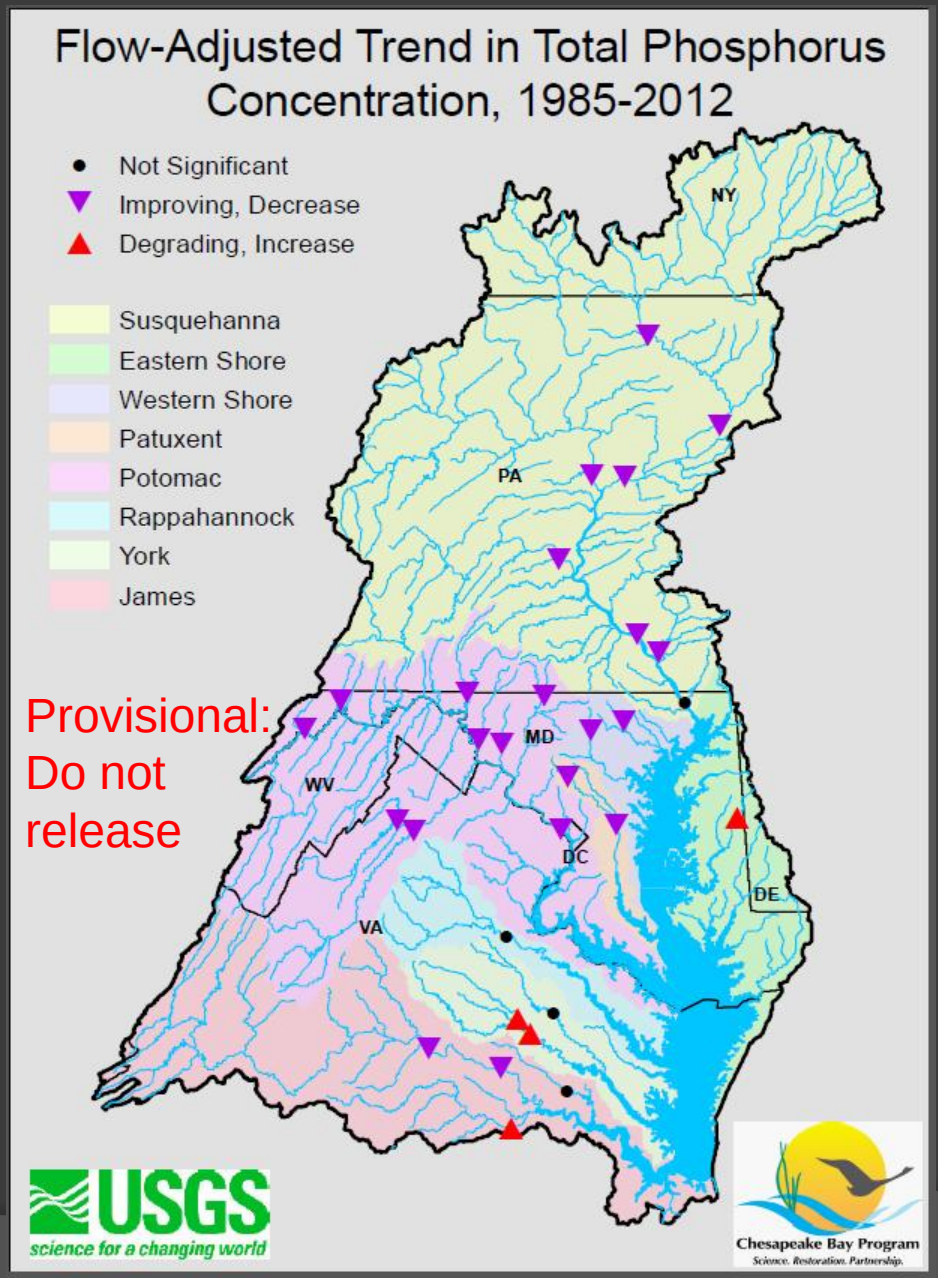
TOTAL NITROGEN YIELDS

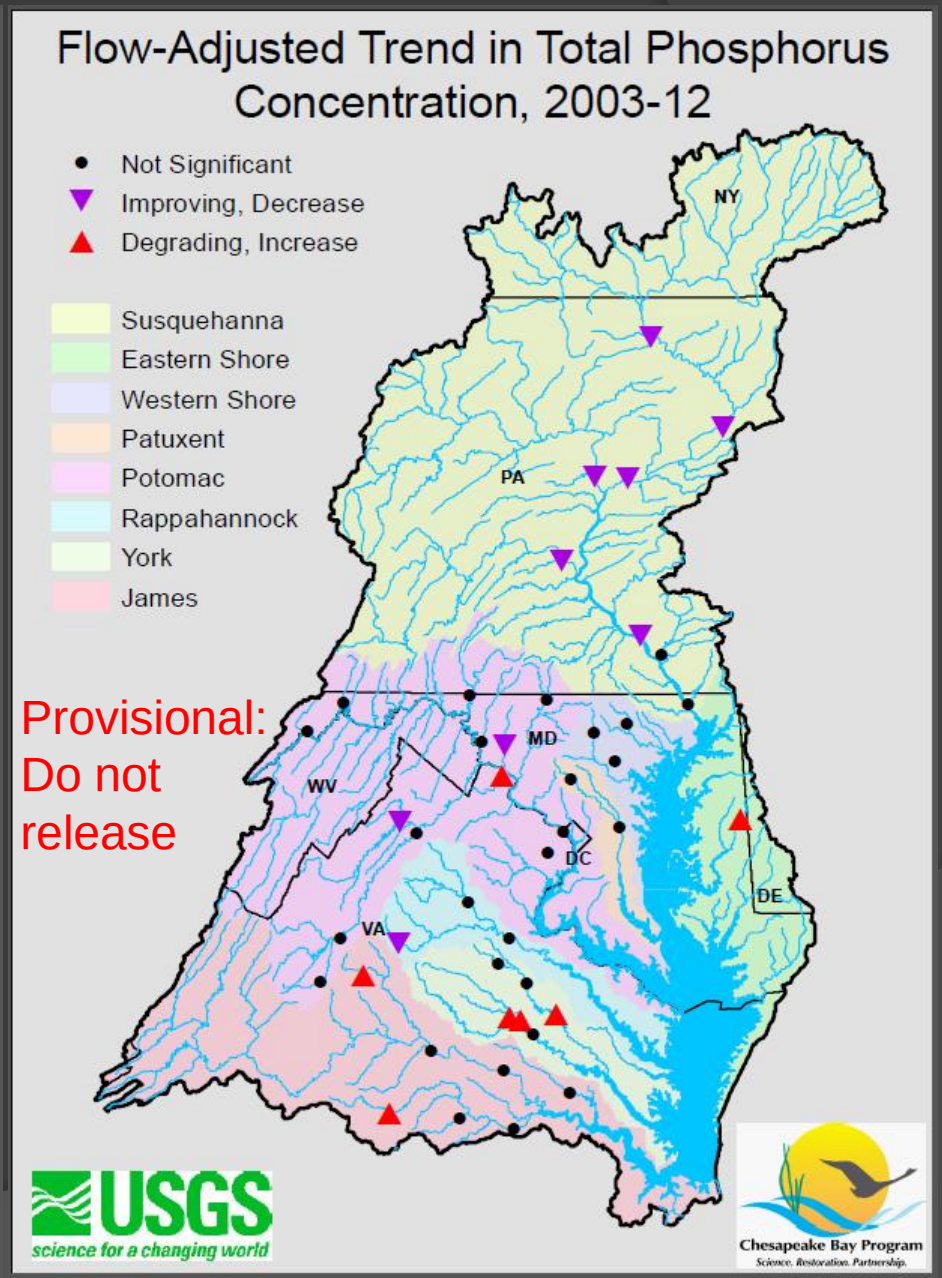


Summary of Phosphorus Flow-Adjusted Concentration Trend Results

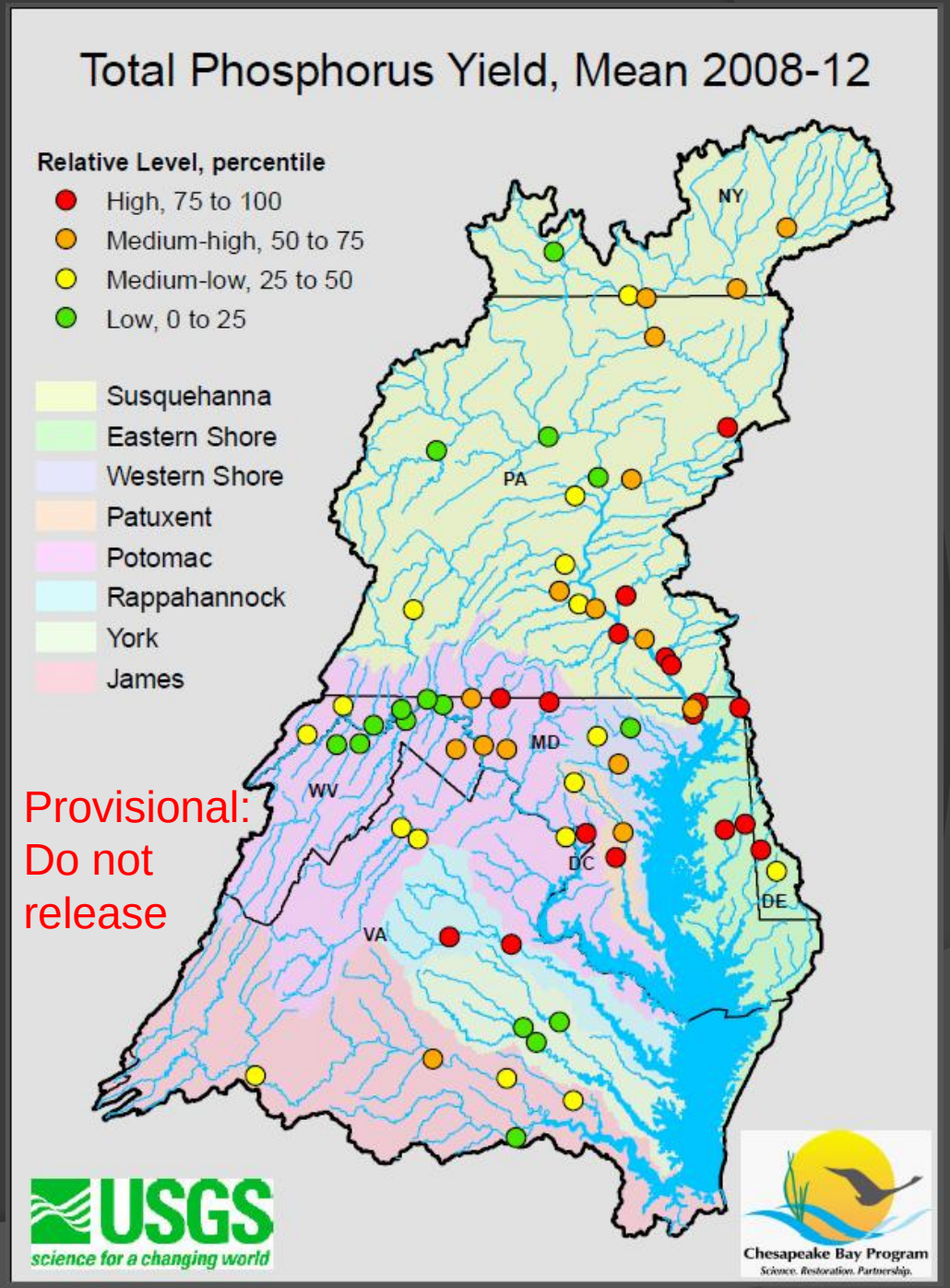
Constituent	Long-term trends				10-year trends		
	Not sig.	Degrading	Improving		Not sig.	Degrading	Improving
Total Phosphorus	4	4	22		27	7	9
(%)	13	13	73		63	16	21
Ortho-P	3	8	13		9	7	21
(%)	12	33	54		24	19	57

TOTAL PHOSPHORUS: Flow Adjusted Concentration Trends





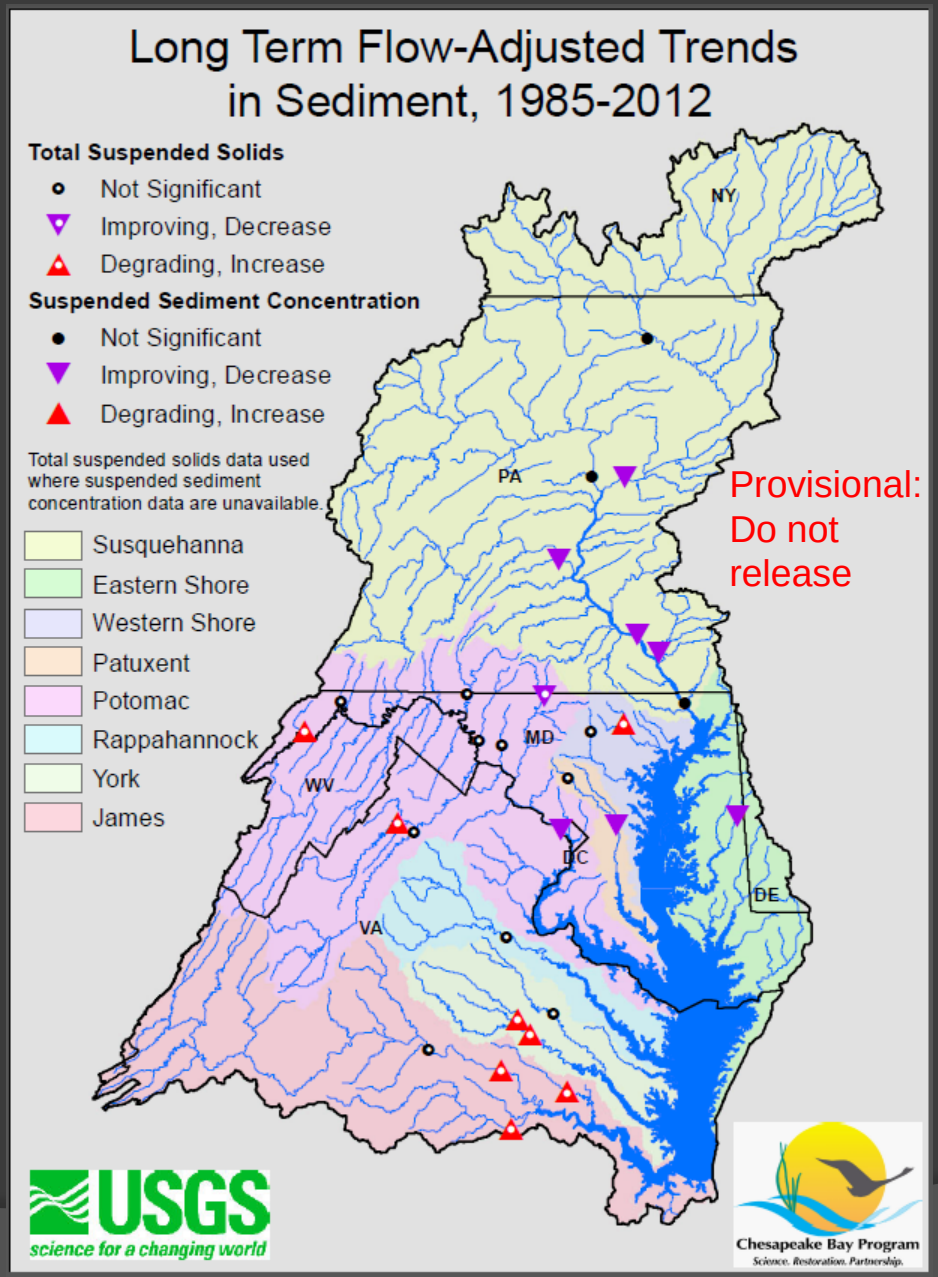
TOTAL PHOSPHORUS YIELDS

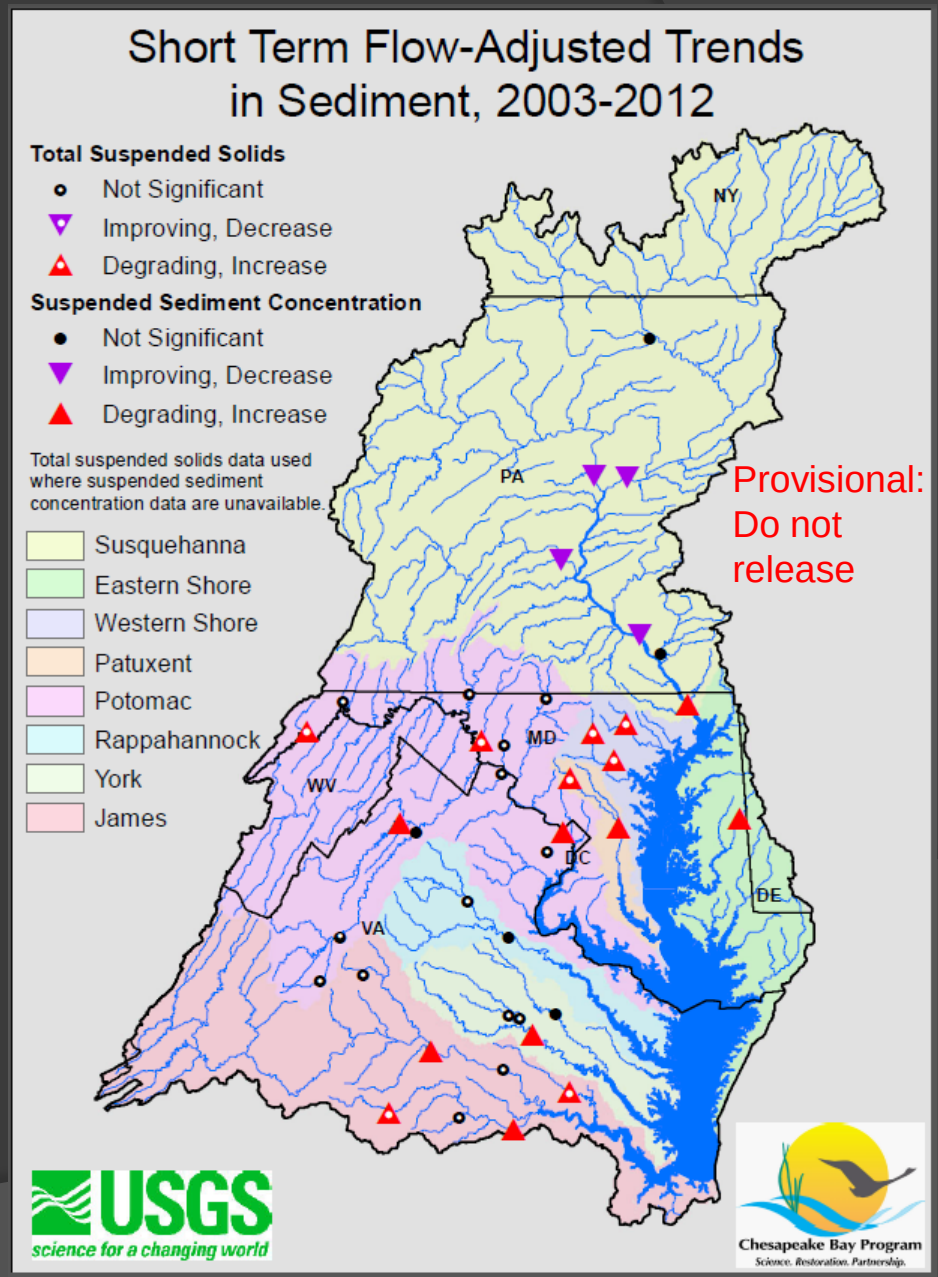


Summary of Suspended-Sediment/Solids Flow-Adjusted Concentration Trend Results

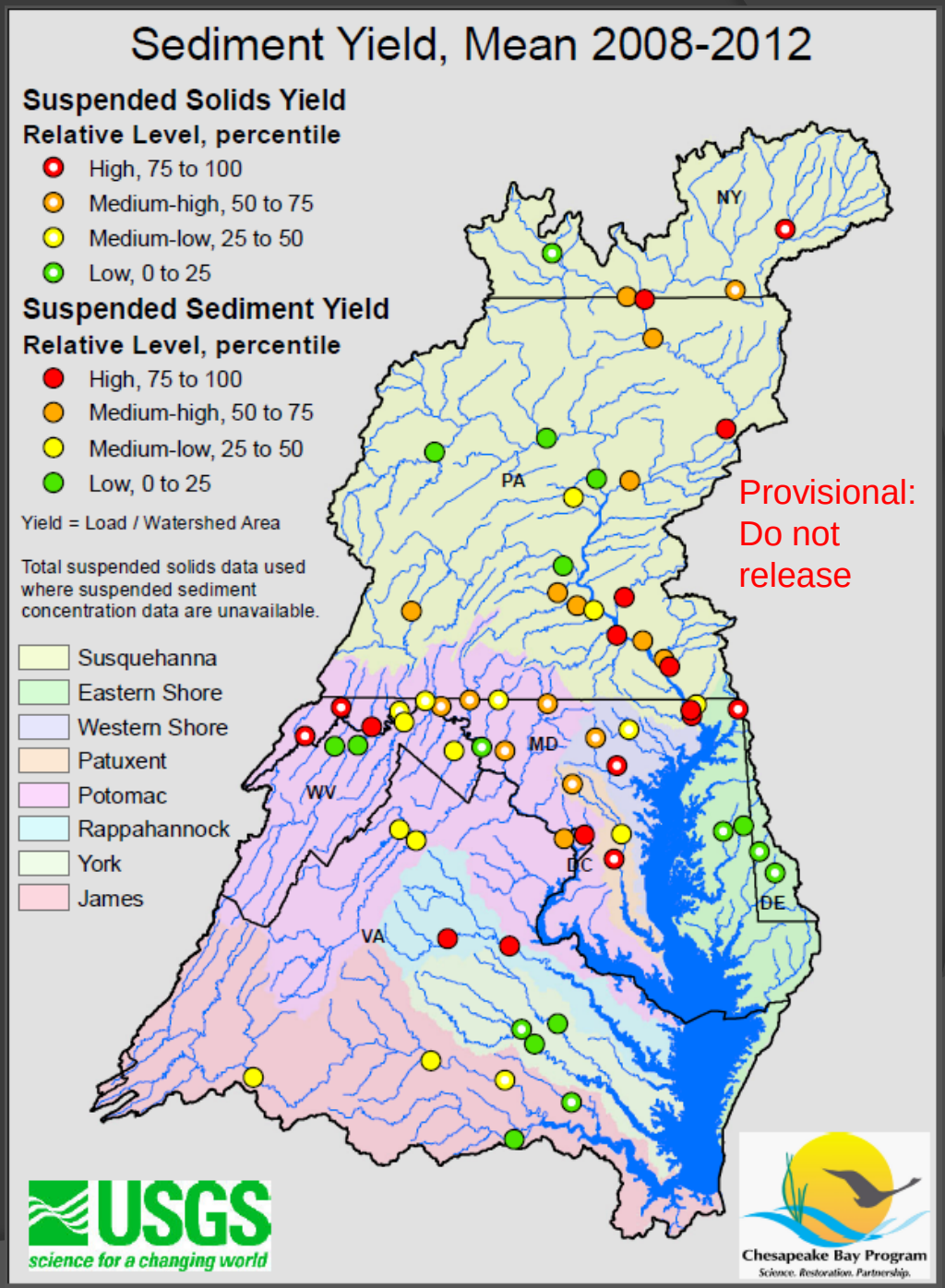
Constituent	Long-term trends				10-year trends		
	Not sig.	Degrading	Improving		Not sig.	Improving	Degrading
Suspended Sediment & Solids	13	8	8		19	16	4
(%)	44	28	28		49	41	10

Suspended Sediment: Flow Adjusted Concentration Trends



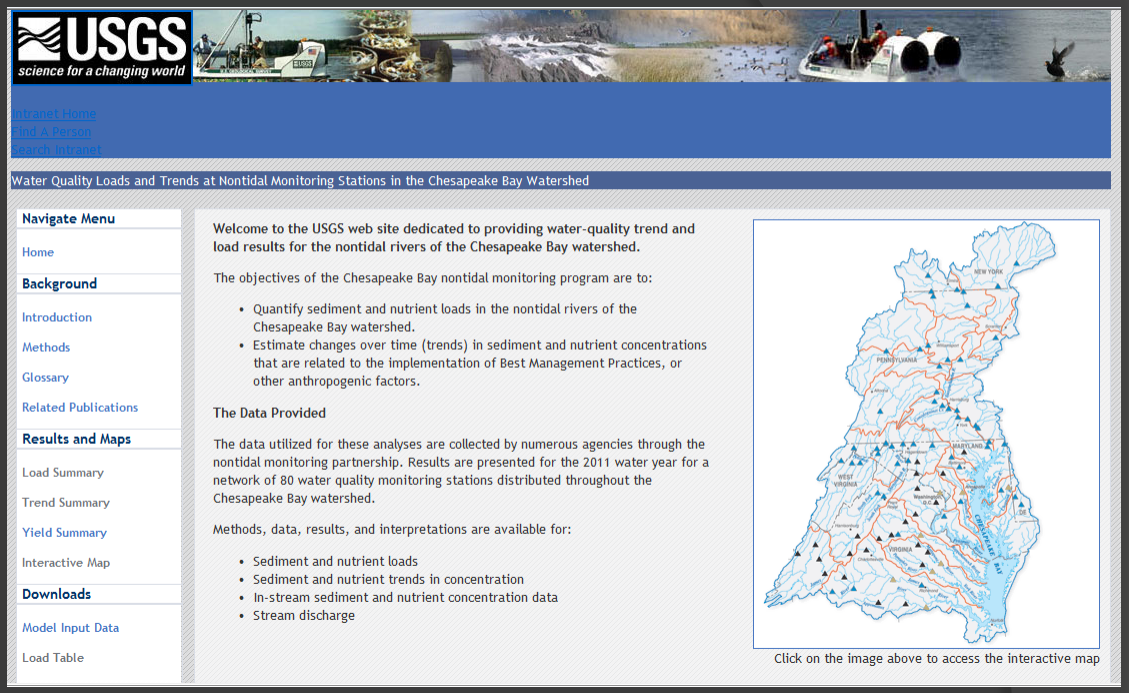


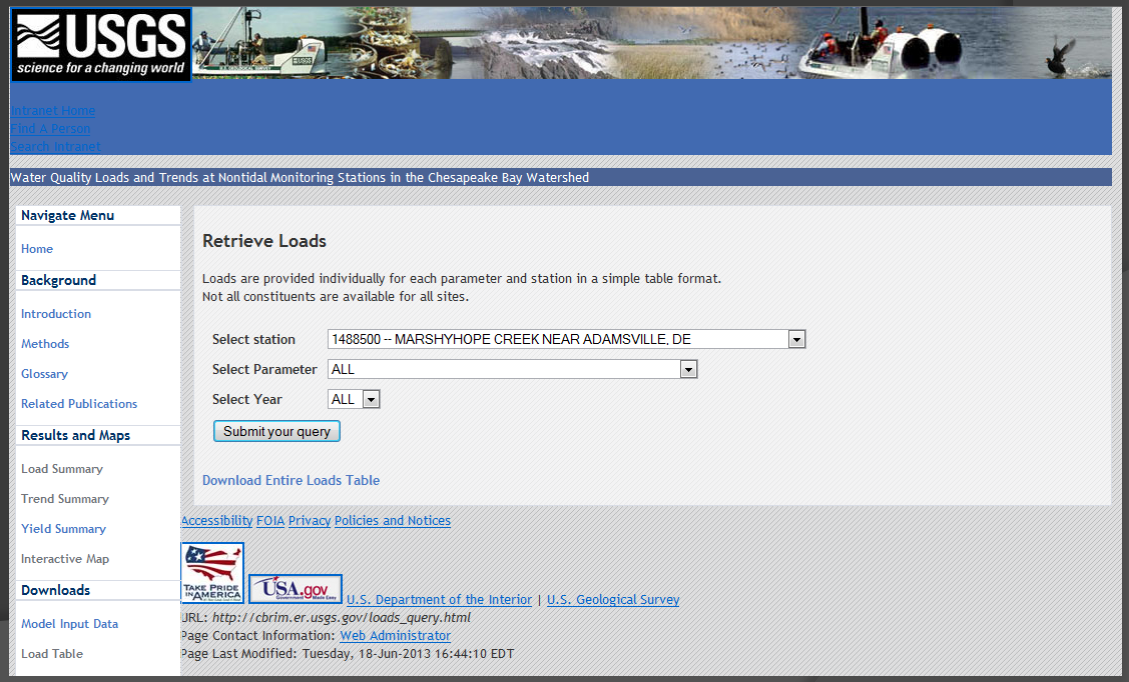
SUSPENDED SEDIMENT & SOLIDS YIELDS



WEB Updates

- Updated text
- Updated interactive maps (loads, yields, and trends)
- Updated annual load download
- Adding monthly load download
- Final review of web products still required





Timeline

- We need approximately 2 weeks to finish updating and reviewing the NTN web page
- Anticipated release of load and trend results and associated indicators no later than December 1.
- Still need to update the supporting text for each indicator maps on the EPA web page.