The Chesapeake Bay Program's Watershed Model Phase 6 -- Physical Transport Webinar

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Interstate Commission on the Potomac River Basin

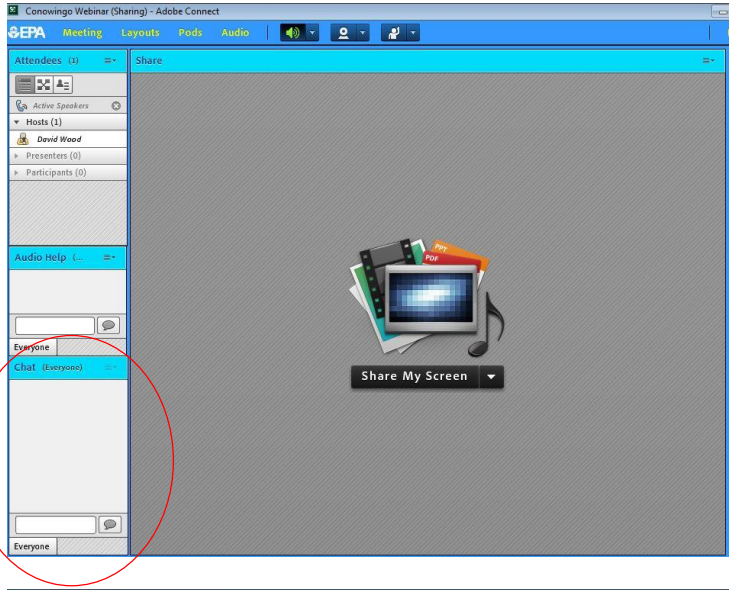
6/1/2017

Welcome to the Phase 6 Model Review Webinar

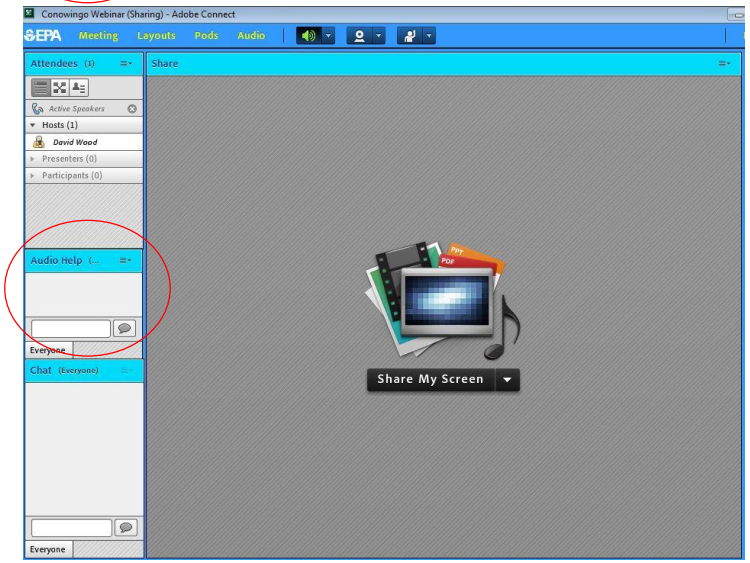
- We are Recording this Session
  - The recording and related resources will be available on the Chesapeake Bay Program's calendar page for today's webinar.
  - http://www.chesapeakebay.net/calendar/event/25116/

Welcome to the Phase 6 Model Review Webinar

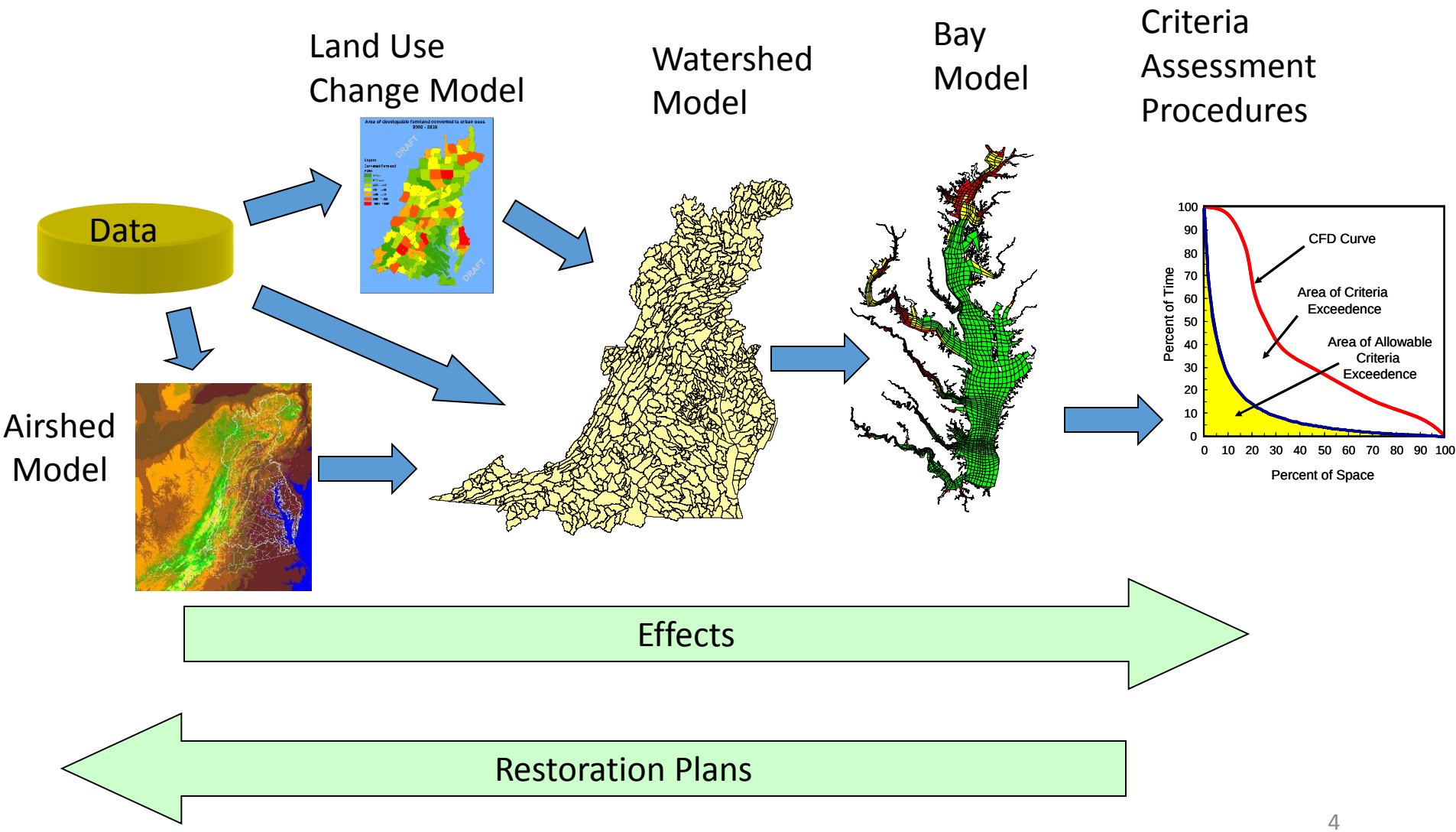
- To Ask a Question
  - Submit your question in the chat box, located in the bottom left of the screen, at any time during the webinar. We will answer as many as possible during a Q&A session following the presentation.



- For A/V Help
  - For audio or visual questions, please use the “Audio Help” box in the center-left of the screen.

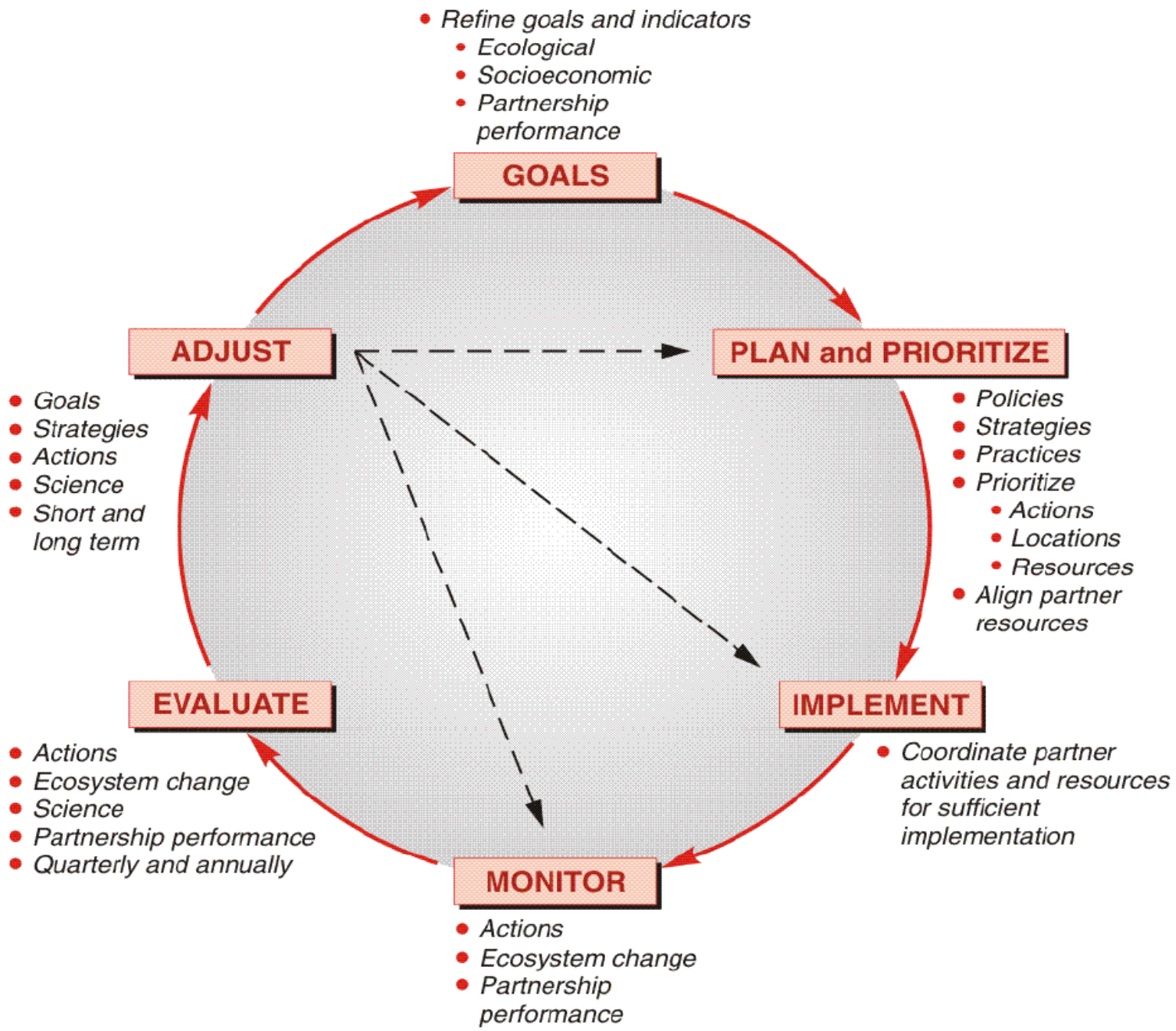


Decision Support System

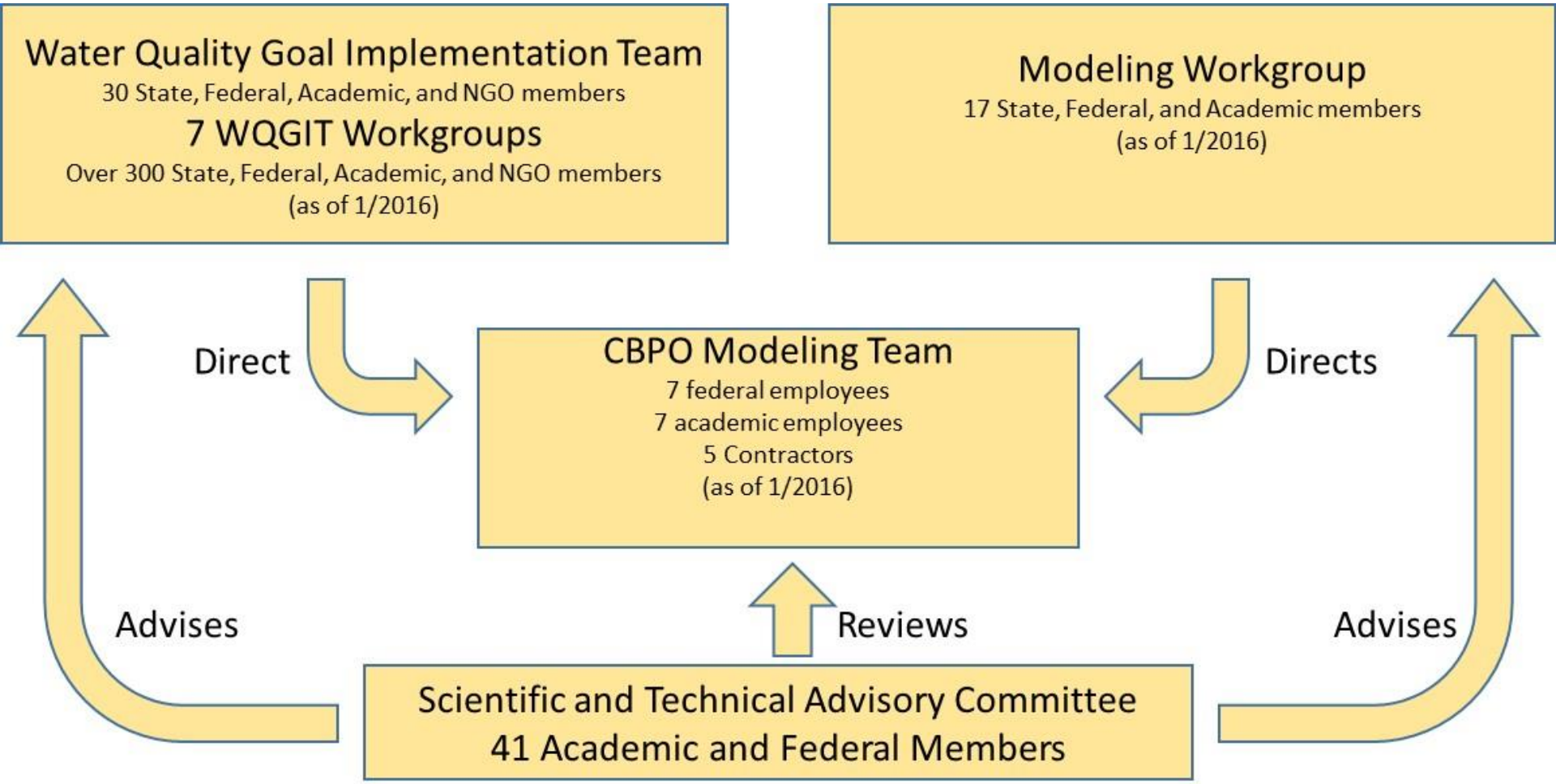


Continual Updates to Models

Year	Model Phase	Goal
1987	0	40% reduction
1992	2	40% of controllable loads
1997	4.1	Confirm 1992 loads
2003	4.3	Reallocation
2010	5.3.0	TMDL
2011	5.3.2	Phase 2 WIP targets
2017	6.0	Phase 3 WIP targets



Sources: Williams et al. 2007, Levine et al. 2009.


Water Quality Goal Implementation Team
30 State, Federal, Academic, and NGO members
7 WQGIT Workgroups
Over 300 State, Federal, Academic, and NGO members
(as of 1/2016)
Modeling Workgroup
17 State, Federal, and Academic members
(as of 1/2016)
Direct
CBPO Modeling Team
7 federal employees
7 academic employees
5 Contractors
(as of 1/2016)
Directs
Advises
Reviews
Advises
Scientific and Technical Advisory Committee
41 Academic and Federal Members

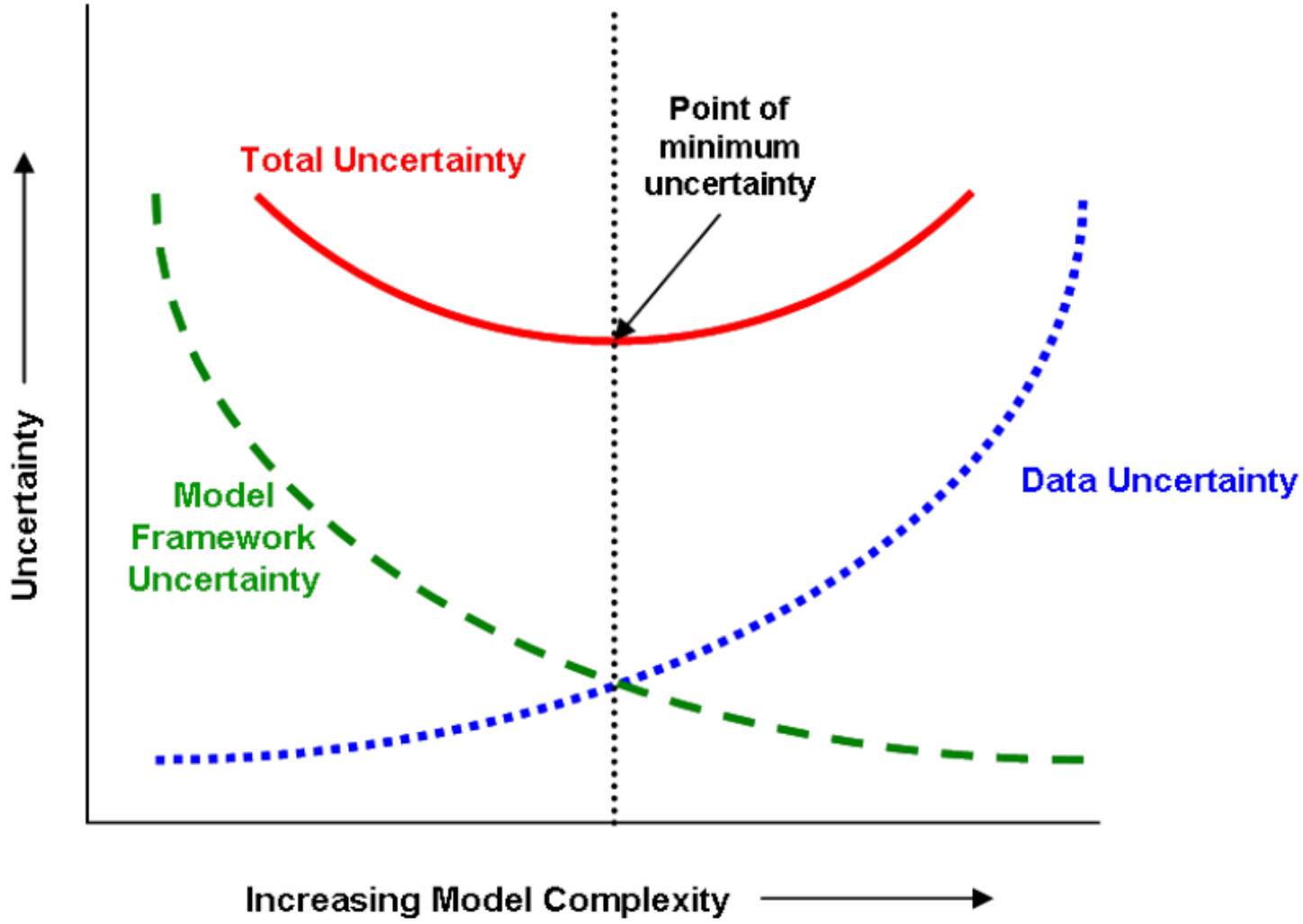
Partnership Feedback on Modeling

- **Water Quality Managers**
  - Need more **transparent and easier** to understand decision-support tools to enable successful engagement of local partners

- **Scientific and Technical Advisory Committee**
  - Multiple Models
  - Phosphorus
  - Complex Reservoir Dynamics
  - Fine-scale processes

Keep it Simple!!

Include Everything!!!



Relationship between **model framework uncertainty** and **data uncertainty**, and their combined effect on **total model uncertainty**. Application niche uncertainty would scale the total uncertainty. Adapted from Hanna (1988) and EPA (2009a).

https://www.epa.gov/sites/production/files/2015-09/documents/mod8-saua-mod-final.pdf

Main Prediction of the Watershed Model for decision support

- Change in Anthropogenic Load
  - BMPs
  - WWTP
  - Land use Change
  - Response to Change in inputs

- How to keep it simple and include everything?





Phase 6 Model Structure

Average Load + Δ Inputs * Sensitivity

*

Land Use Acres

*

BMPs

*

Land to Water

*

Stream Delivery

*

River Delivery

Direct Loads

Phase 6

Keep It Simple

Include Everything

Average Load + ΔInputs * Sensitivity

*

Land Use Acres

*

BMPs

*

Land to Water

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Stream Delivery

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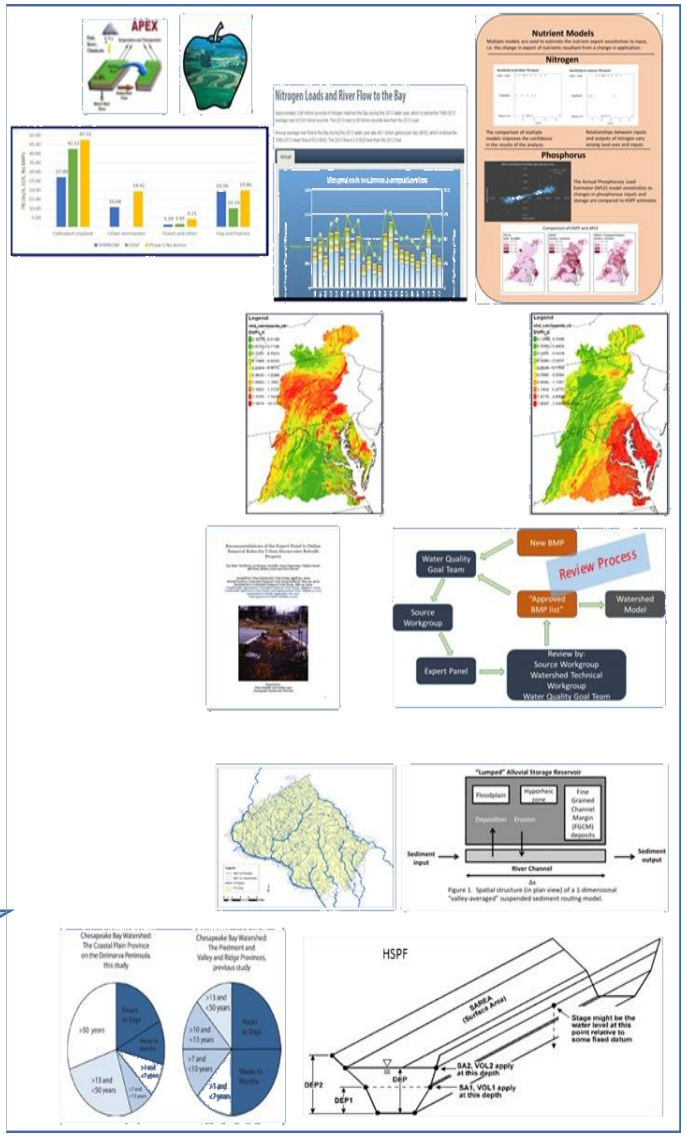
River Delivery

Direct Loads



Finished

Potentially Finished

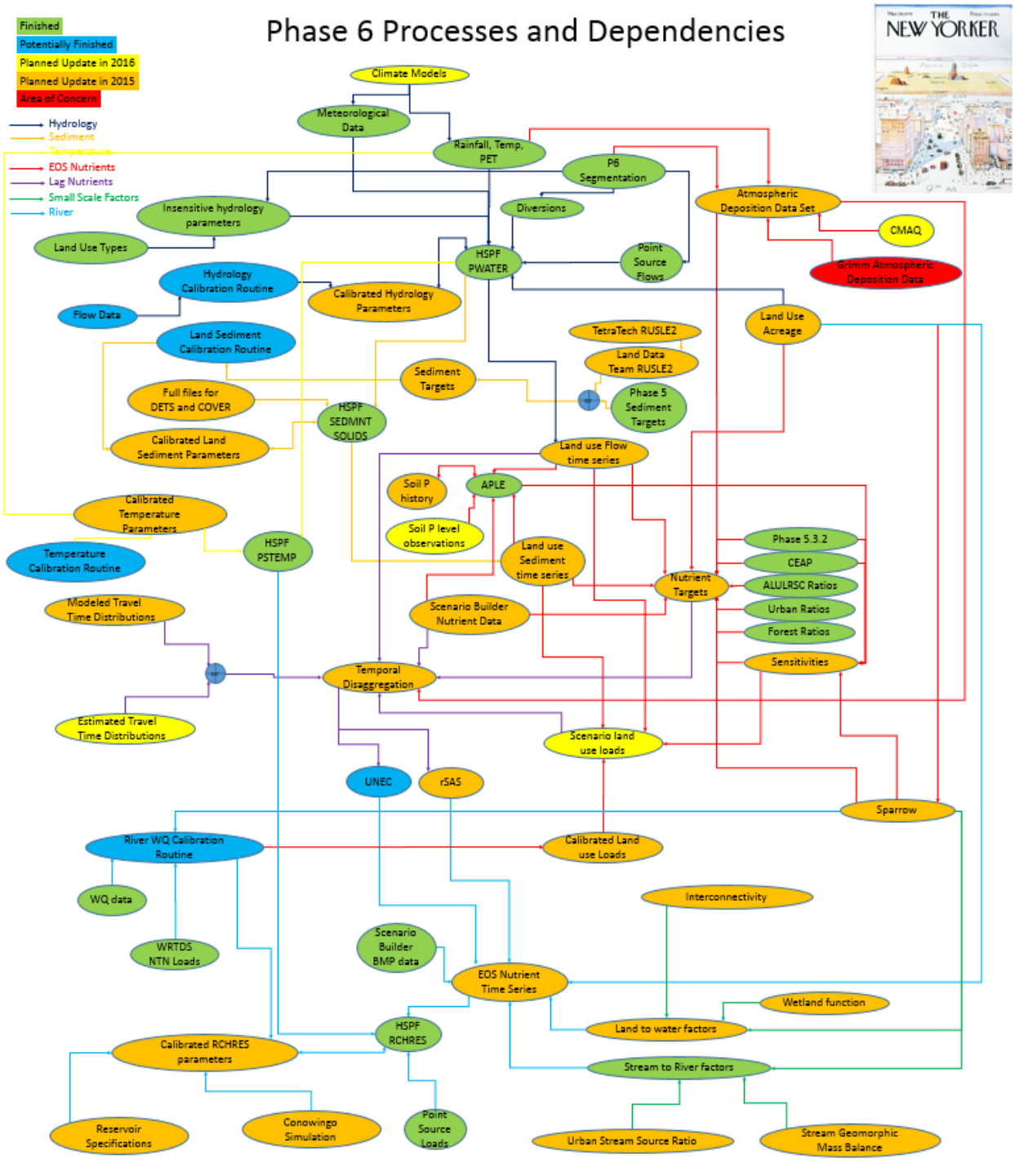
Planned Update in 2016

Planned Update in 2015

Area of Concern

Each box represents a dataset, model, or process

9/3/15







Phase 6 Model Documentation

Section 2: Ave Load + Section 3: Inputs * Section 4: Sensitivity

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Section 5: Land Use

*

Section 6: BMPs

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Section 7: Land to Water

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Section 9: Stream Delivery

*

Section 10: River Delivery

Section 1: Overview

Section 8: Direct Loads

Section 11: Physical Setting

Section 12: Applications

Section 13: Reviews

Section 14: References





Phase 6 Model Structure

Average Load + Δ Inputs * Sensitivity

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Land Use Acres

*

BMPs

*

Land to Water

*

Stream Delivery

*

River Delivery

Direct Loads

Phase 6





Phase 6 Model Structure

Average Load + Δ Inputs * Sensitivity

*****

Land Use Acres

Loads change across regions and through scenarios based on inputs and land use

5/25/17 and 6/1/17 Webinars

Phase 6





Phase 6 Model Structure

Loads change across regions and through scenarios based on inputs and land use

Data-driven

BMPs

Direct Loads

Phase 6





Phase 6 Model Structure

Loads change across regions based on transport effects

Mostly **constant across scenarios**

Today's Webinar

Land to Water

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Stream Delivery

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River Delivery

Phase 6





Phase 6 Model Documentation

Section 2: Ave Load + Section 3: Inputs * Section 4: Sensitivity

*

Section 5: Land Use

*

Section 6: BMPs

*

Section 7: Land to Water

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Section 9: Stream Delivery

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Section 1: Overview

Section 8: Direct Loads

Section 11: Physical Setting

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Questions and Answers Session

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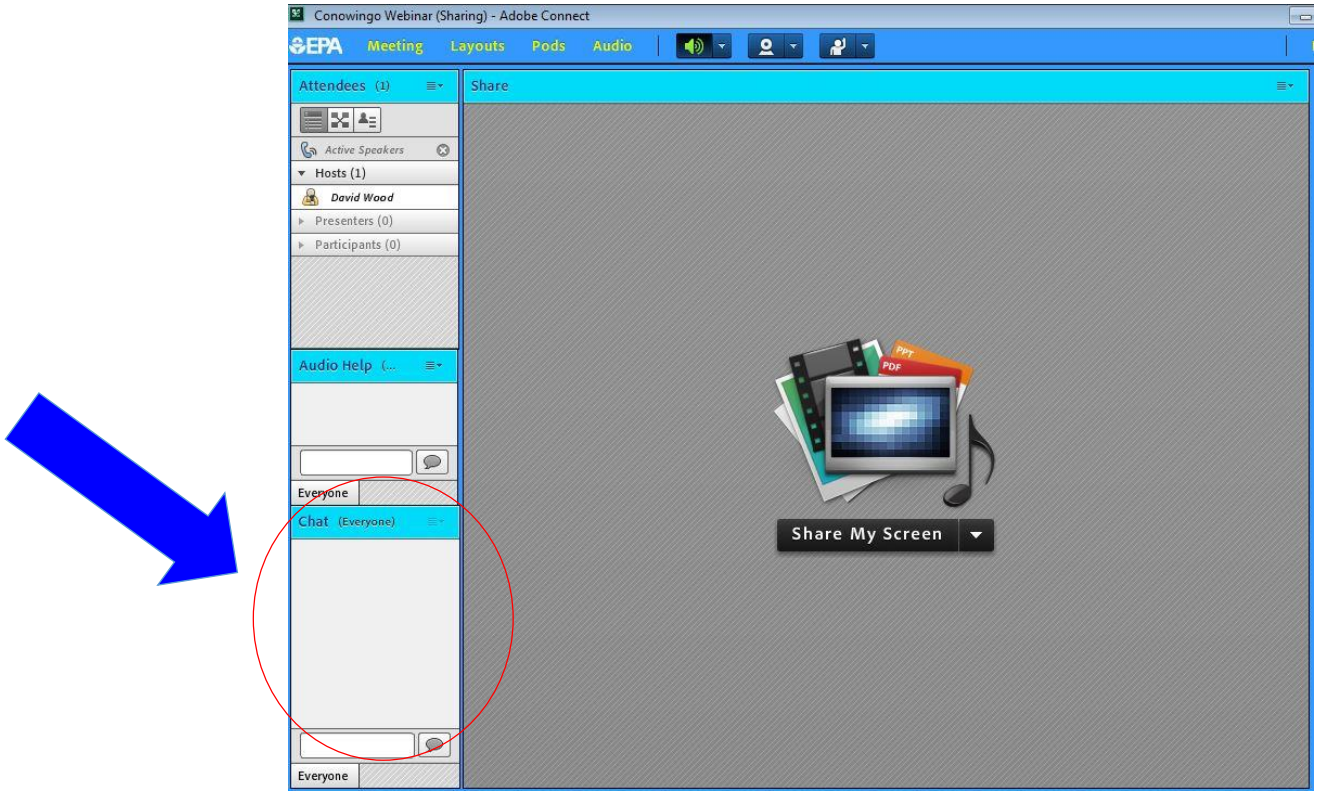






Phase 6 Model Structure

Average Load + Δ Inputs * Sensitivity

*

Land Use Acres

*

BMPs

*

Land to Water

*

Stream Delivery

*

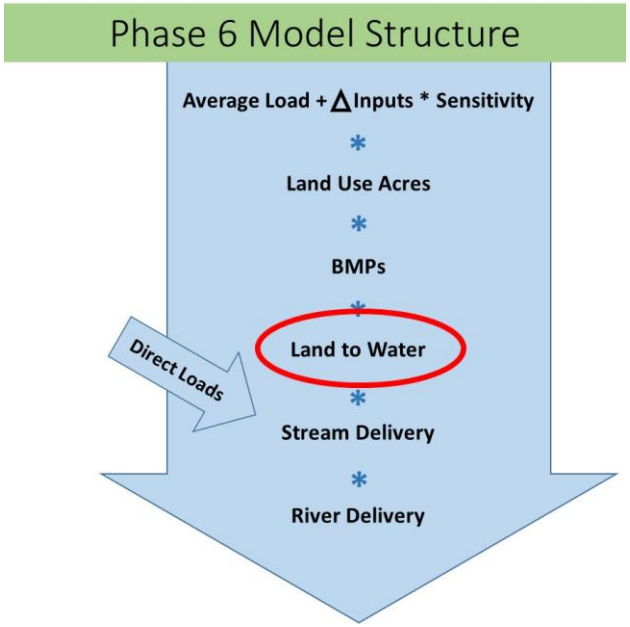
River Delivery

Direct Loads

Phase 6

Land to Water Factors

- The spatial effect of watershed transport characteristics
- Have no aggregate effect on loads
  - Spatial variability
  - Weighted average is one

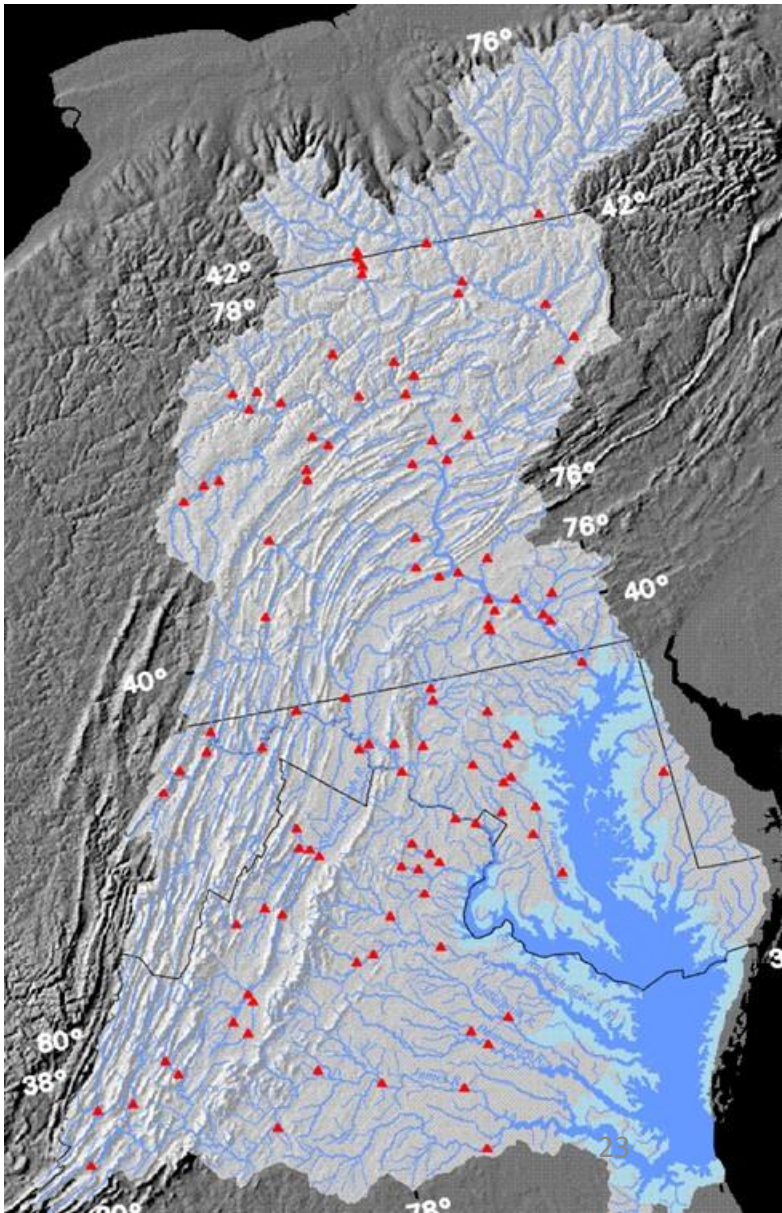


$$LOAD_i = \left\{ \sum_{j \in J(i)} \left[\sum_{n=1}^{N} S_{n,j} \beta_n \exp(-\alpha' Z_j) \right] \prod_m \exp(-\delta_m^s T_{i,j,m}) \prod_l 1/(1+\lambda^r q_{i,j,l}^{-1}) \right\} \exp(\varepsilon_i)$$

USGS Sparrow Model

- Regression Model
- Gain knowledge about the watershed based on observations

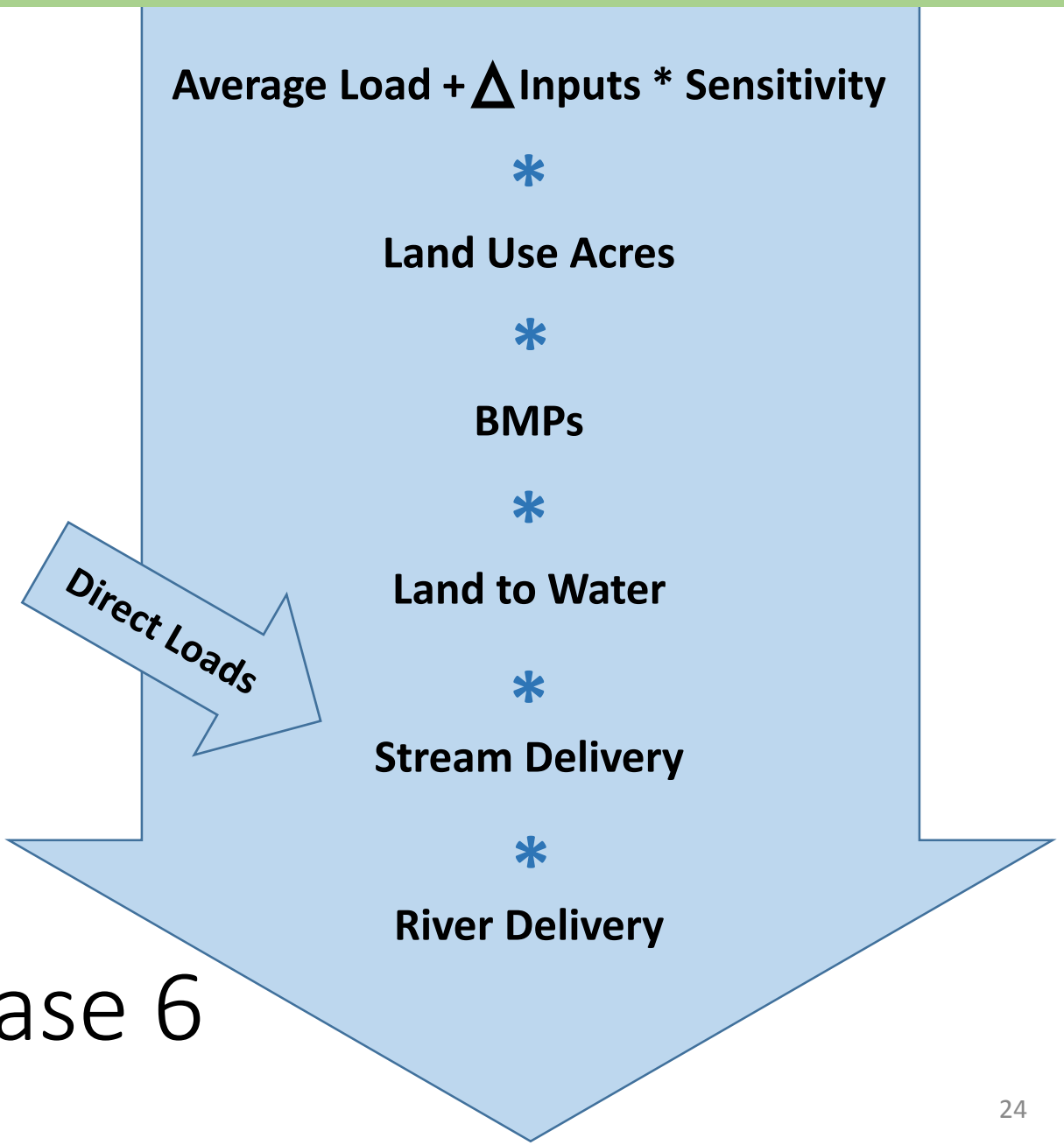
- Chesapeake Sparrow, version 4 used for calculations
  - Ator and other 2011



Phase 6 Model Structure

Sparrow Structure

$$LOAD_i = \left\{ \sum_{j \in J(i)} \left[\sum_{n=1}^{N} S_{n,j} \beta_n \exp(-\alpha' Z_j) \right] \prod_m \exp(-\delta_m^s T_{i,j,m}) \prod_l 1/(1 + \lambda^r q_{i,j,l}^{-1}) \right\} \exp(\varepsilon_i)$$



Phase 6

Phase 6 Model Structure

Sparrow Structure

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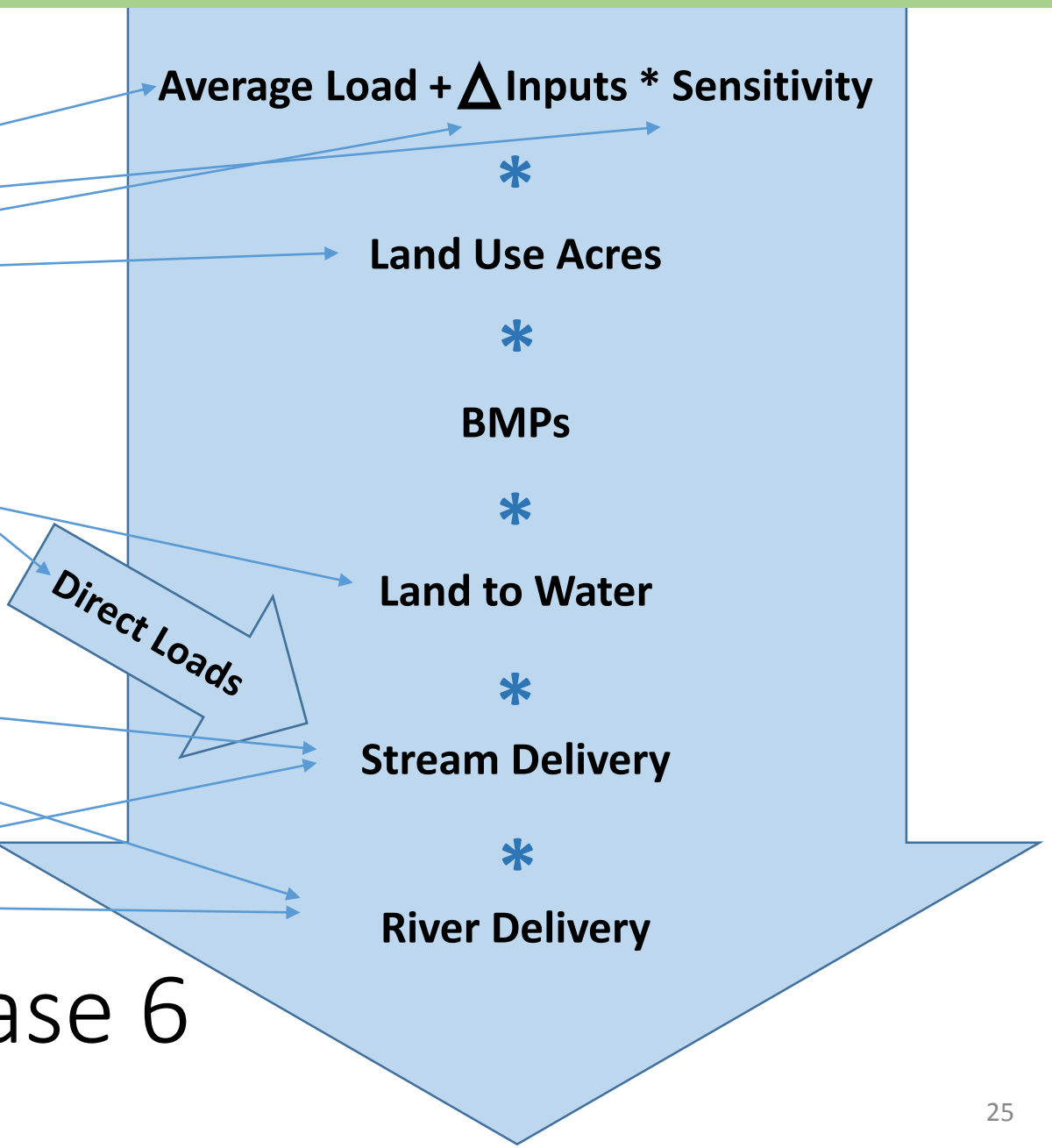
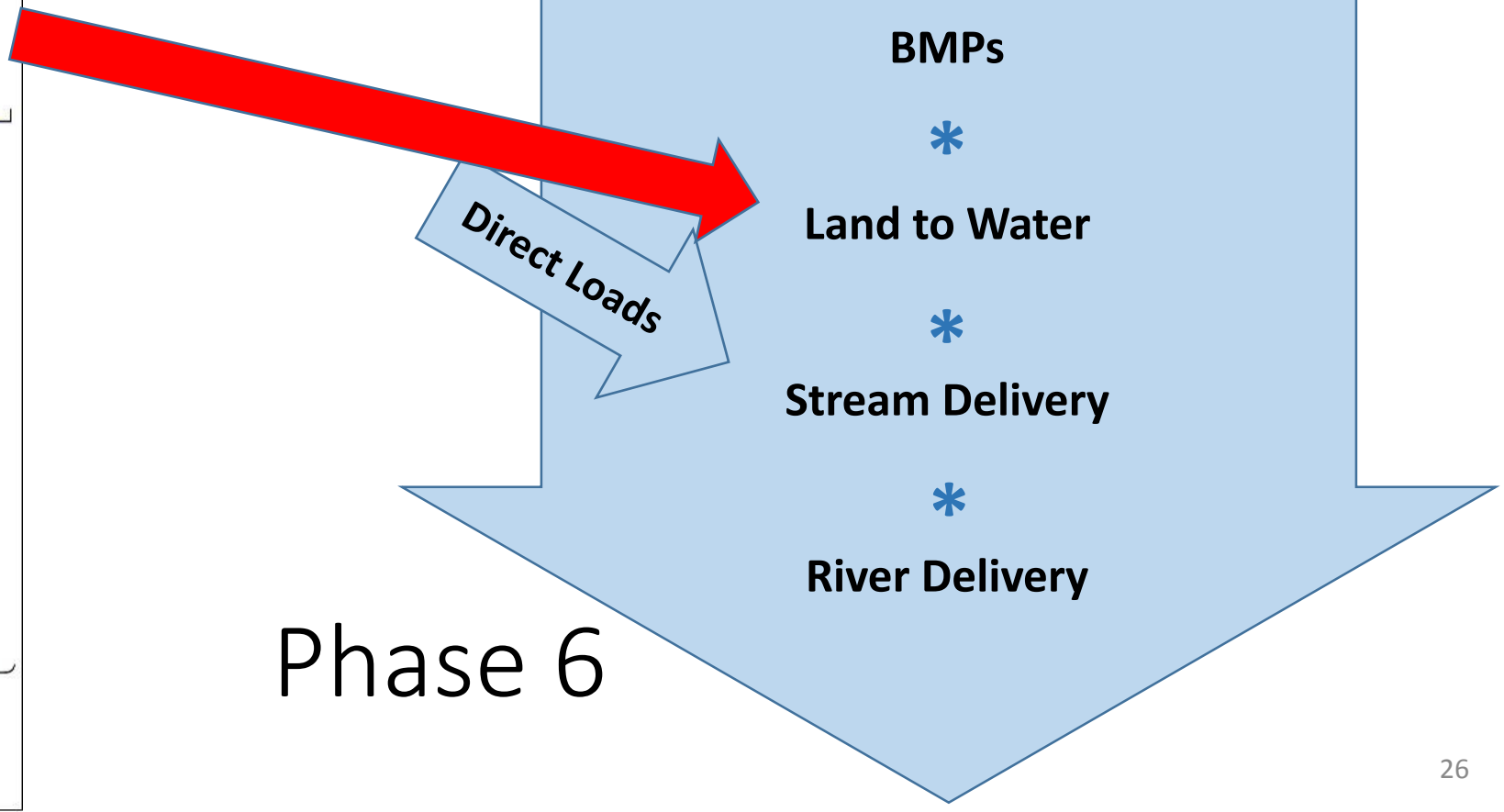


Phase 6

Phase 6 Model Structure

Sparrow Structure

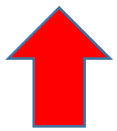
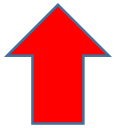
$$LOAD_i = \left\{ \sum_{j \in J(i)} \left[\sum_{n=1}^{N} S_{n,j} \beta_n \exp(-\alpha' Z_j) \right] \prod_{m} \exp(-\delta_m^s T_{i,j,m}) \prod_{l} 1/(1 + \lambda^r q_{i,j,l}^{-1}) \right\} \exp(\varepsilon_i)$$



Phase 6

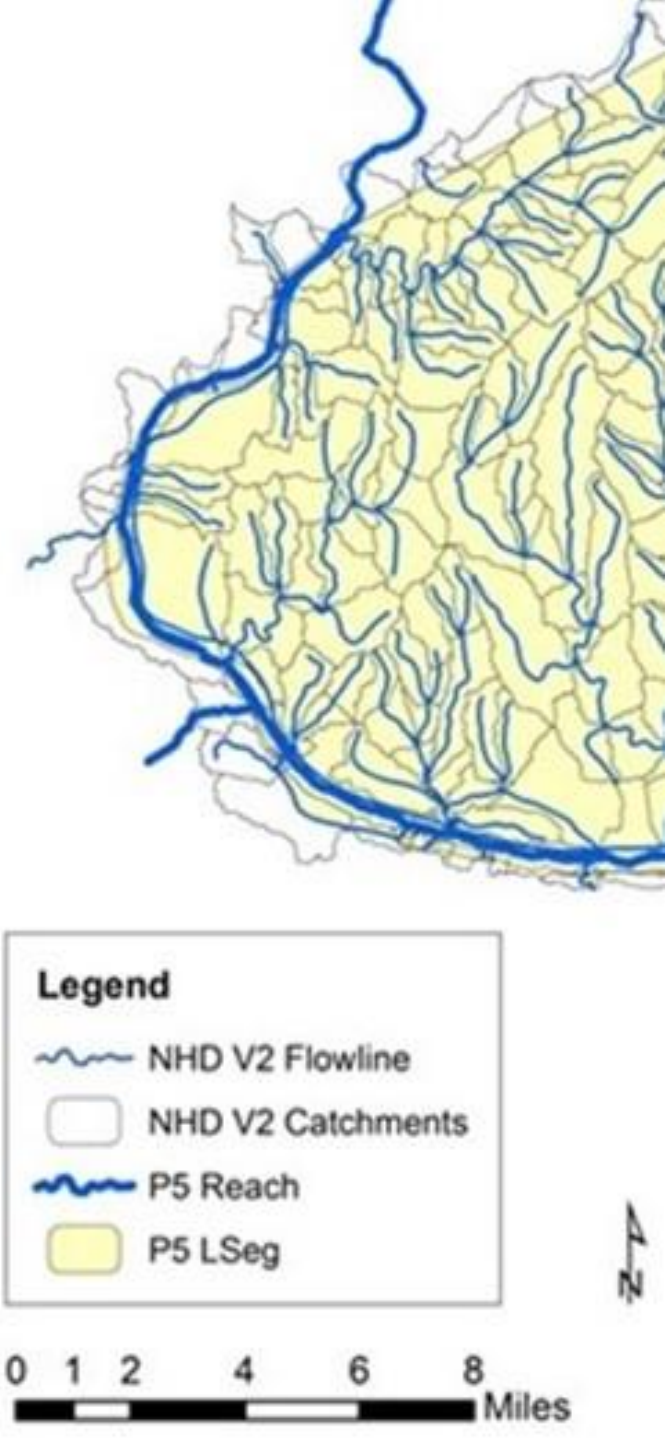
Nitrogen Land to Water Factors

- Groundwater recharge
  - Important pathway for nitrogen transport
- Piedmont Carbonate
  - Groundwater moves faster in these regions
- Enhanced Vegetative Index (greenness)
  - Plant utilization of nitrogen
- Available water capacity
  - Related to denitrification

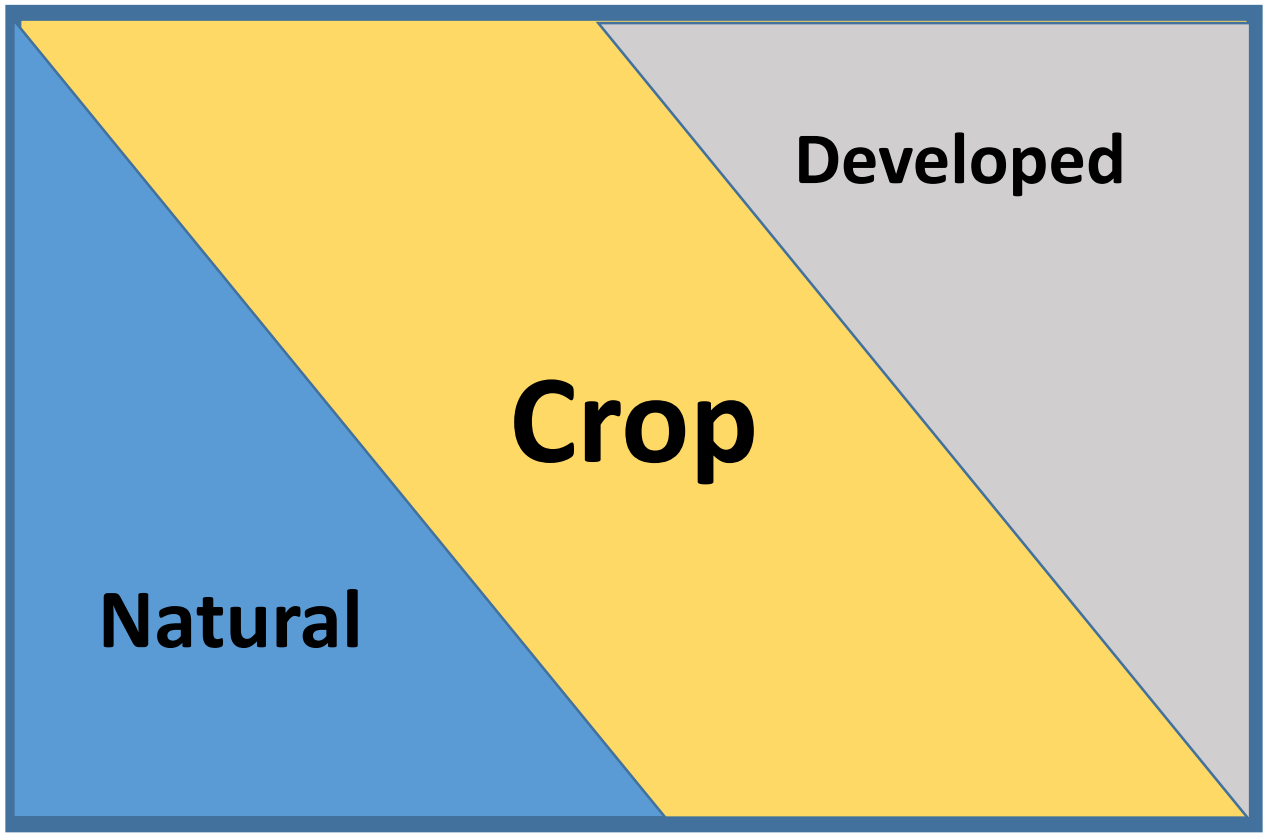



Scaling to Phase 6

- Sparrow available on NHD catchments
- Phase 6 Land-river segments are larger
- Weighted average by major land use type



Conceptual Land-River segment

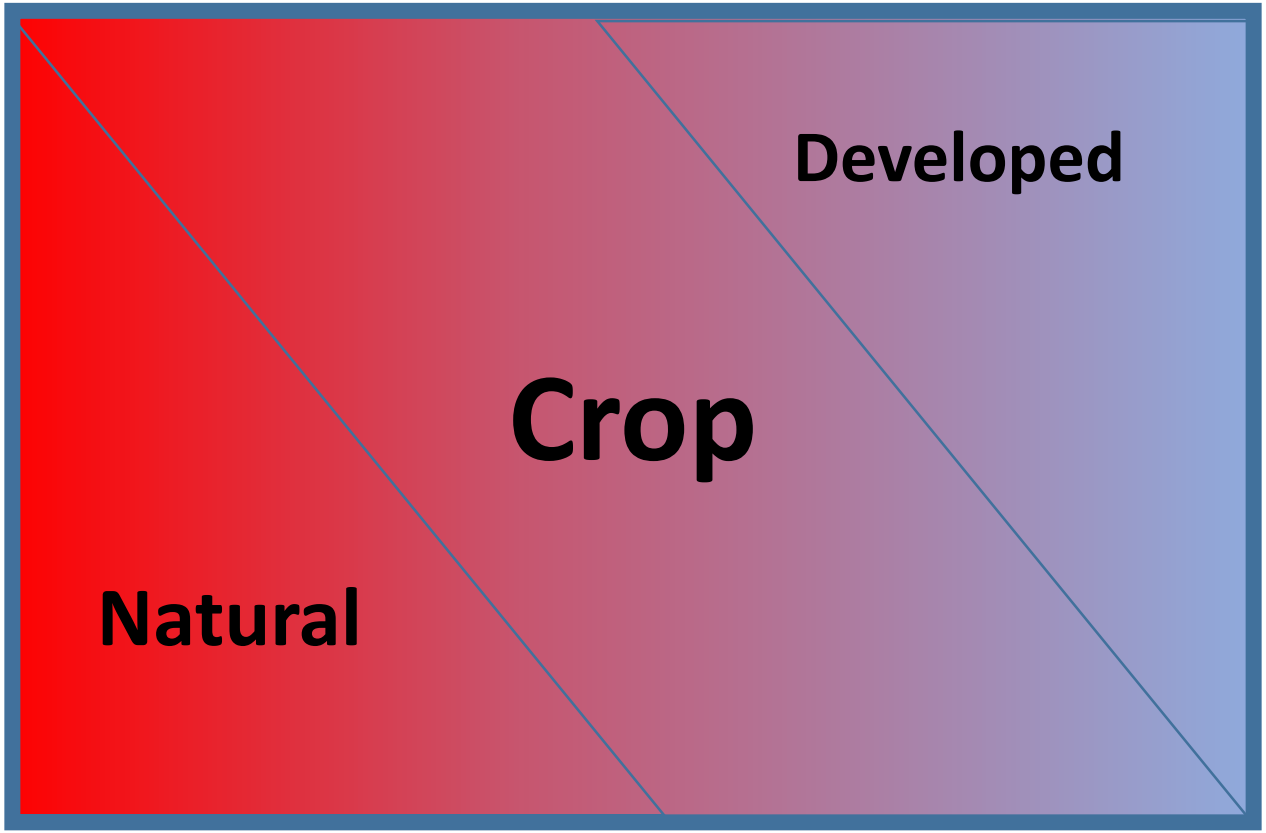


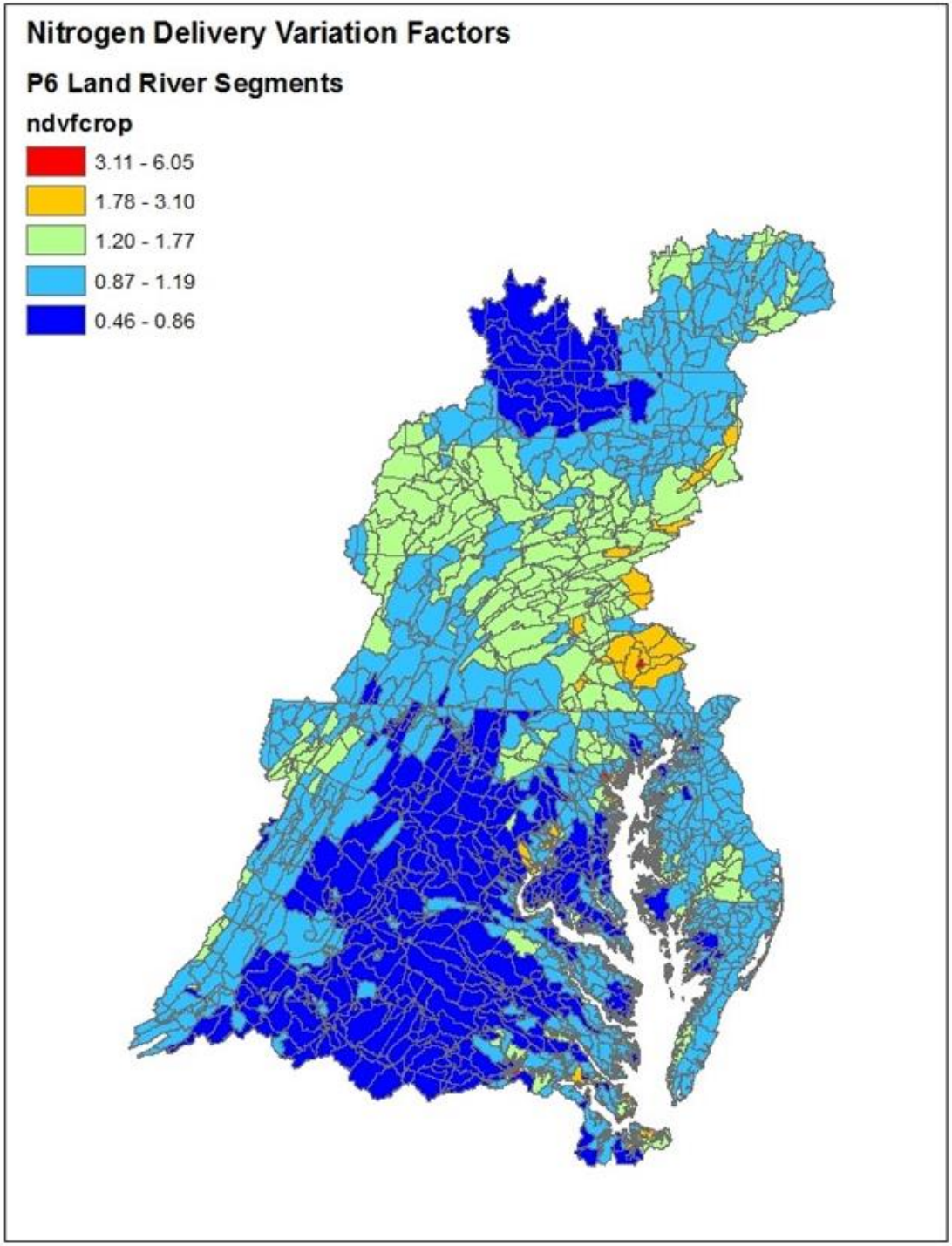
Conceptual Land-River segment

Delivery: High => Low

Conceptual Land-River segment

Delivery: High => Low





Land to Water factors for

Crop

Groundwater recharge ↑
Piedmont Carbonate ↑
Enhanced Vegetative Index ↓
Available water capacity ↓

Nitrogen

to Revision.
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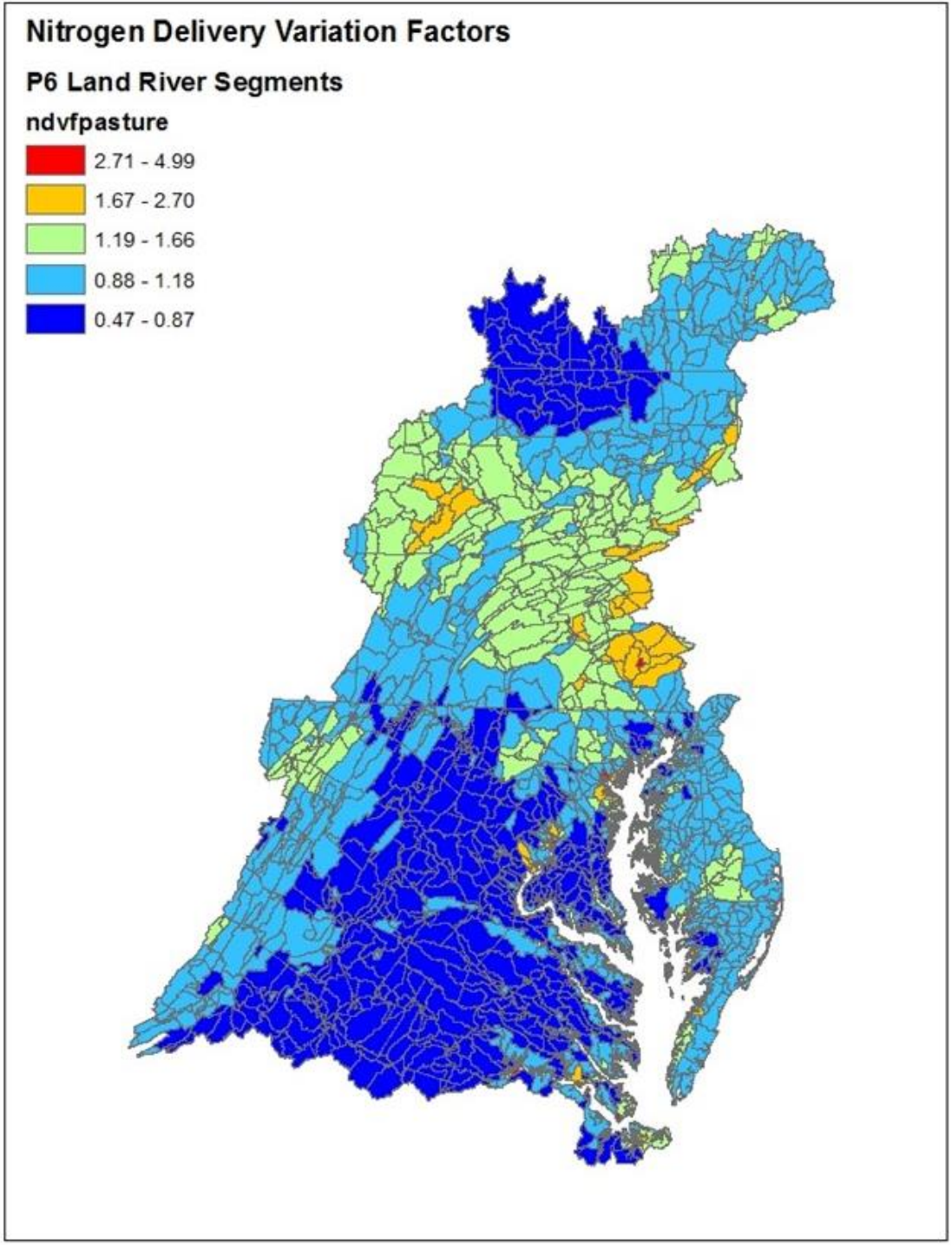

Land to Water factors for

Pasture

Groundwater recharge ↑
Piedmont Carbonate ↑
Enhanced Vegetative Index ↓
Available water capacity ↓

Nitrogen

to Revision.
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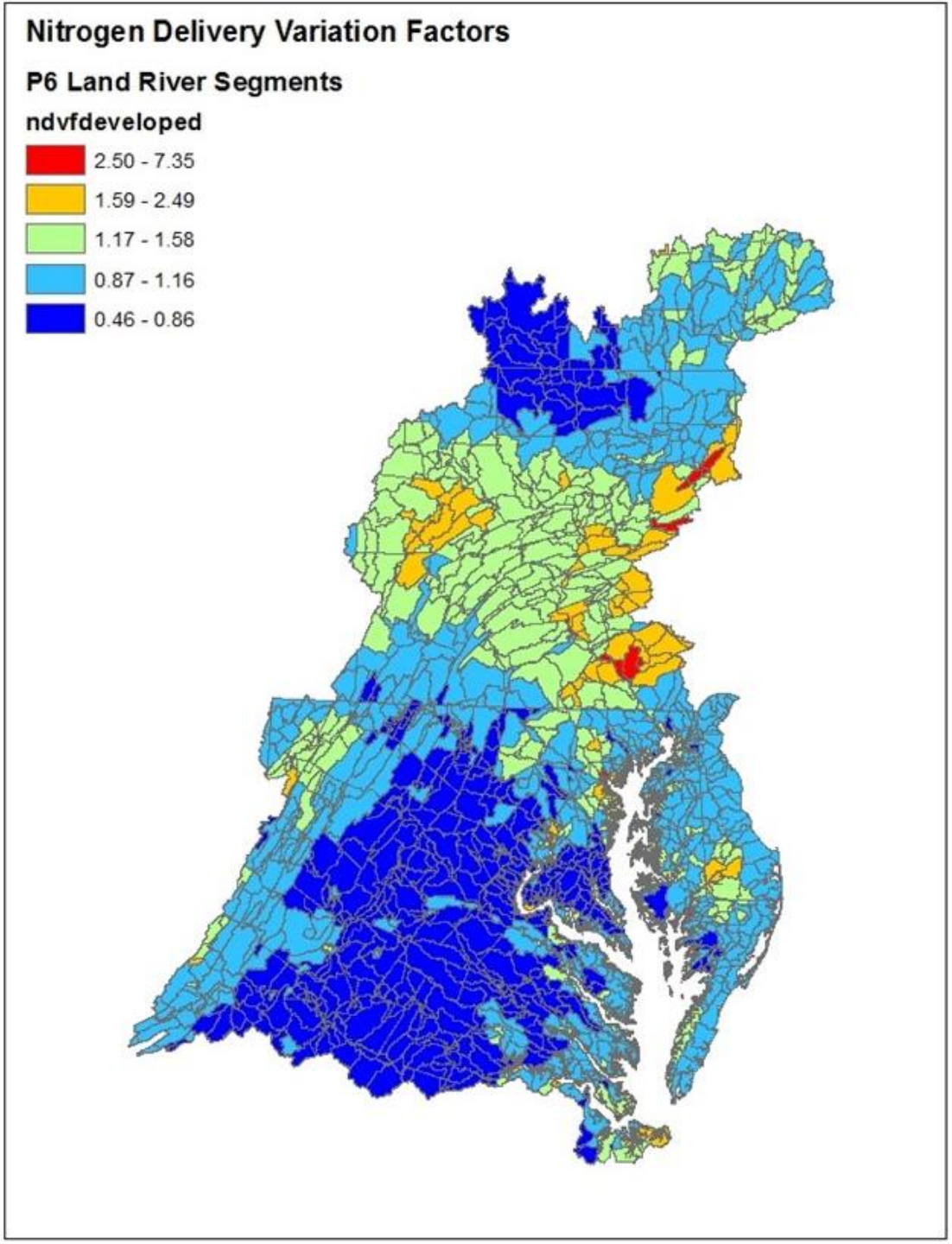
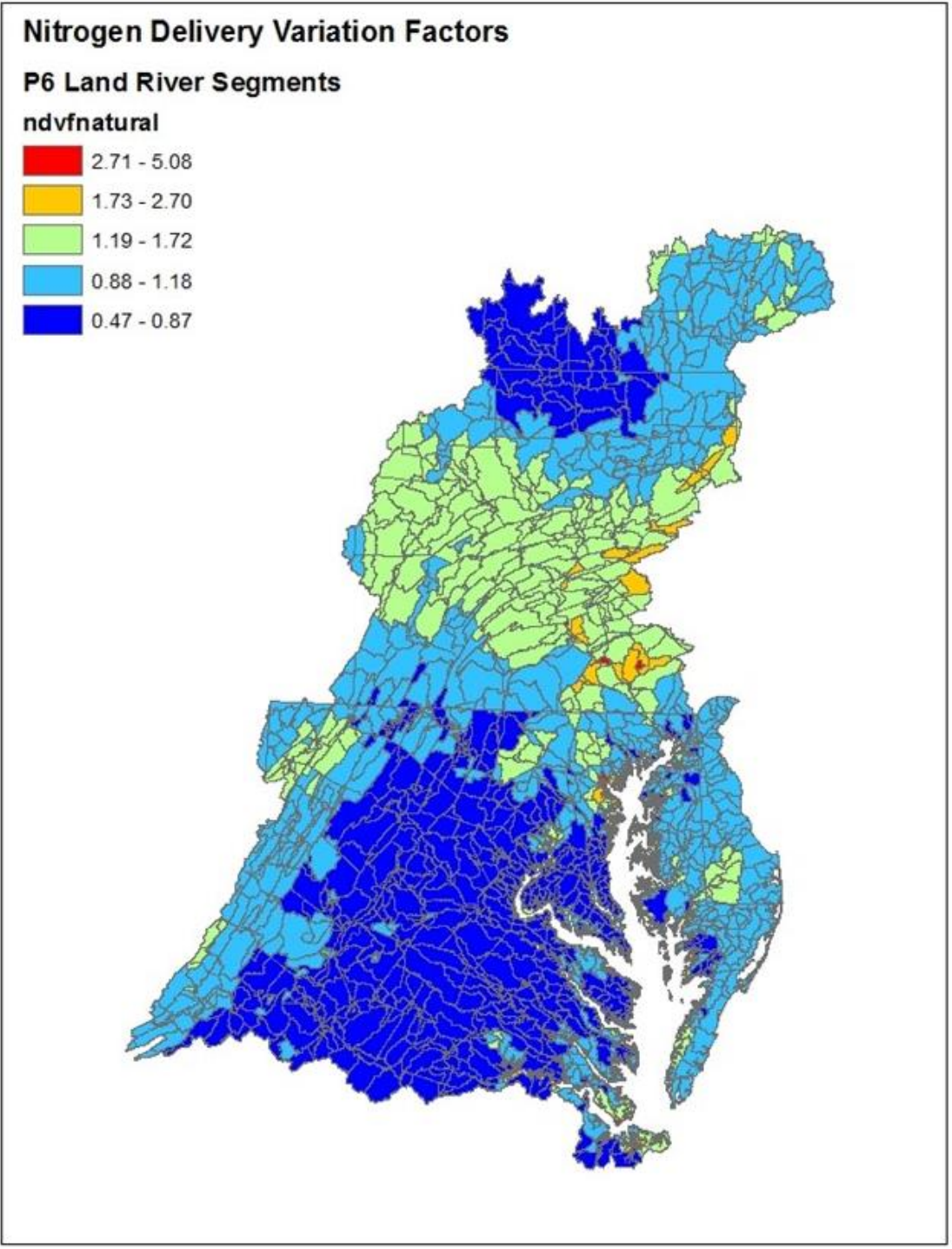


Land to Water factors for

Developed

Groundwater recharge ↑
Piedmont Carbonate ↑
Enhanced Vegetative Index ↓
Available water capacity ↓

Nitrogen



Land to Water factors for

Natural

Groundwater recharge ↑
Piedmont Carbonate ↑
Enhanced Vegetative Index ↓
Available water capacity ↓

Nitrogen

to Revision.
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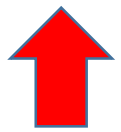
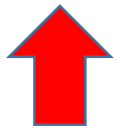
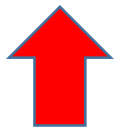
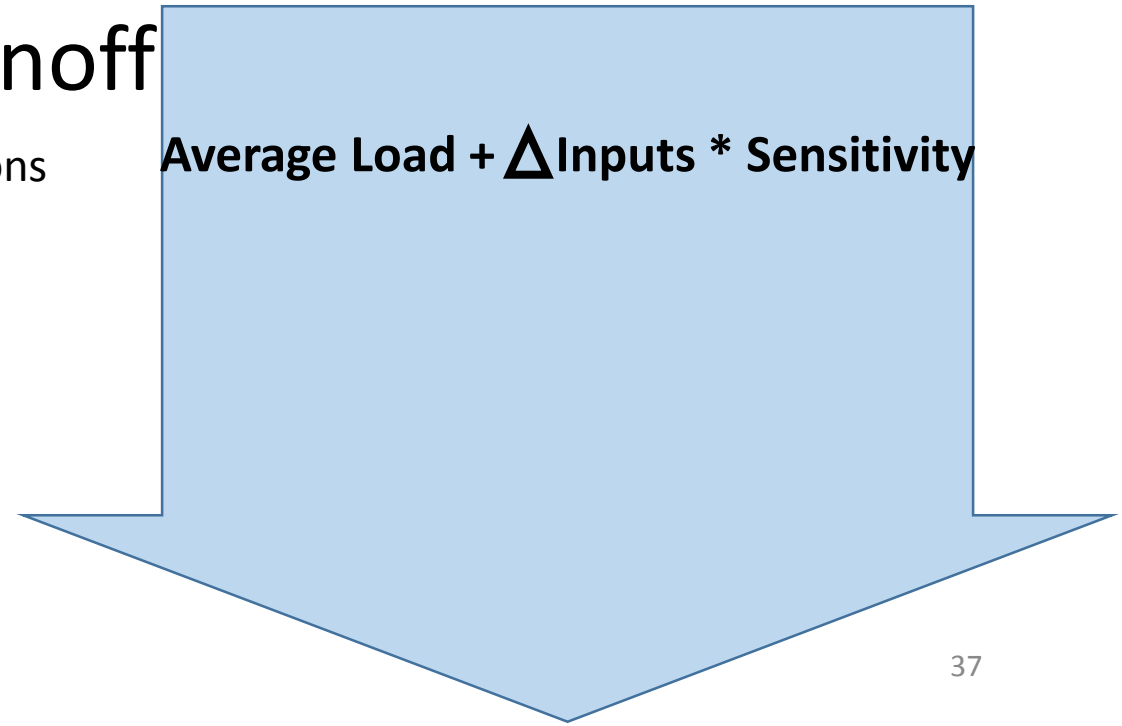
Phosphorus Factors

- Precipitation
  - Stormwater runoff and sediment washoff produce more P
- Erodibility
  - Erodible soils produce more sediment washoff that produces more P
- Coastal Plain
  - Unsure of mechanism – high soil P?
- Well-drained soils
  - Production of stormwater runoff and sediment washoff


What determines P loads in a given year?

- Soil Storage
- Sediment Washoff
- Stormwater Runoff
  - Water Extractable P Applications
  - Manure
  - Fertilizer
  - Uptake



Average Load + ∆Inputs * Sensitivity

P Load from grain without manure =

1.87 + 0.013 * (Mehlich – 98.2) ppm
+ 0.144 * (storm runoff - 6.73) inches
+ 0.049 * (sediment loss - 4.75) tons
+ 0.015 * (WEP – 14.3) lbs

Source: http://www.androidauthority.com/best-android-calculator-apps-577878/

Phosphorus Factors

- ~~Precipitation~~
  - ~~Stormwater runoff and sediment washoff produce more P~~
- ~~Erodibility~~
  - ~~Erodible soils produce more sediment washoff that produces more P~~
- Coastal Plain
  - Unsure of mechanism – high soil P?
- Well-drained soils
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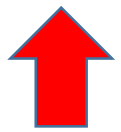
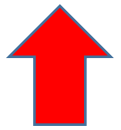
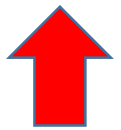




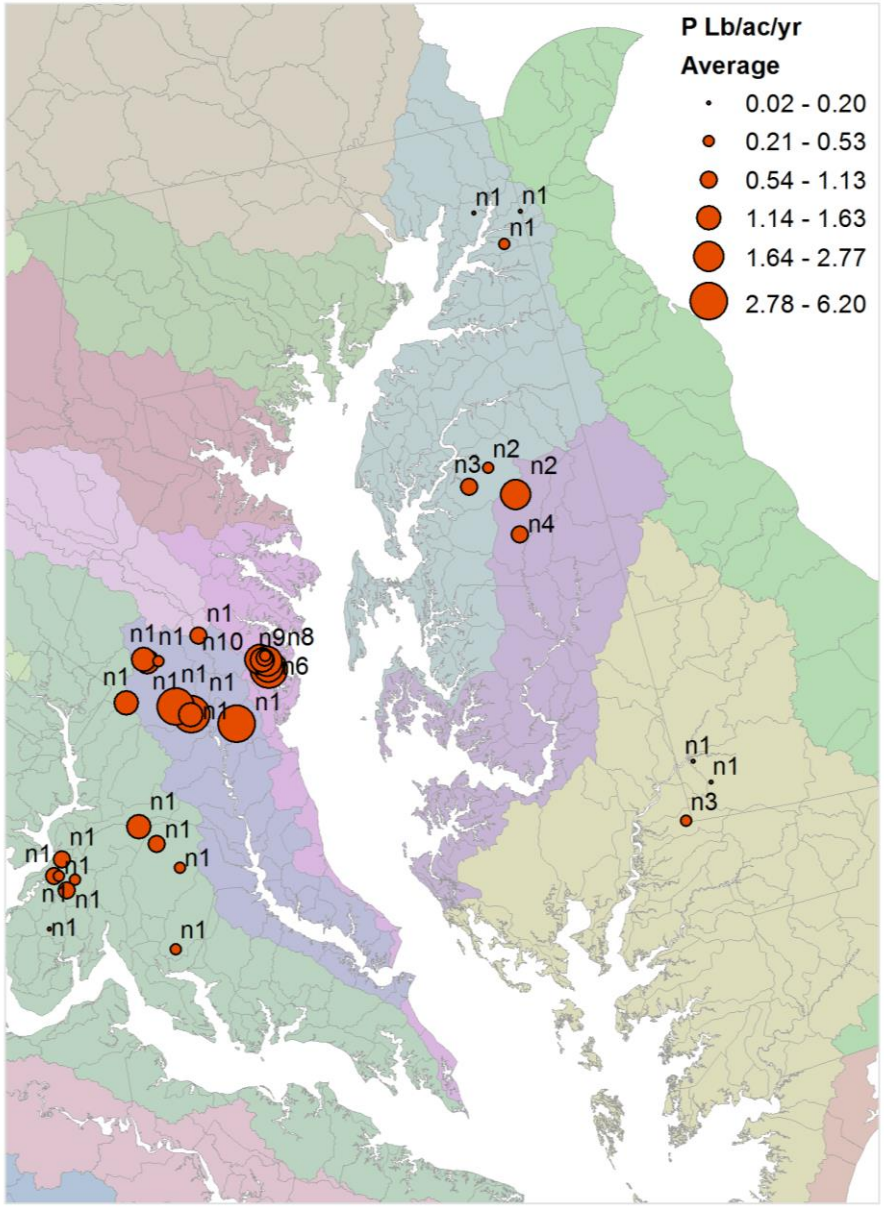


What about well-drained soils?

- Precipitation and Erodibility explicitly in calculation of sediment washoff
- Precipitation explicitly in stormwater runoff
- Soil type not explicit in hydrologic calibration

- Improved the calibration

Annual Phosphorus Runoff



UMCES analysis of SERC data

Major/Minor Basin	Nobs
Eastern Shore of Chesapeake Bay	19
Upper Eastern Shore	8
Middle Eastern Shore, including Choptank River	6
Lower Eastern Shore	5
Western Shore of Chesapeake Bay	71
Lower Western shore	71
Patuxent River Basin	9
Patuxent River below Bowie, Maryland	9
Potomac River Basin	10
Lower Potomac River, below Chain Bridge	10

16 LRsegs containing sites

Average Load + Δ Inputs * Sensitivity

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Land Use Acres

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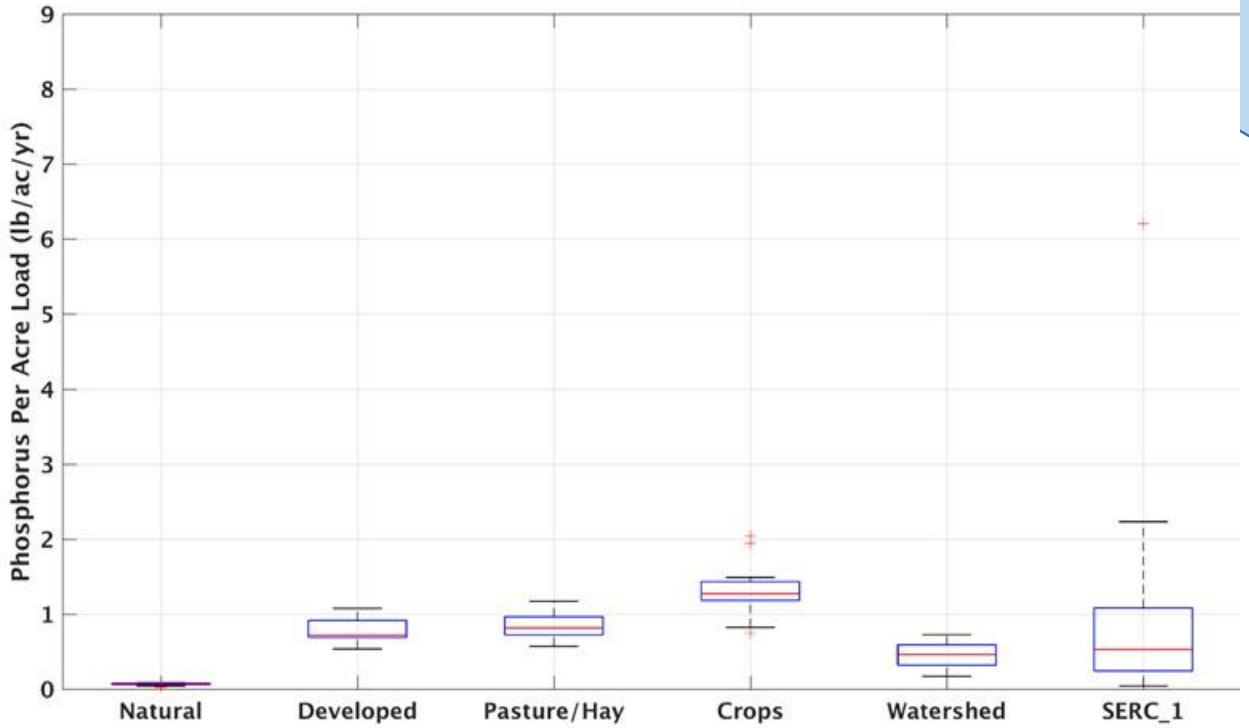
BMPs

*

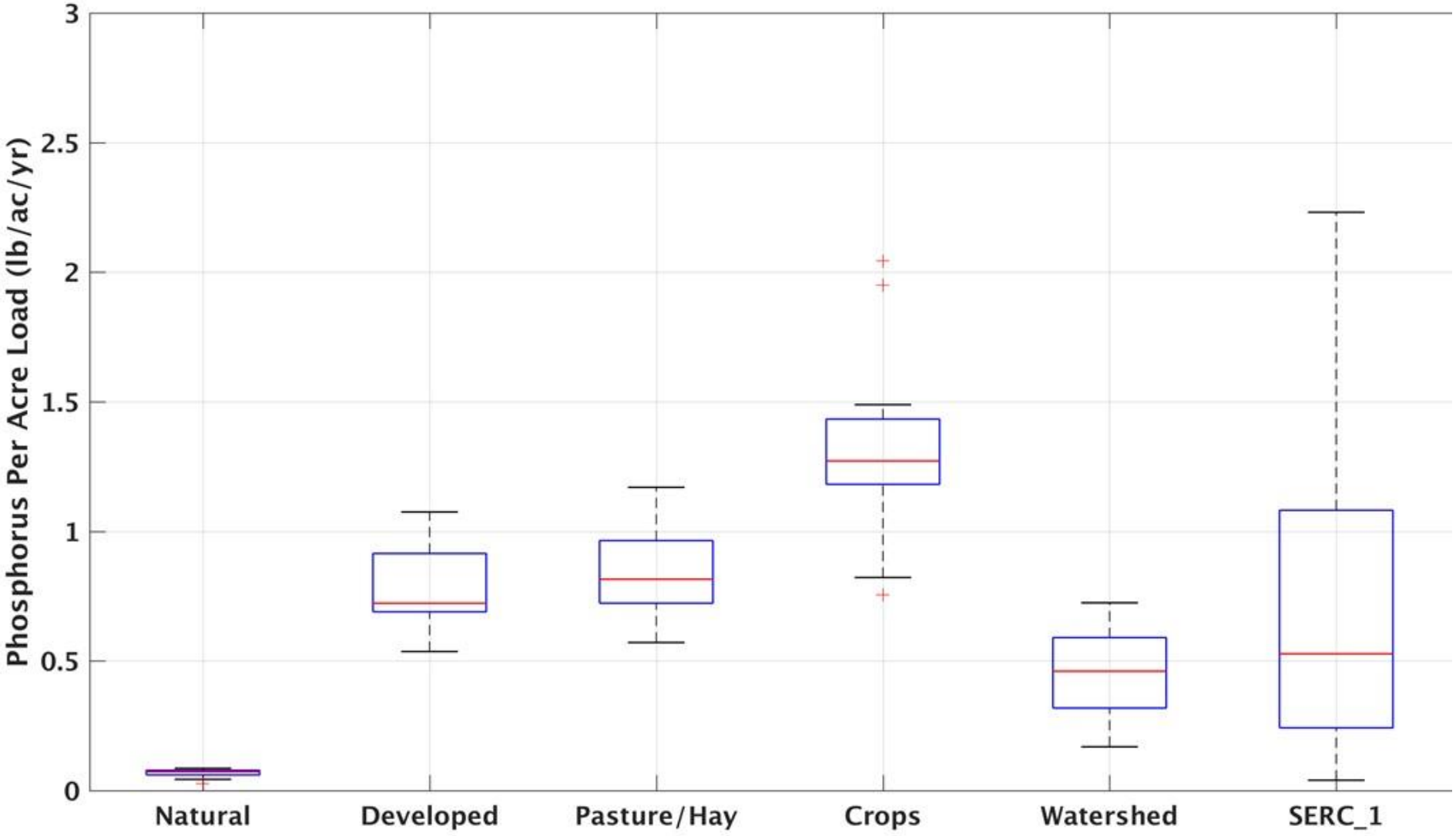
Land to Water

Stream Delivery

River Delivery



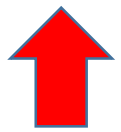
16 LRsegs containing sites

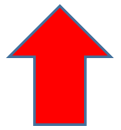


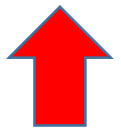
SERC_1 – phosphorus per watershed acres

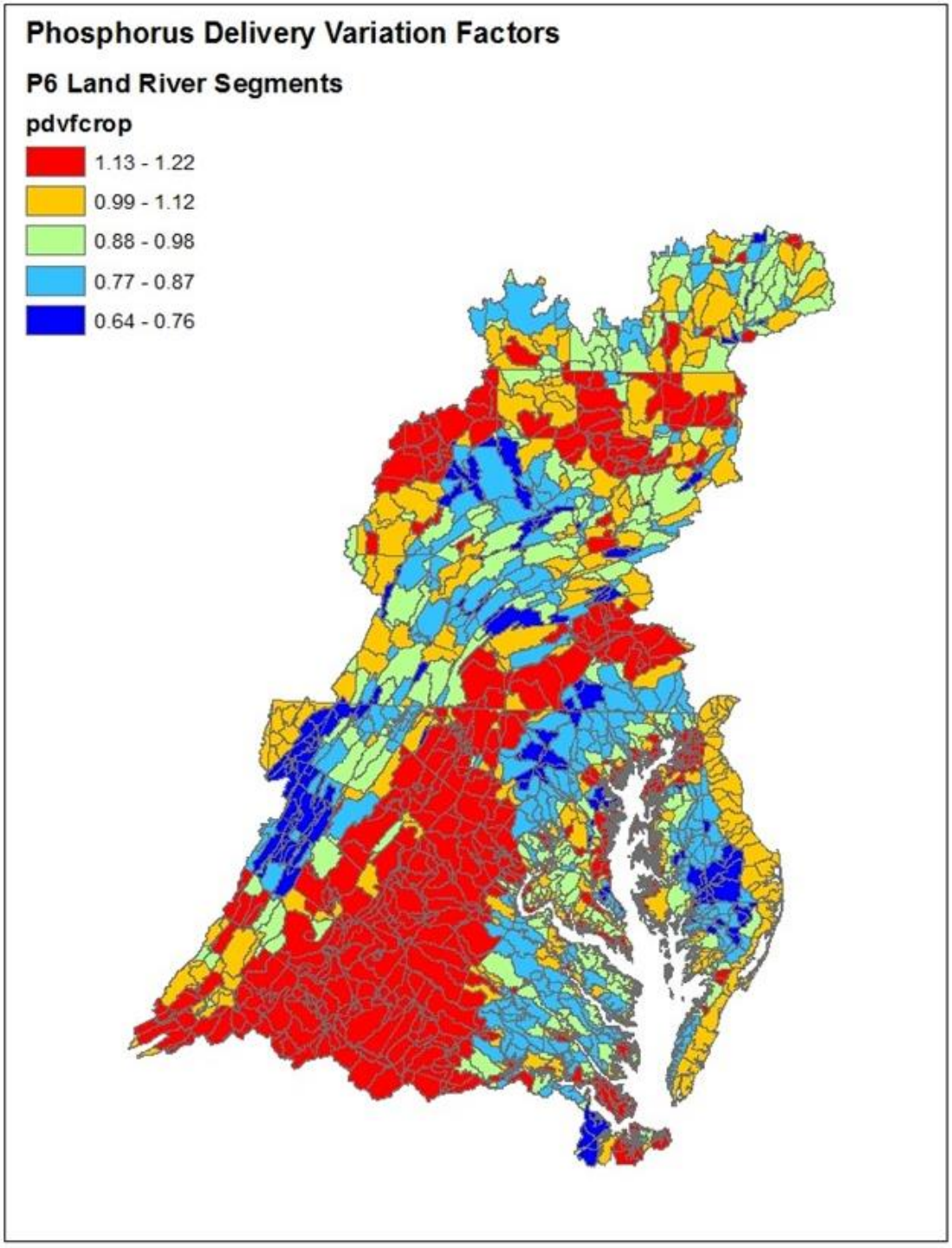
Phosphorus Factors

- ~~Precipitation~~
  - ~~Stormwater runoff and sediment washoff produce more P~~
- ~~Erodibility~~
  - ~~Erodible soils produce more sediment washoff that produces more P~~
- ~~Coastal Plain~~
  - ~~Unsure of mechanism – high soil P?~~
- Well-drained soils
  - Production of stormwater runoff and sediment washoff







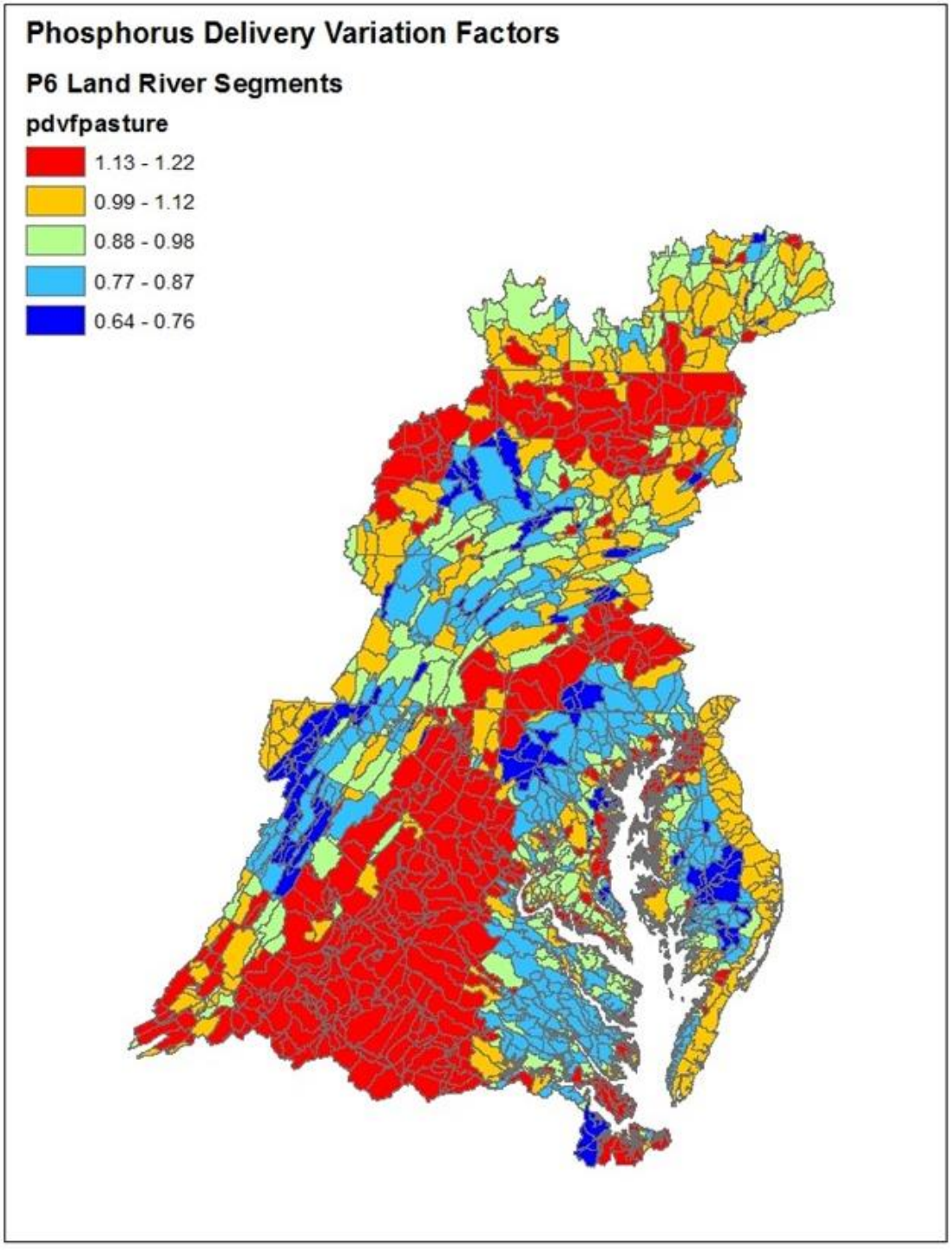


Land to Water factors for

Crop

- Well-drained soils ⇩

Phosphorus



Land to Water factors for

Pasture

- Well-drained soils ⇩

Phosphorus

:o Revision.
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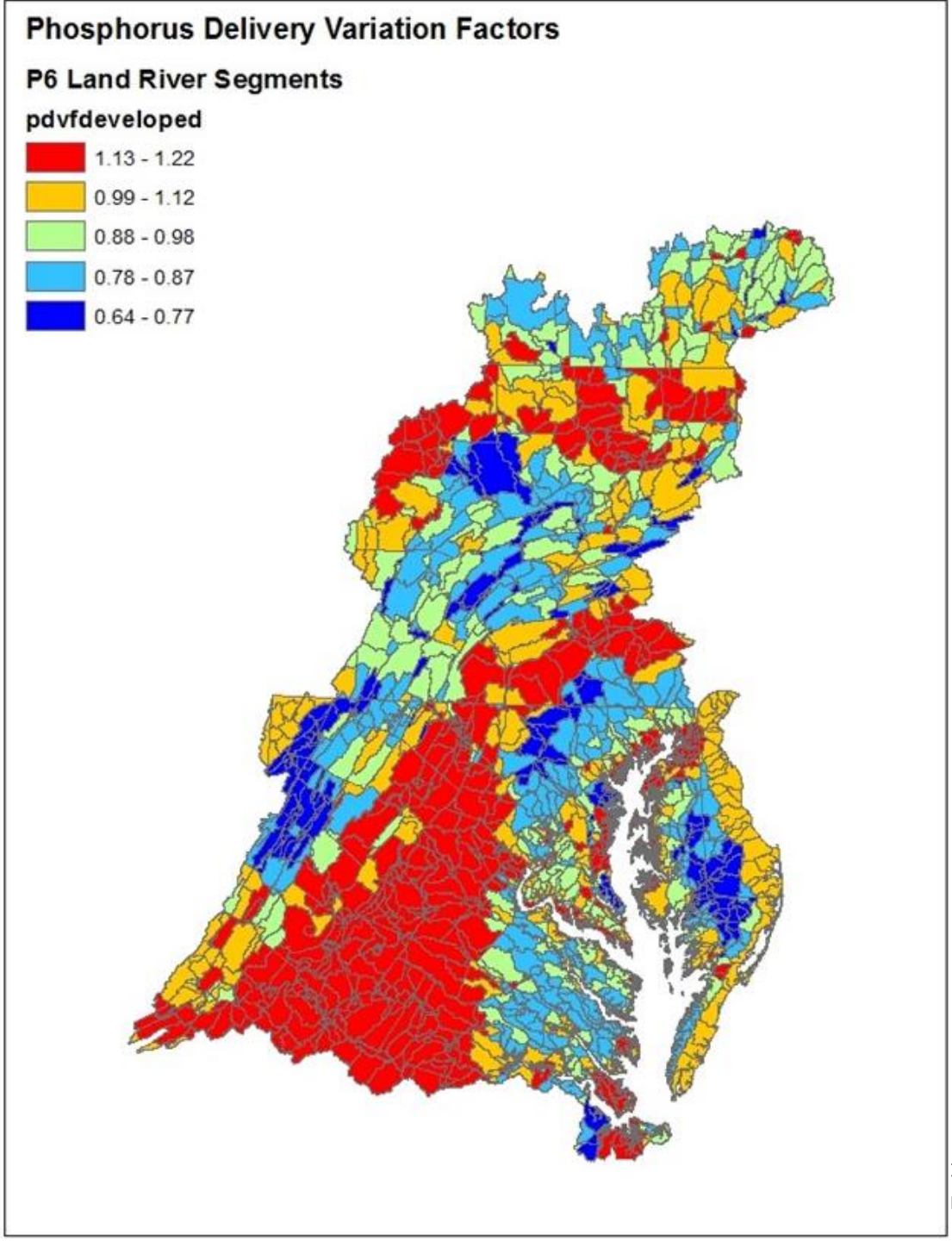
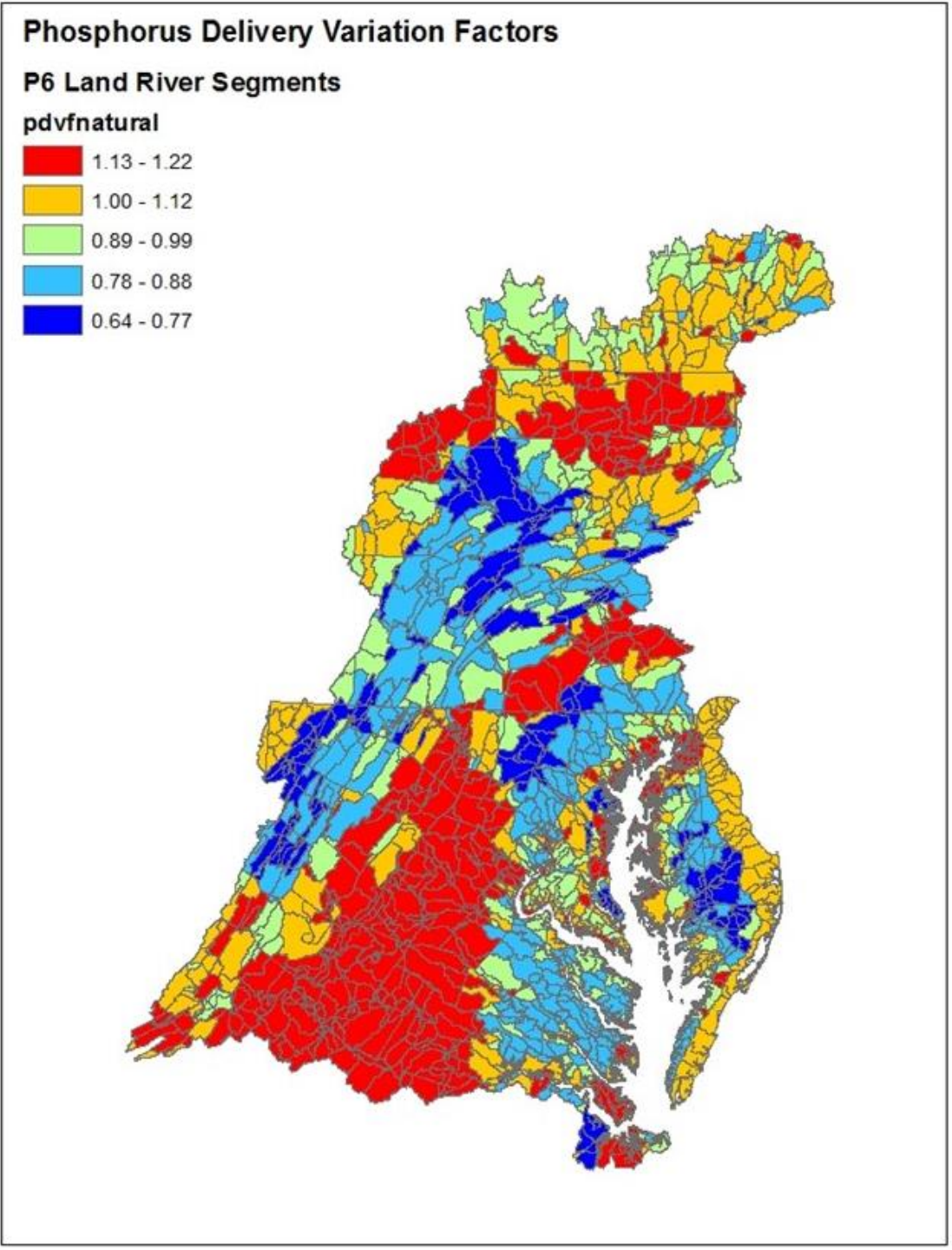


Land to Water factors for

Developed

- Well-drained soils ⬇

Phosphorus



Land to Water factors for

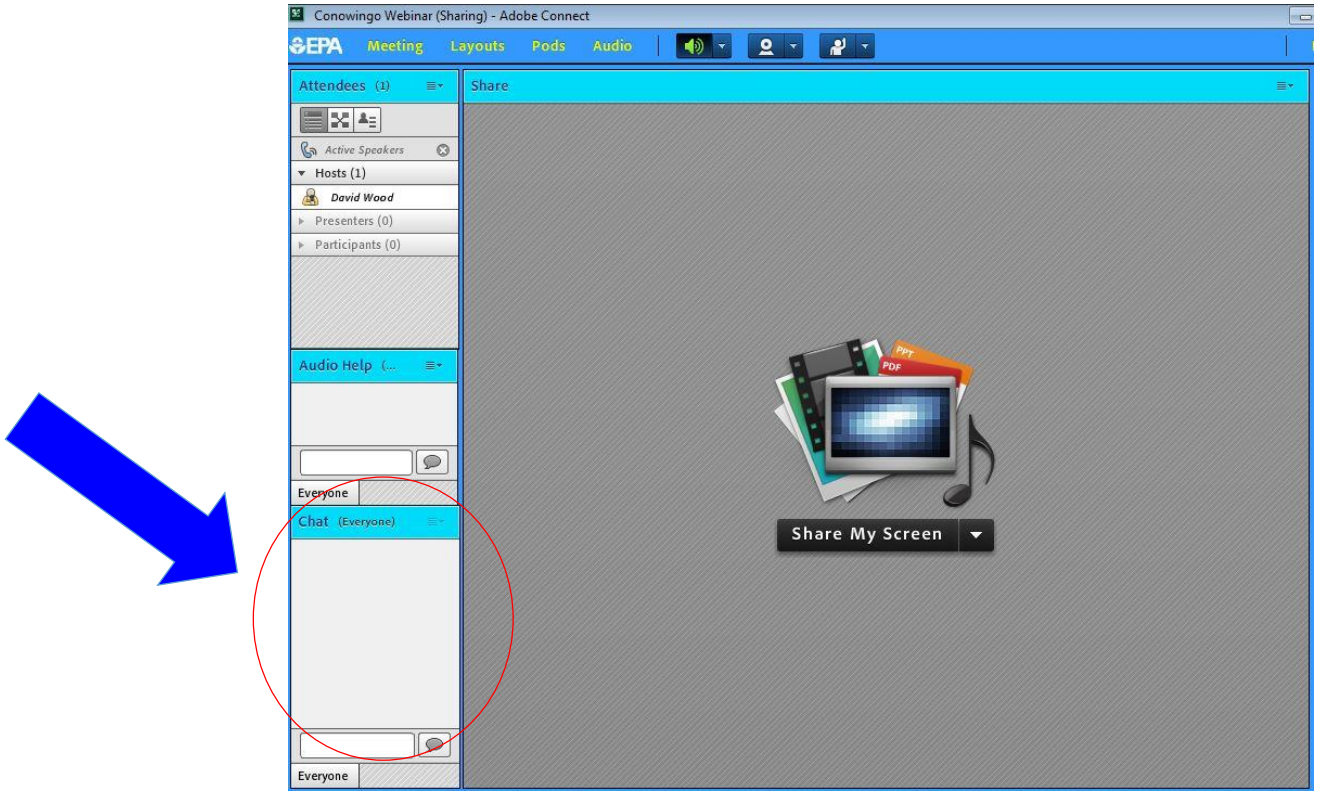
Natural

- Well-drained soils ⇩

Phosphorus

Questions and Answers Session

- To Ask a Question
  - Submit your question in the chat box, located in the bottom left of the screen.







Phase 6 Model Structure

Average Load + Δ Inputs * Sensitivity

*

Land Use Acres

*

BMPs

*

Land to Water

*

Direct Loads

Stream Delivery

*

River Delivery

Phase 6

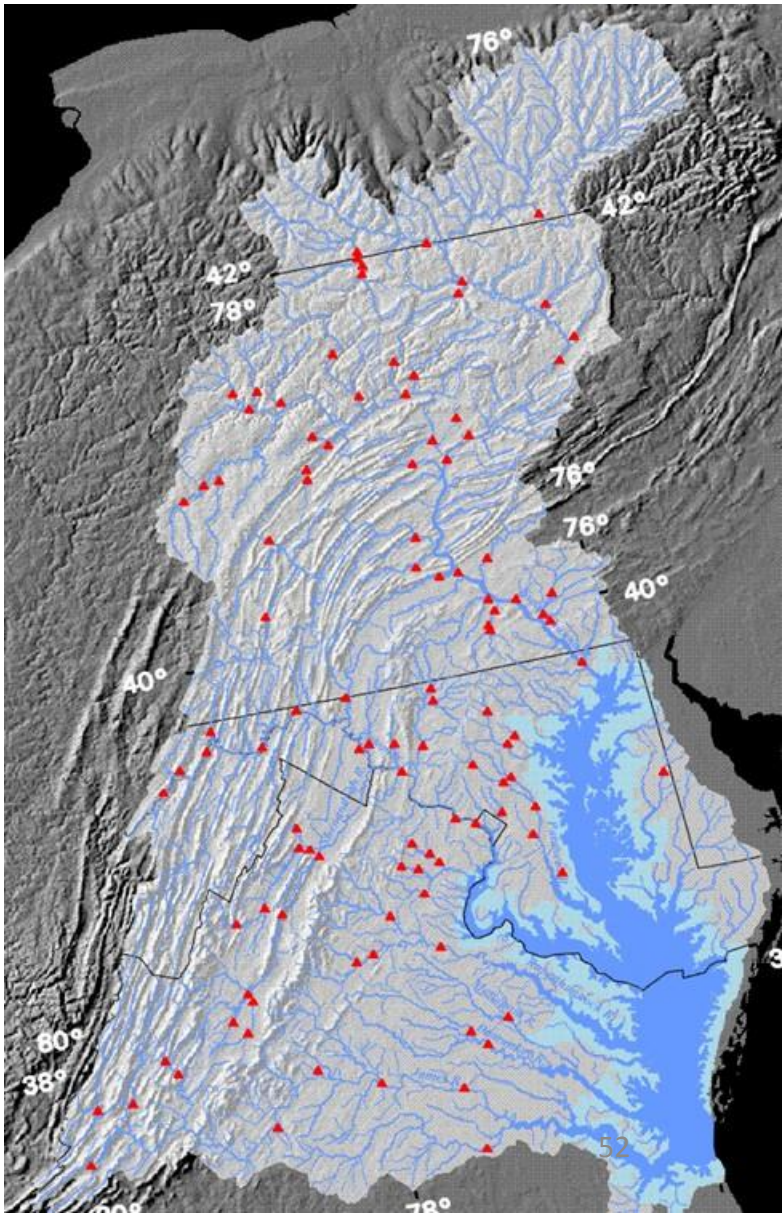
Methods of Stream Delivery

- Sparrow
  - Implemented in all beta versions and Draft Phase 6
- Chesapeake Floodplain Network
  - Tested in Beta 4
  - Contributed to concept of stream bank and floodplain loads
- Stream source ratio
  - Available for sediment only
  - Implemented in beta 2 and beta 3

$$LOAD_i = \left\{ \sum_{j \in J(i)} \left[\sum_{n=1}^{N} S_{n,j} \beta_n \exp(-\alpha' Z_j) \right] \prod_m \exp(-\delta_m^s T_{i,j,m}) \prod_l 1/(1+\lambda^r q_{i,j,l}^{-1}) \right\} \exp(\varepsilon_i)$$

USGS Sparrow Model

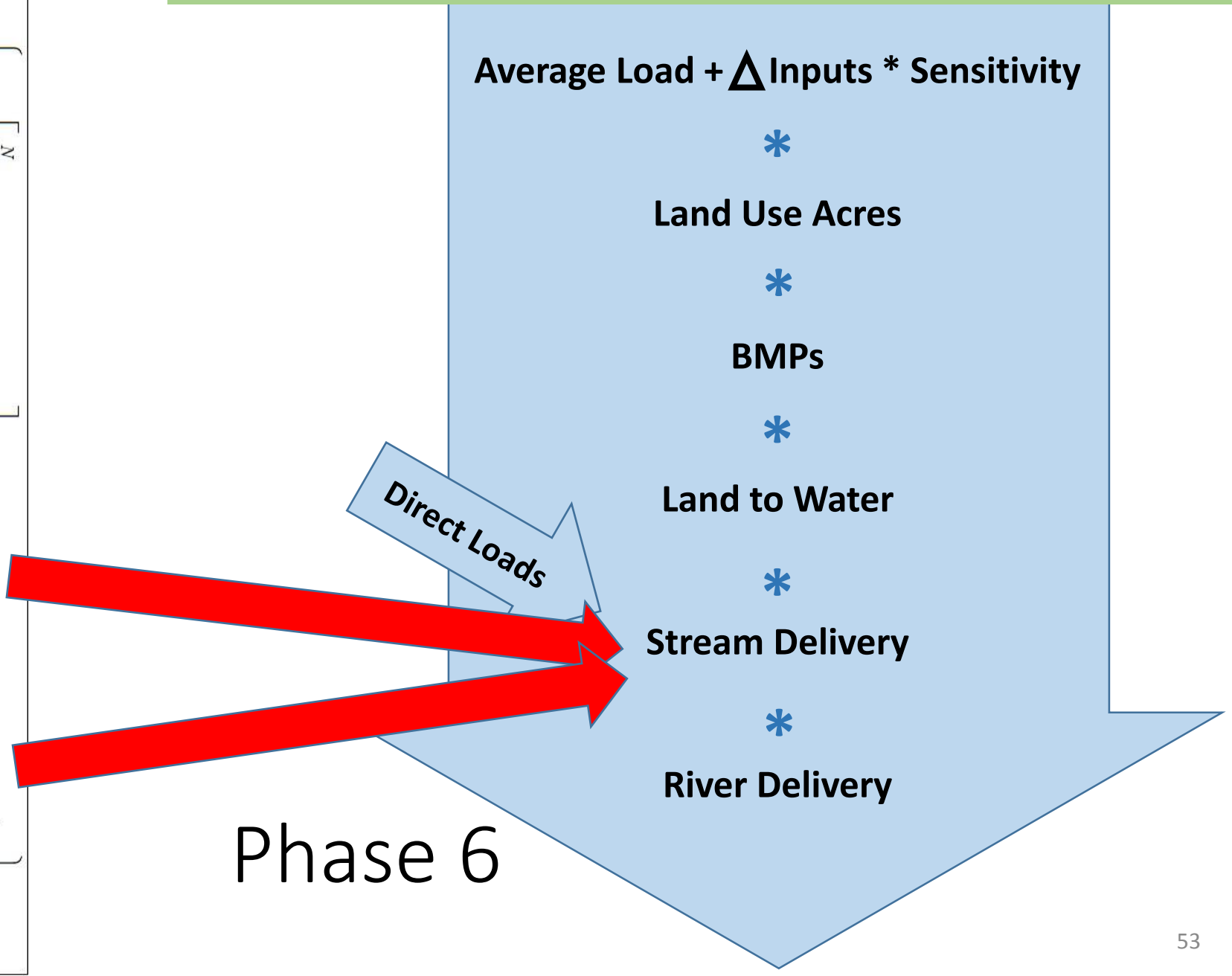
- Regression Model
- Gain knowledge about the watershed based on observations
- Chesapeake Sparrow, version 4 used for calculations
  - Ator and others 2011
- Plus additional studies



Phase 6 Model Structure

Sparrow Structure

$$LOAD_i = \left\{ \sum_{j \in J(i)} \left[\sum_{n=1}^{N} S_{n,j} \beta_n \exp(-\alpha' Z_j) \right] \prod_m \exp(-\delta_m^s T_{i,j,m}) \prod_l 1/(1 + \lambda^r q_{i,j,l}^{-1}) \right\} \exp(\varepsilon_i)$$



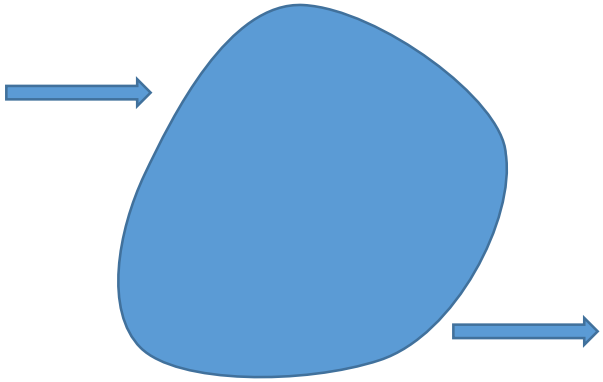
Phase 6

Sparrow Results - Streams

- Small streams < 120 cubic feet per second
- Nitrogen
  - Loss directly related to temperature
  - Loss directly related to travel time
  - Consistent with denitrification
- Phosphorus
  - No loss in streams of any size
  - Consistent with lack of mechanism

Sparrow Results - Impoundments

- Loss in impoundments based on ratio between flow and surface area



Low Flow in large reservoir = Large Loss

Large flow in small reservoir = Small Loss

- Phosphorus affected more than nitrogen

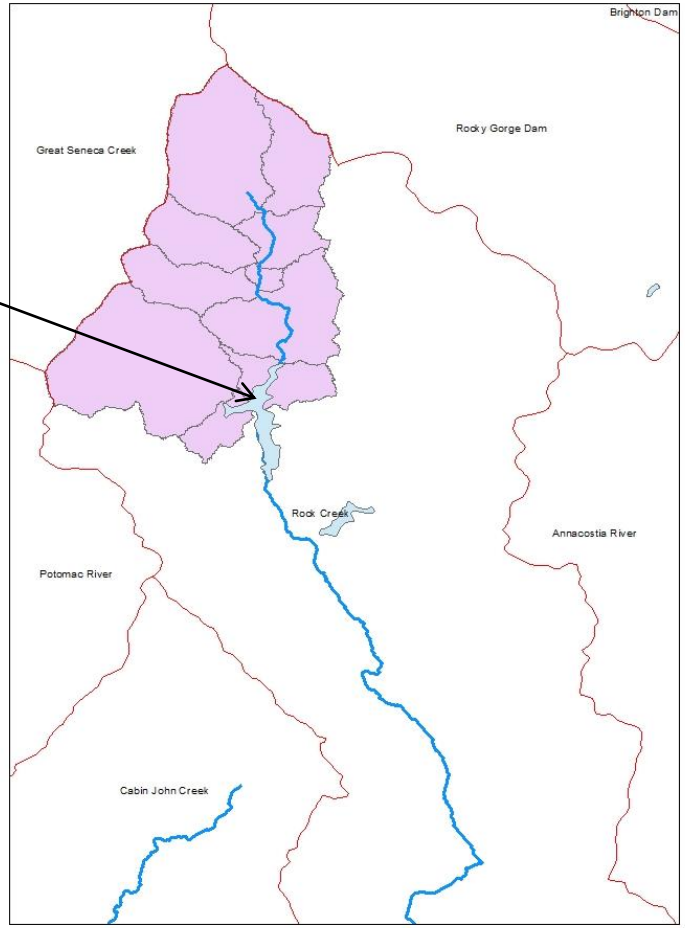
Reservoir Selection

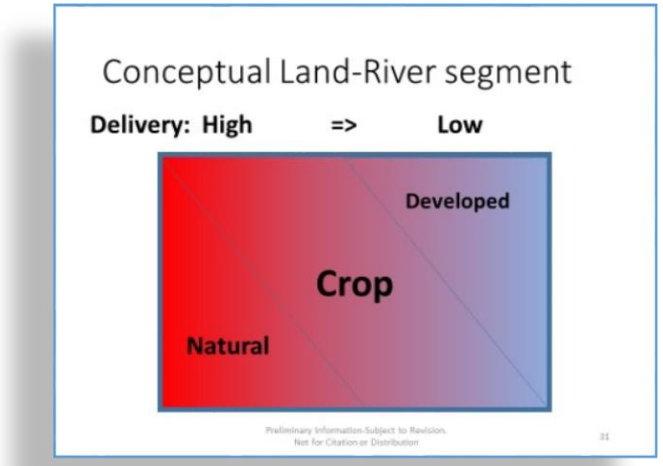
- 4,000+ reservoirs in SPARROW from NHD.
- CBP partners had opportunity to review reservoirs
  - Remove stormwater ponds included in the model as BMPs
  - Remove tidal marshes misidentified as impoundments
  - Remove reservoirs directly simulated by Phase 6
  - Add missing reservoirs
- MDE removed 486 and added 29
- VA DEQ removed 128
- CBPO removed 36 large directly-simulated reservoirs
- Split into streams and rivers

Scaling to Phase 6

Reductions Applied to Upstream NHD+ Catchments Only

Lake Needwood

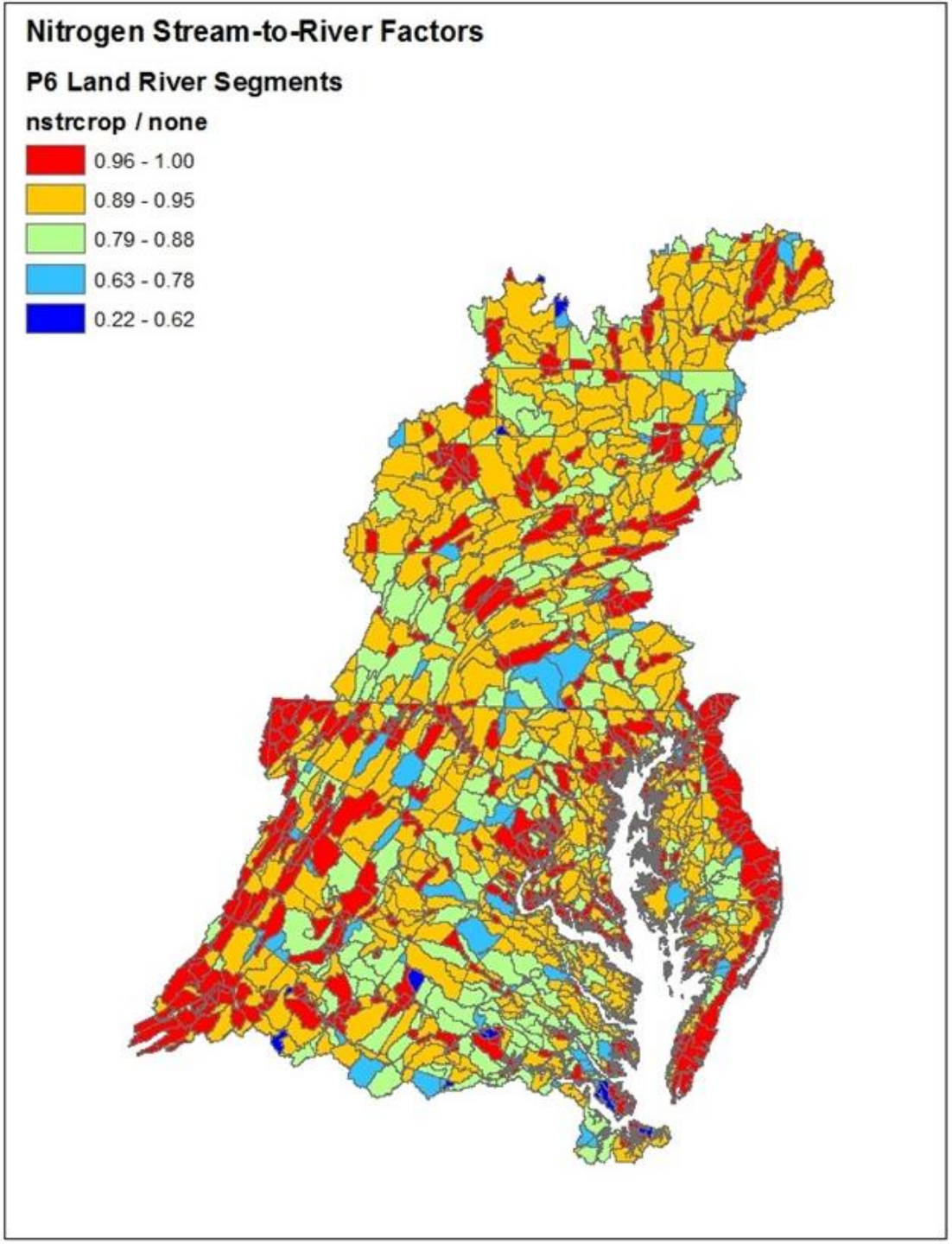




Stream Attenuation by Land Use

- Split between Crop / Pasture / Developed / Natural

- Pasture Direct Deposition assigned to pasture
- Septic assigned to developed
- WWTP and Industrial sources assigned individually

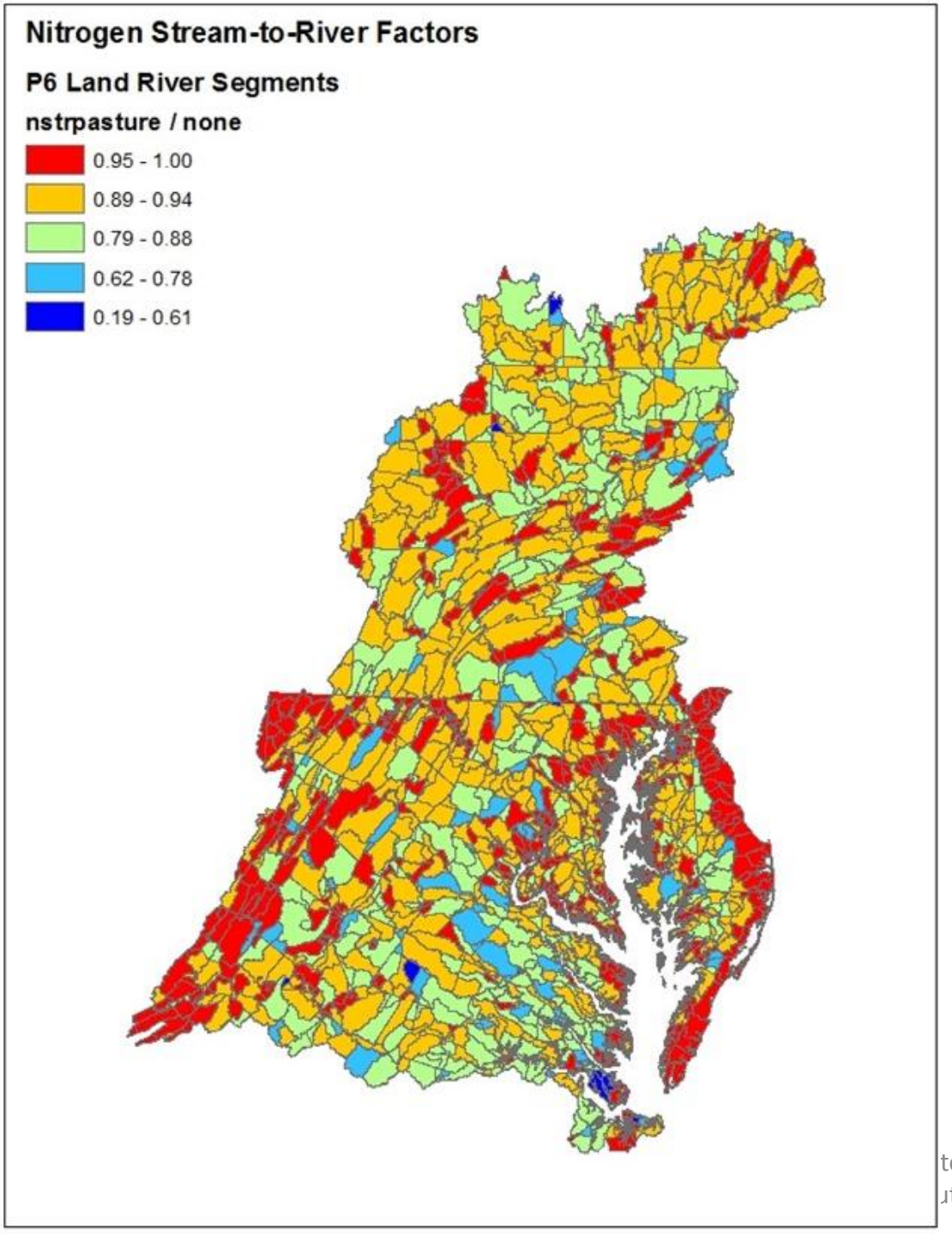


Stream to River factors for

Crop

Temperature ⇩
Travel time ⇩
Reservoirs ⇩

Nitrogen



Stream to River factors for

Pasture

Temperature ⬇
Travel time ⬇
Reservoirs ⬇

Nitrogen

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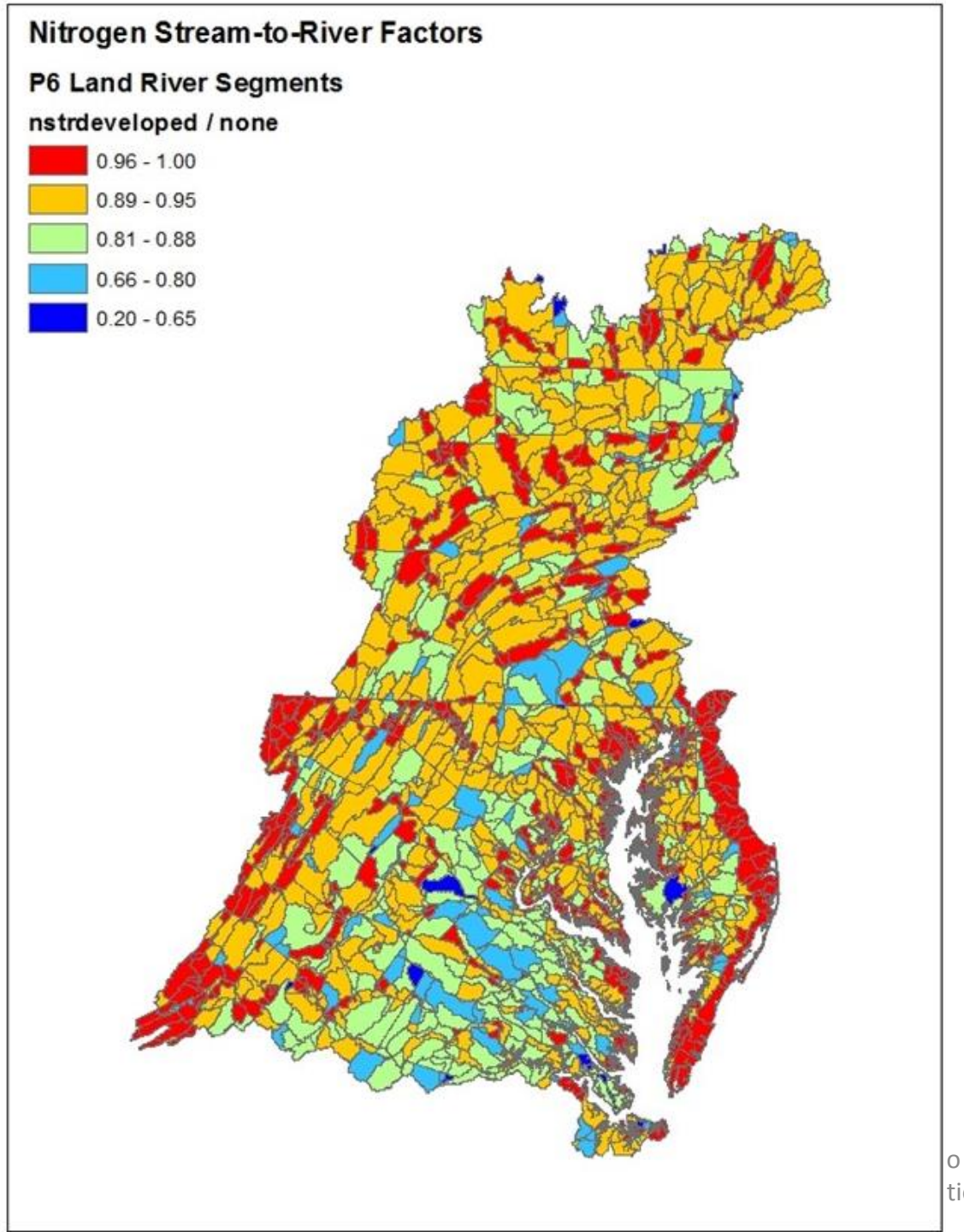
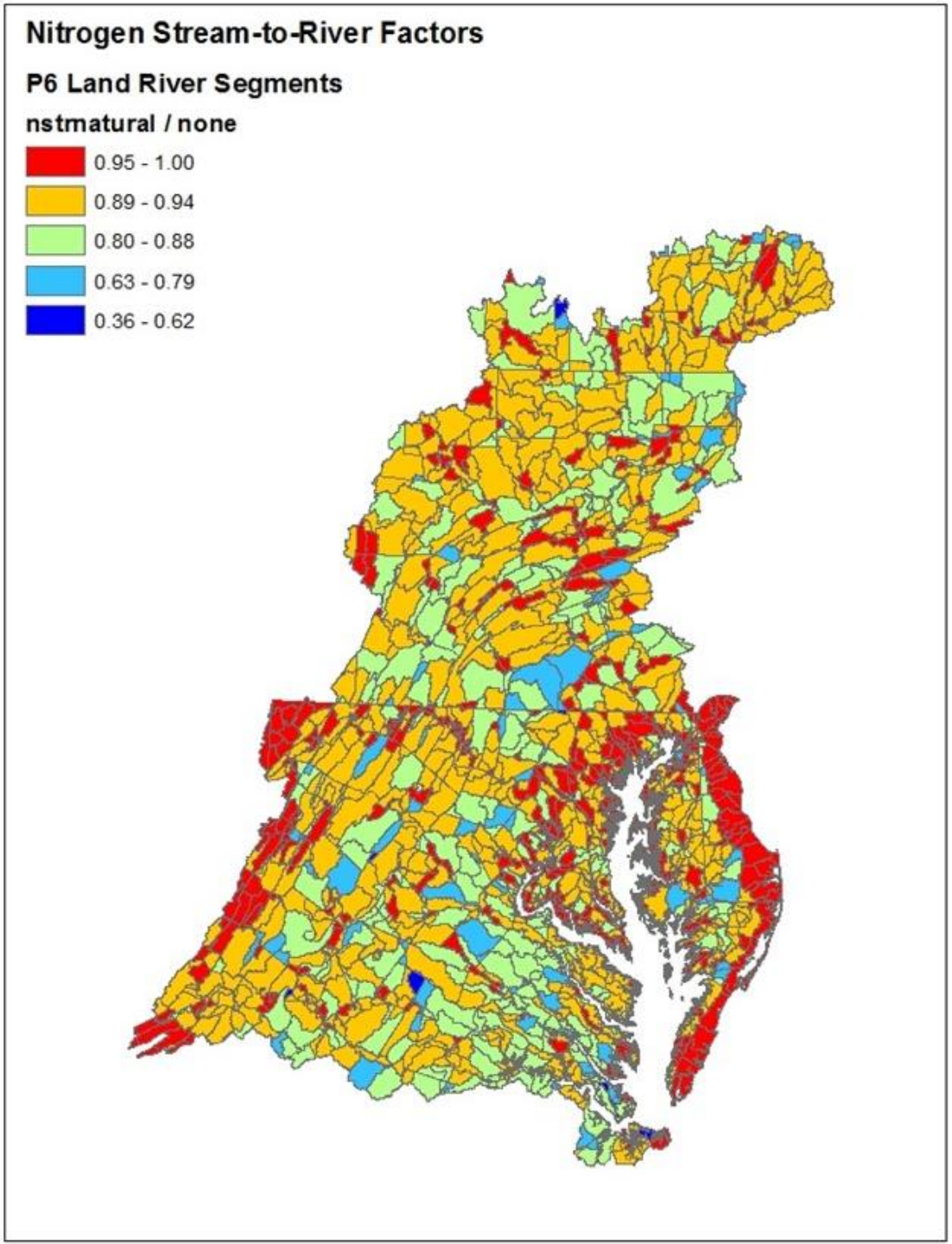


Stream to River factors for

Developed

Temperature ⇩
Travel time ⇩
Reservoirs ⇩

Nitrogen



Stream to River factors for

Natural

Temperature ⇩
Travel time ⇩
Reservoirs ⇩

Nitrogen

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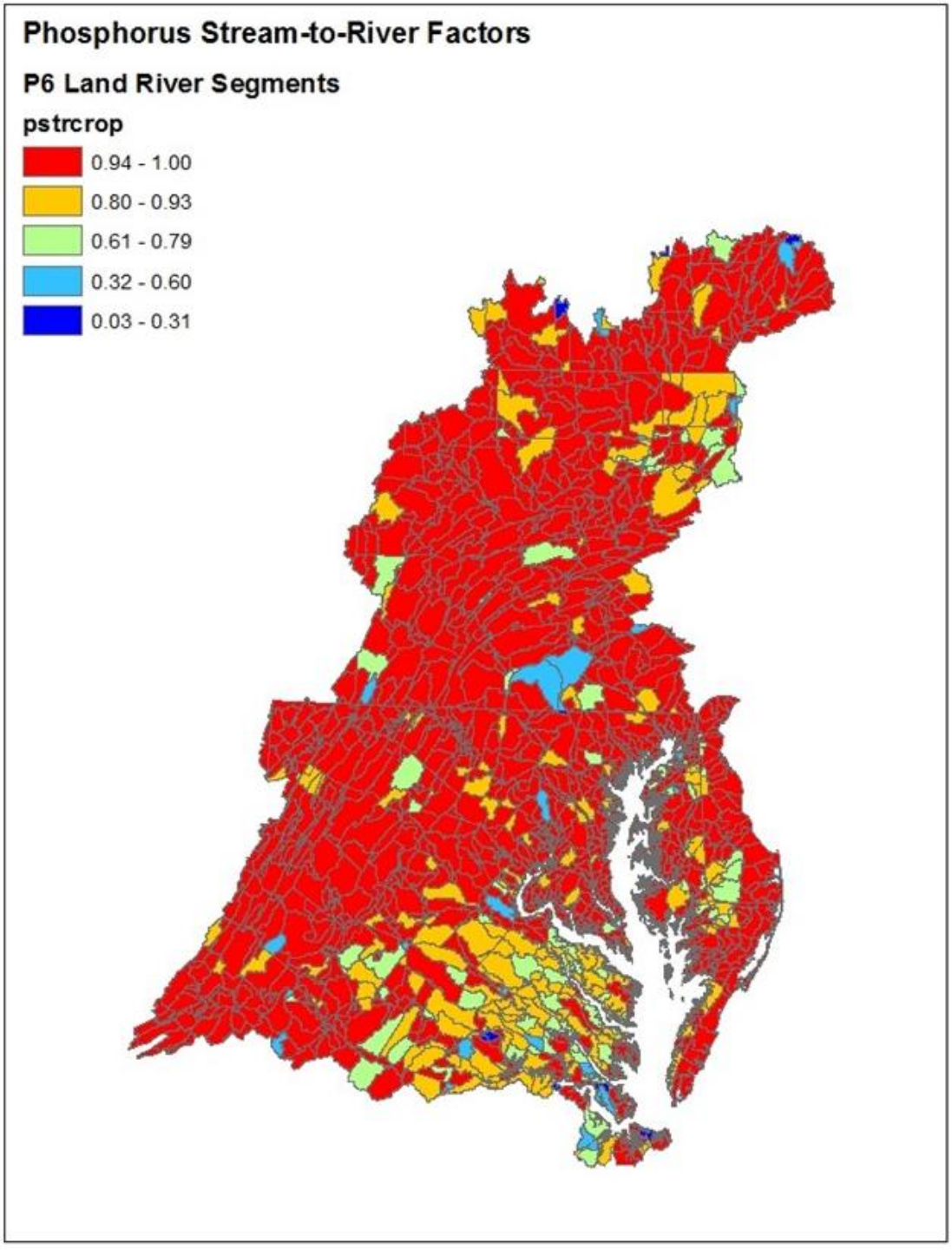
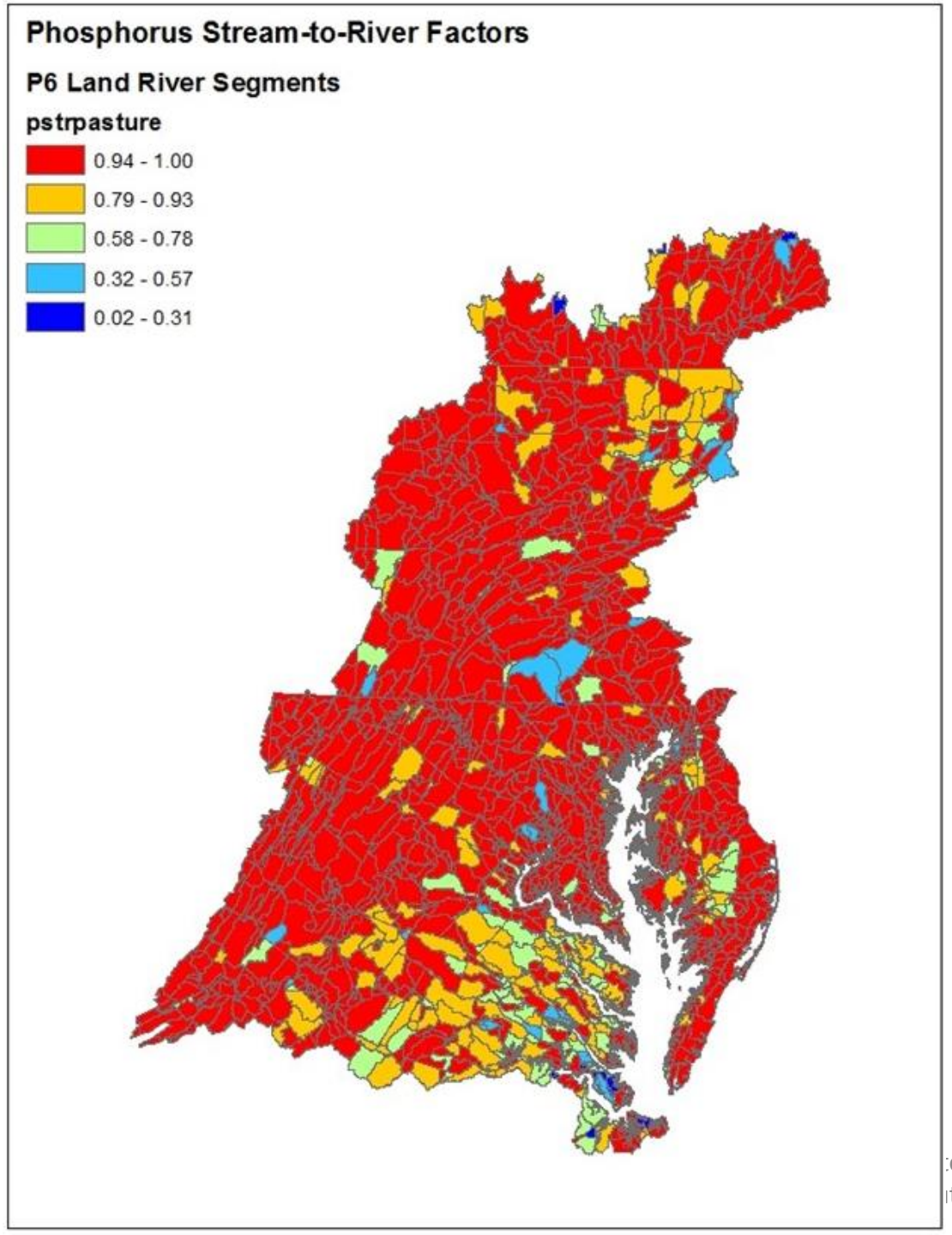


Stream to River factors for

Crop

Reservoirs

Phosphorus

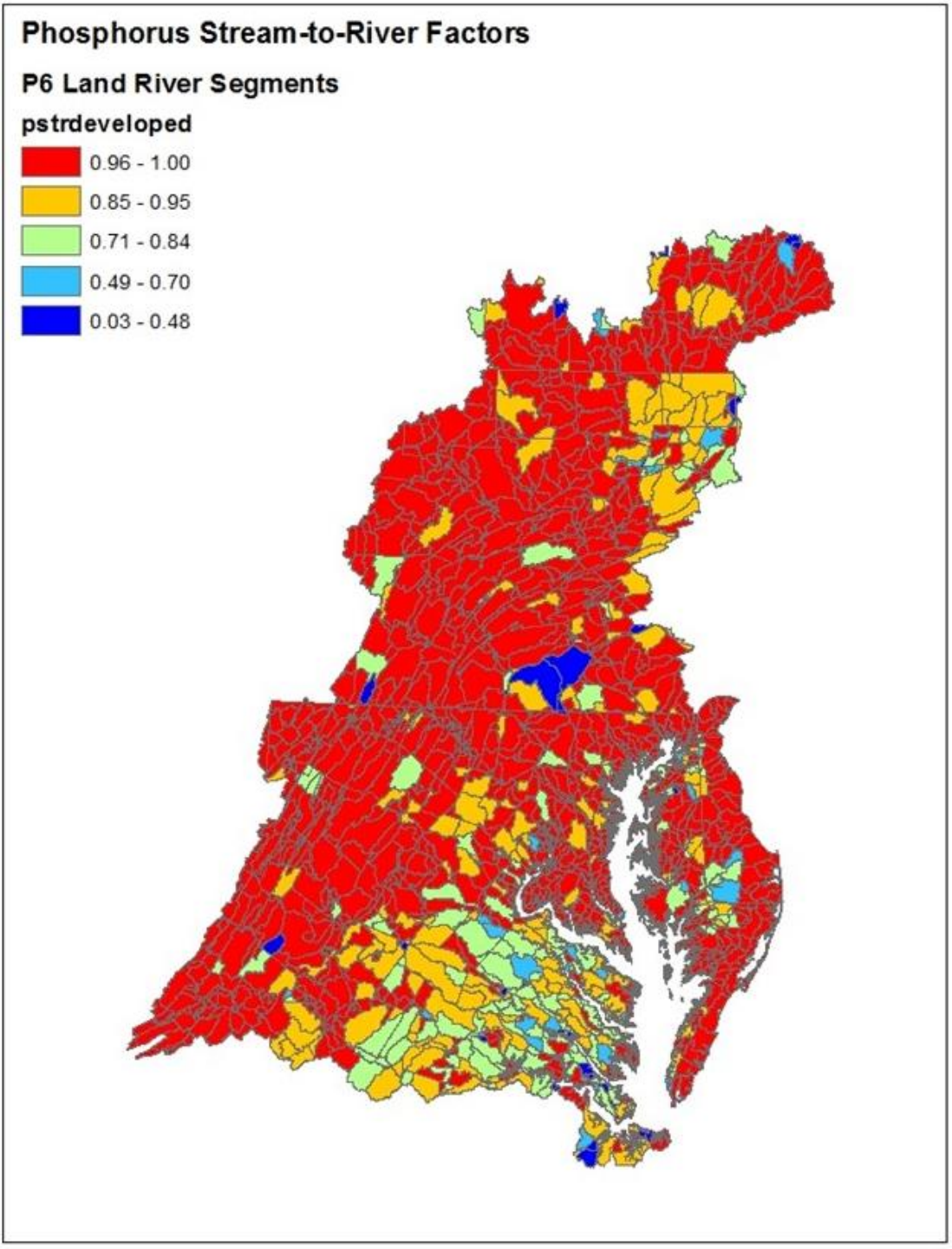


Stream to River factors for

Pasture

Reservoirs

Phosphorus

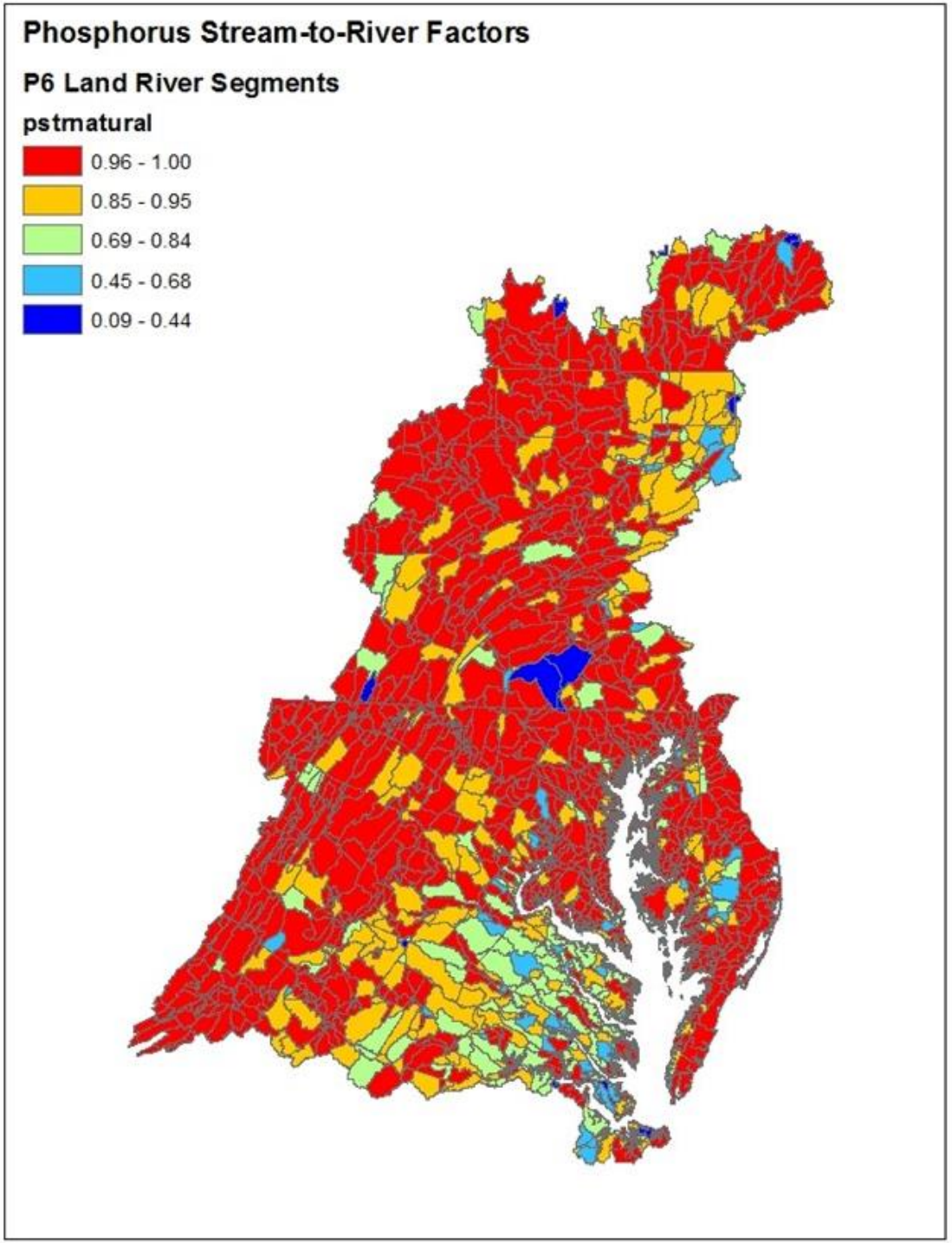


Stream to River factors for

Developed

Reservoirs

Phosphorus



Stream to River factors for

Natural

Reservoirs

Phosphorus

o Revision.
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- Chesapeake Floodplain Network
  - Tested in Beta 4
  - Contributed to concept of stream bank and floodplain loads
- Stream source ratio
  - Available for sediment only
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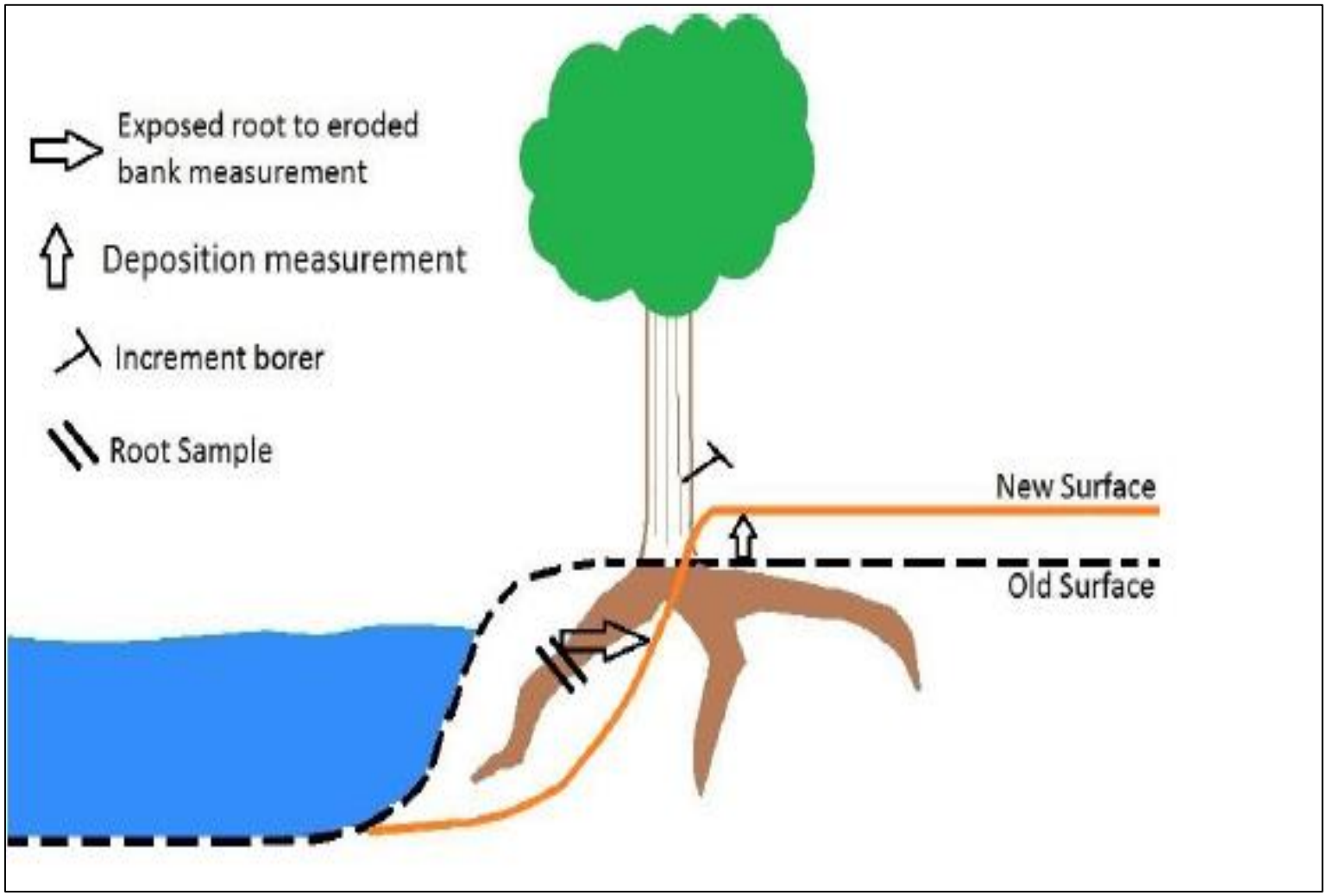
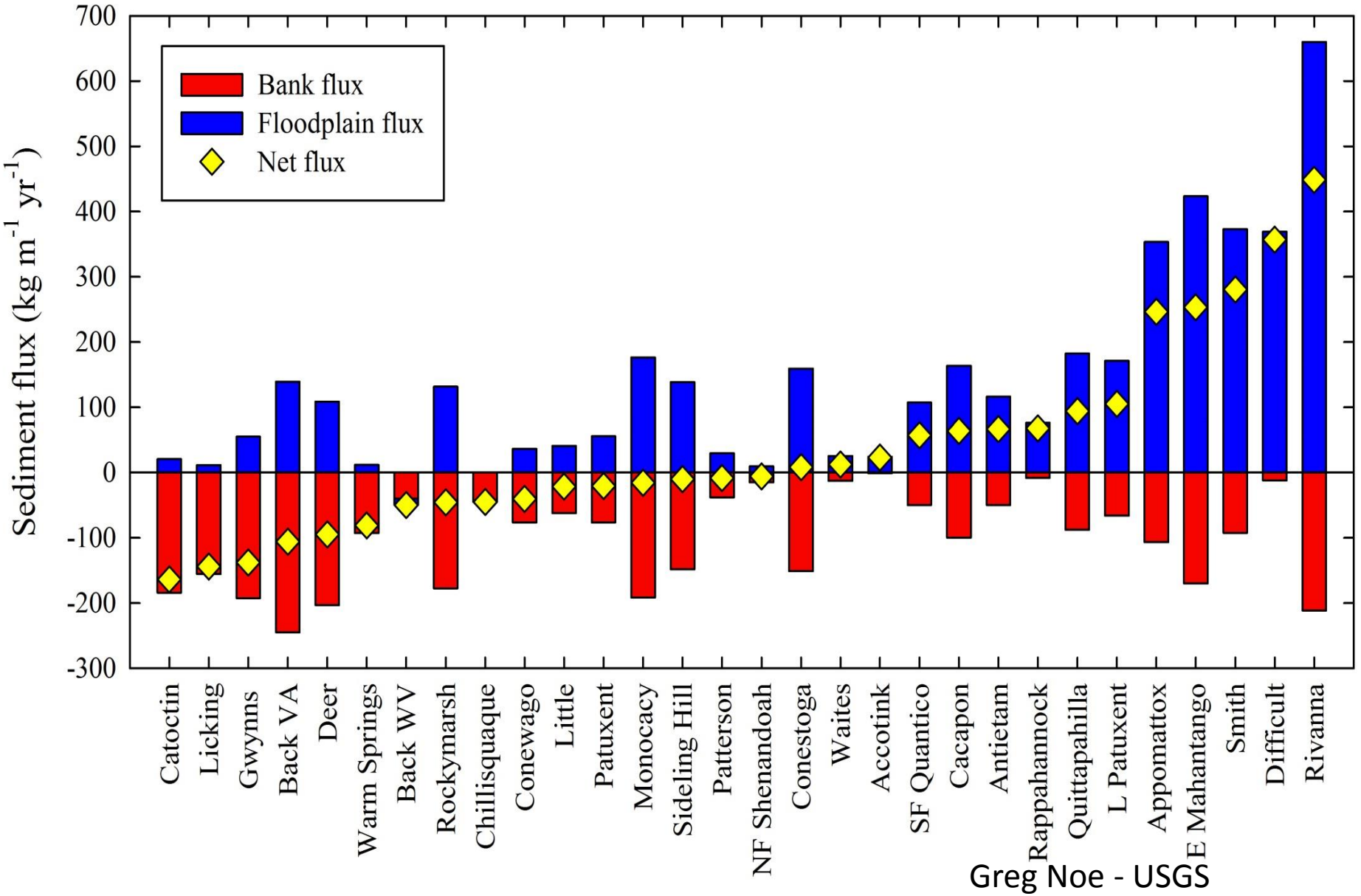
Chesapeake Floodplain Network



Greg Noe - USGS

Chesapeake Floodplain Network



Greg Noe - USGS

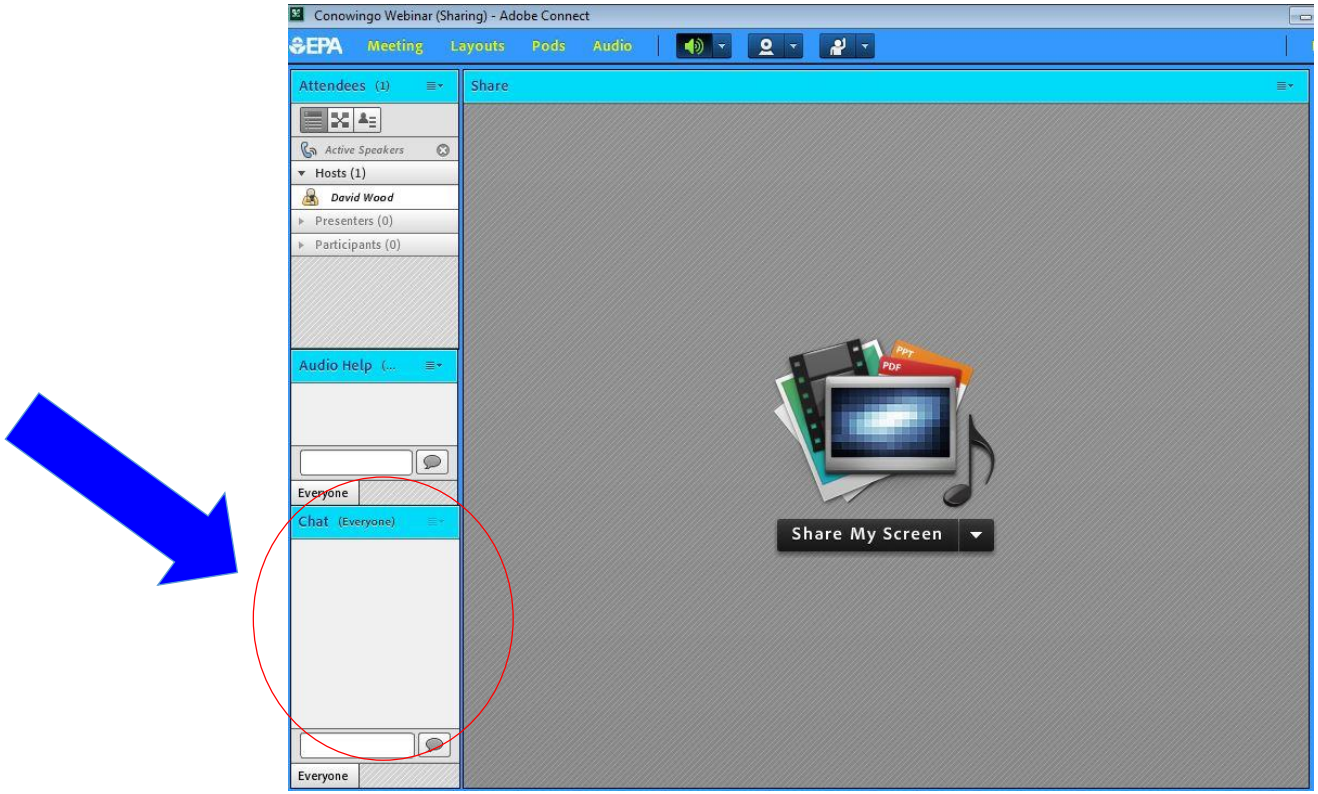
Streams as a source and a sink

- Stream Bed and Bank land use
  - Source of 0.074 lbs N per foot per year
  - Source of 0.022 lbs P per foot per year
  - Reduced by streambank BMPs
  - Allowed to go negative
- Stream Floodplain land use
  - Sink of 0.074 lbs N per foot per year
  - Sink of 0.022 lbs P per foot per year
  - No change through scenarios

- Denitrification and impoundment still apply

Questions and Answers Session

- To Ask a Question
  - Submit your question in the chat box, located in the bottom left of the screen.







Phase 6 Model Structure

Average Load + Δ Inputs * Sensitivity

*

Land Use Acres

*

BMPs

*

Land to Water

*

Stream Delivery

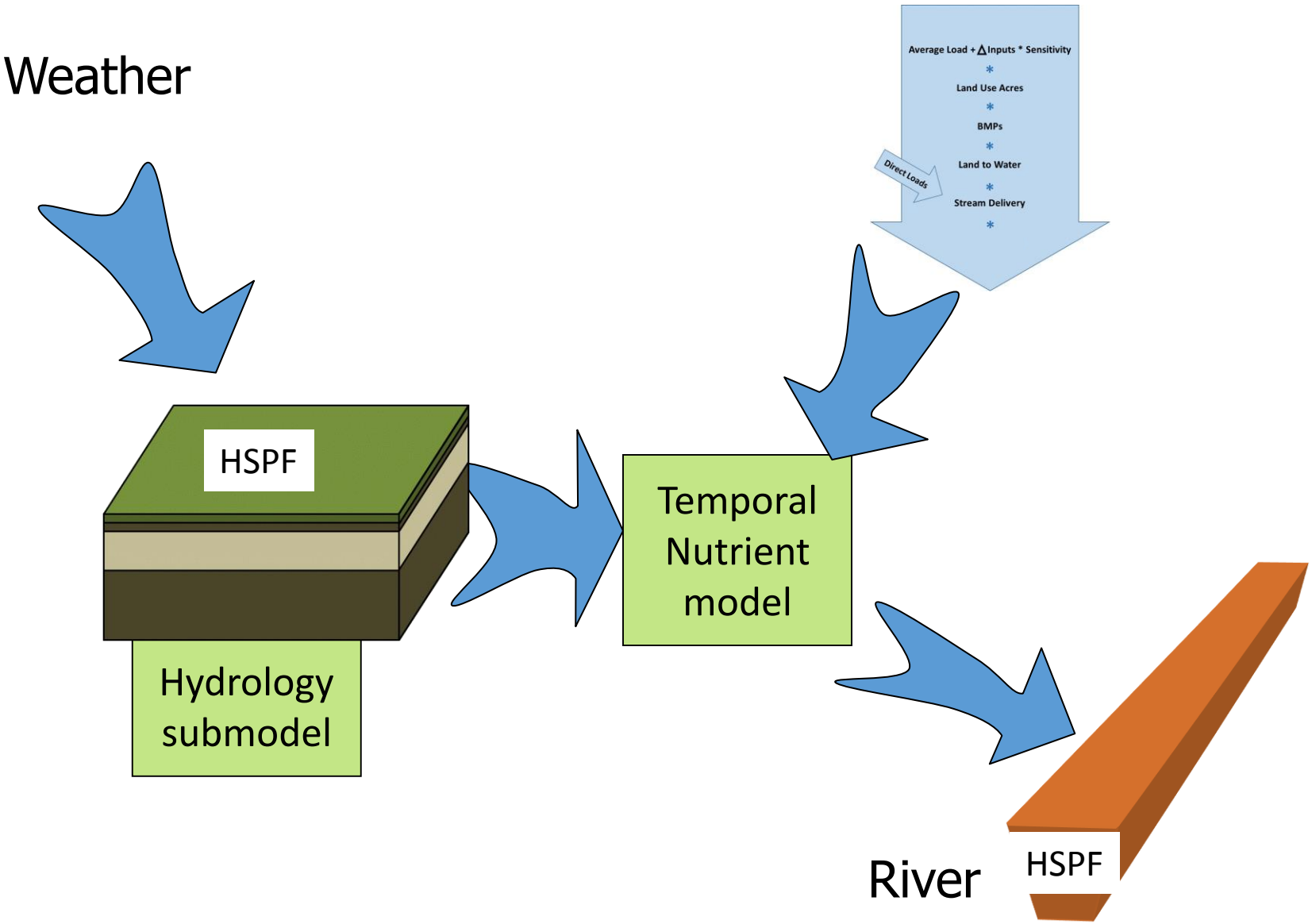
*

River Delivery

Direct Loads

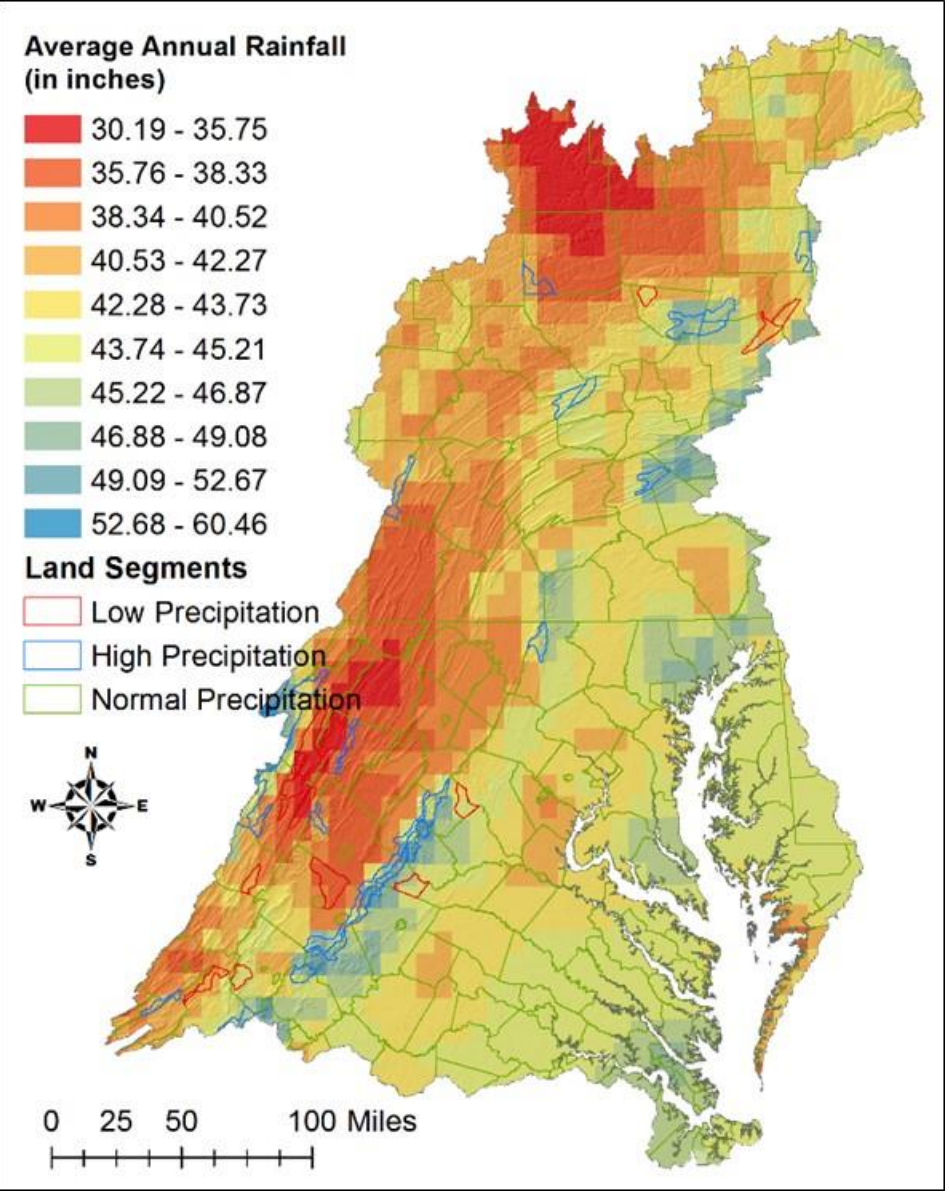
Phase 6

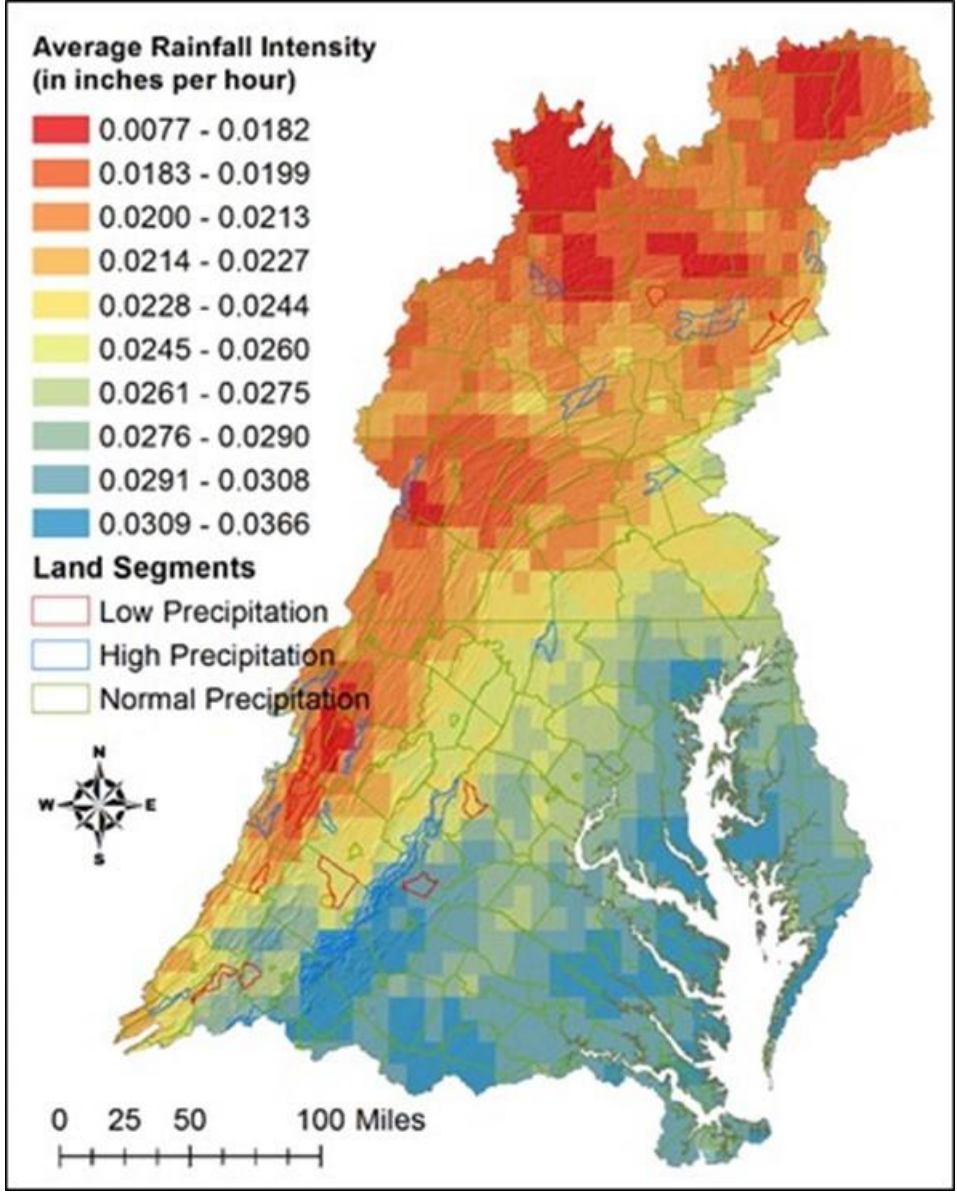
Model to compare against Observations

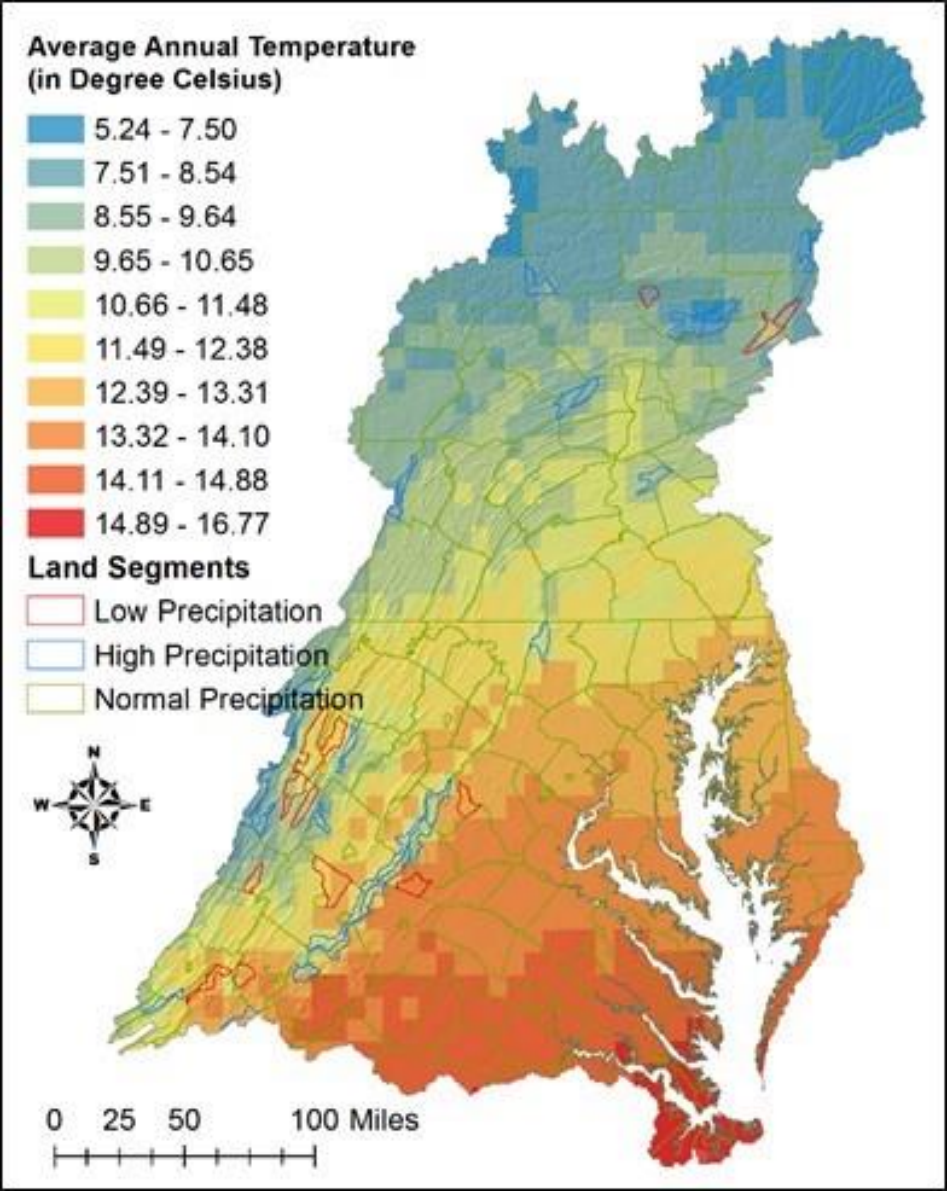


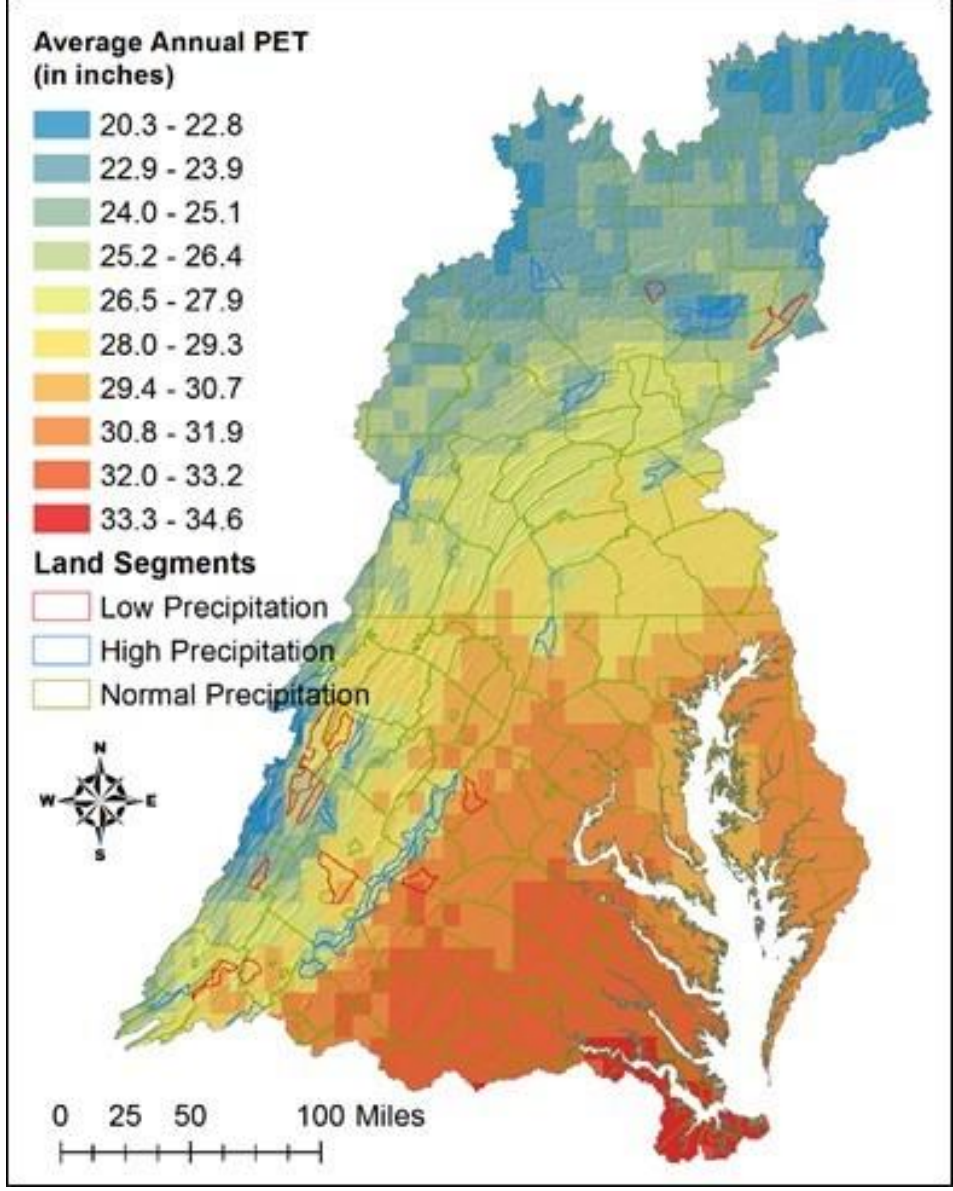
Purposes of the temporal model

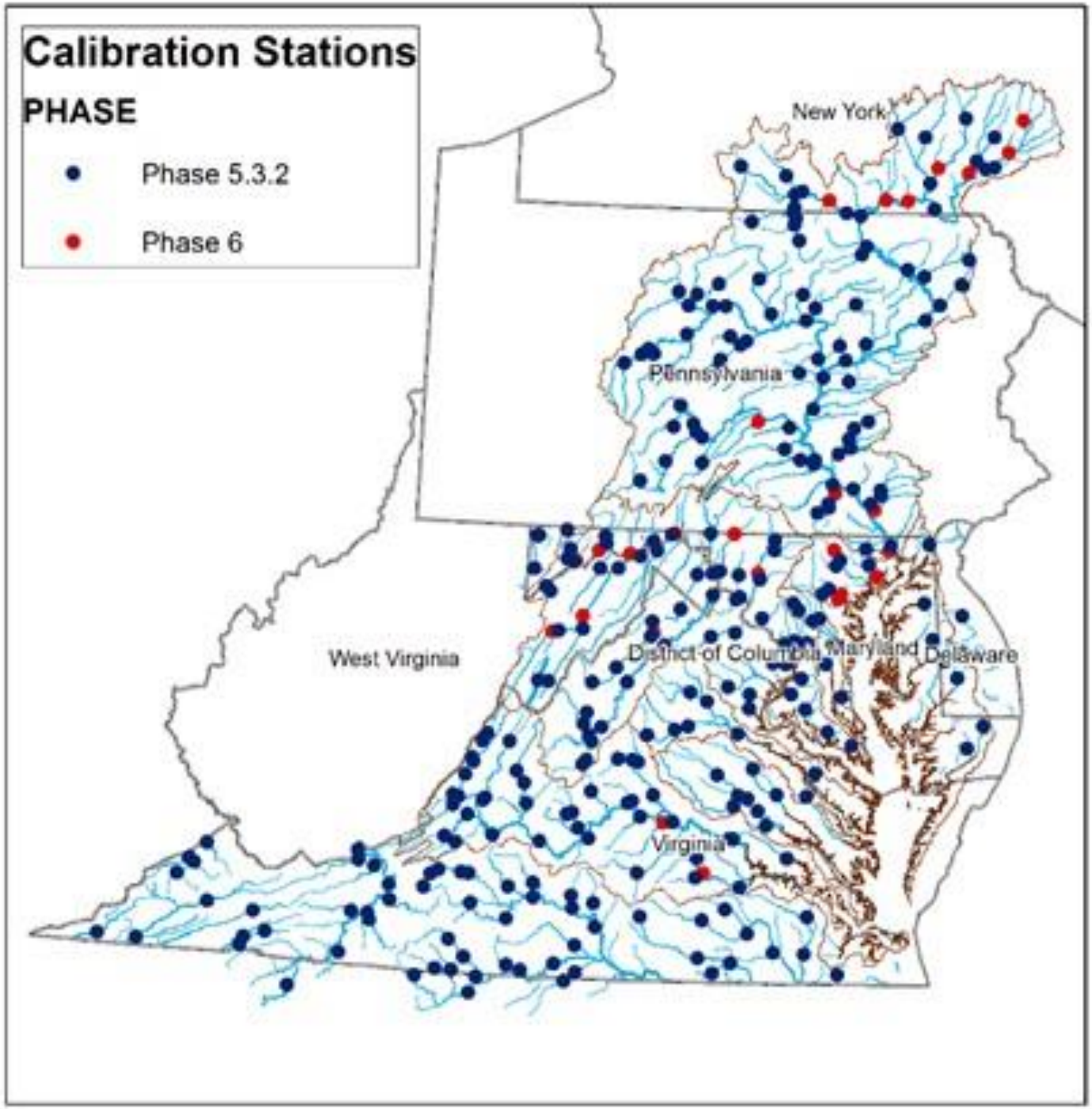
- Calibrate the watershed model to observations
- Estimate river delivery 
- Create input loads for the estuarine model
- Scientific investigations – lag time

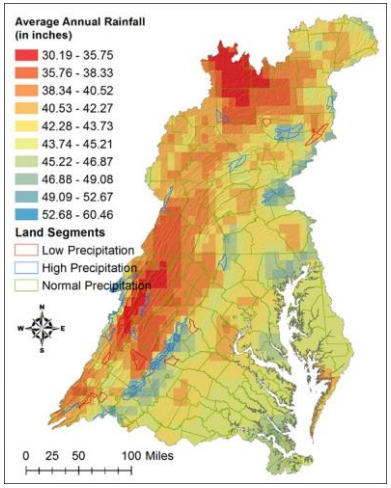


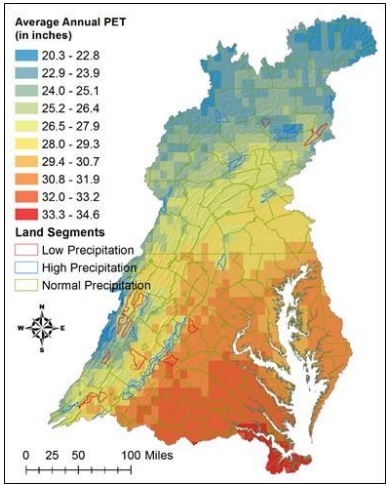


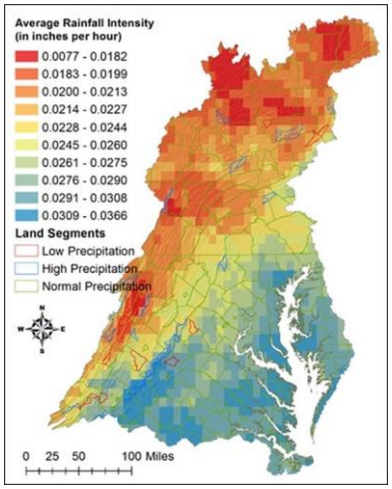


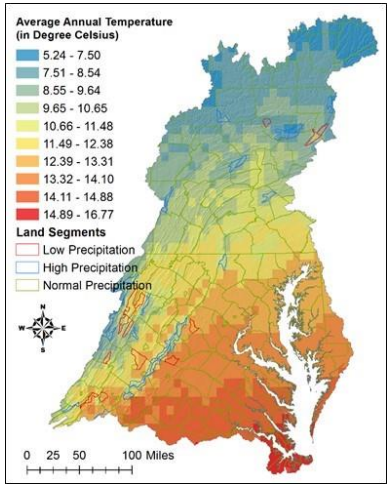


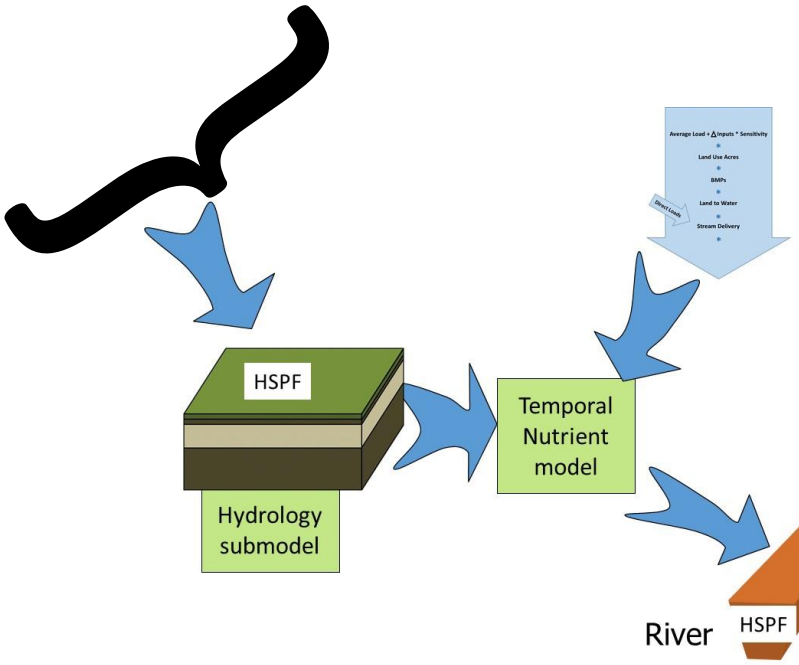

Calibration Stations
PHASE
Phase 5.3.2
Phase 6
New York
Pennsylvania
West Virginia
District of Columbia
Maryland
Delaware
Virginia

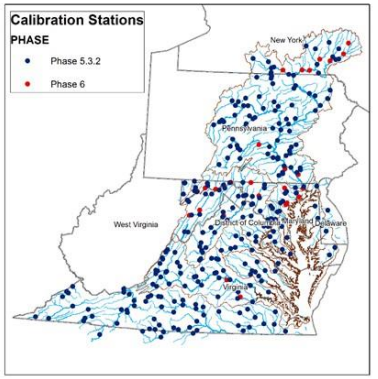












Hydrology Calibration

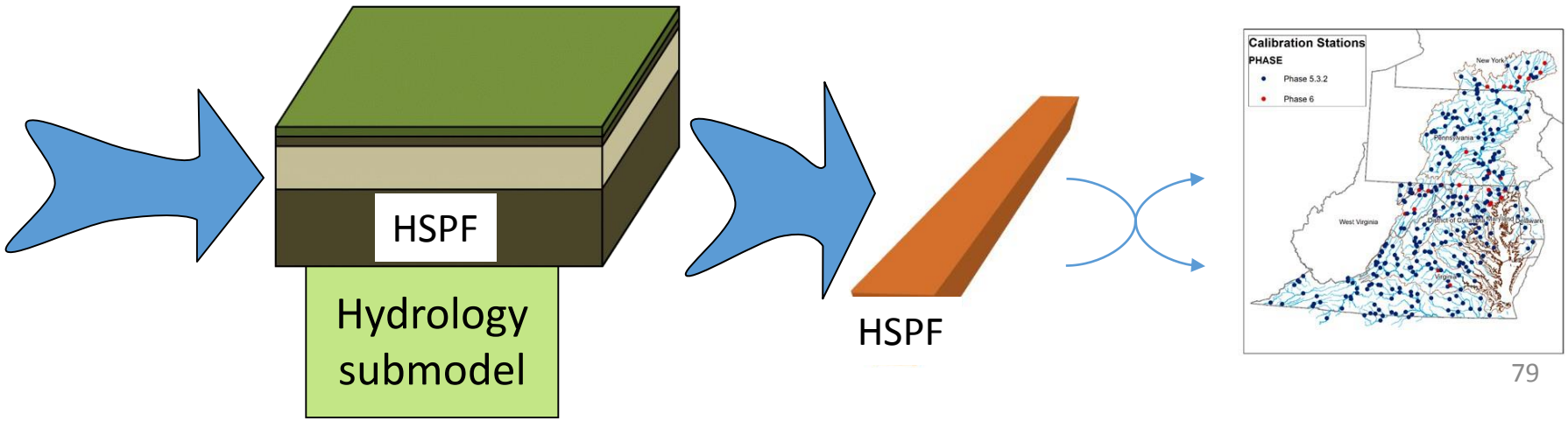
Metric → **Informs** → **Process**

Long-term water balance
Baseflow / Stormflow Balance
Peak heights

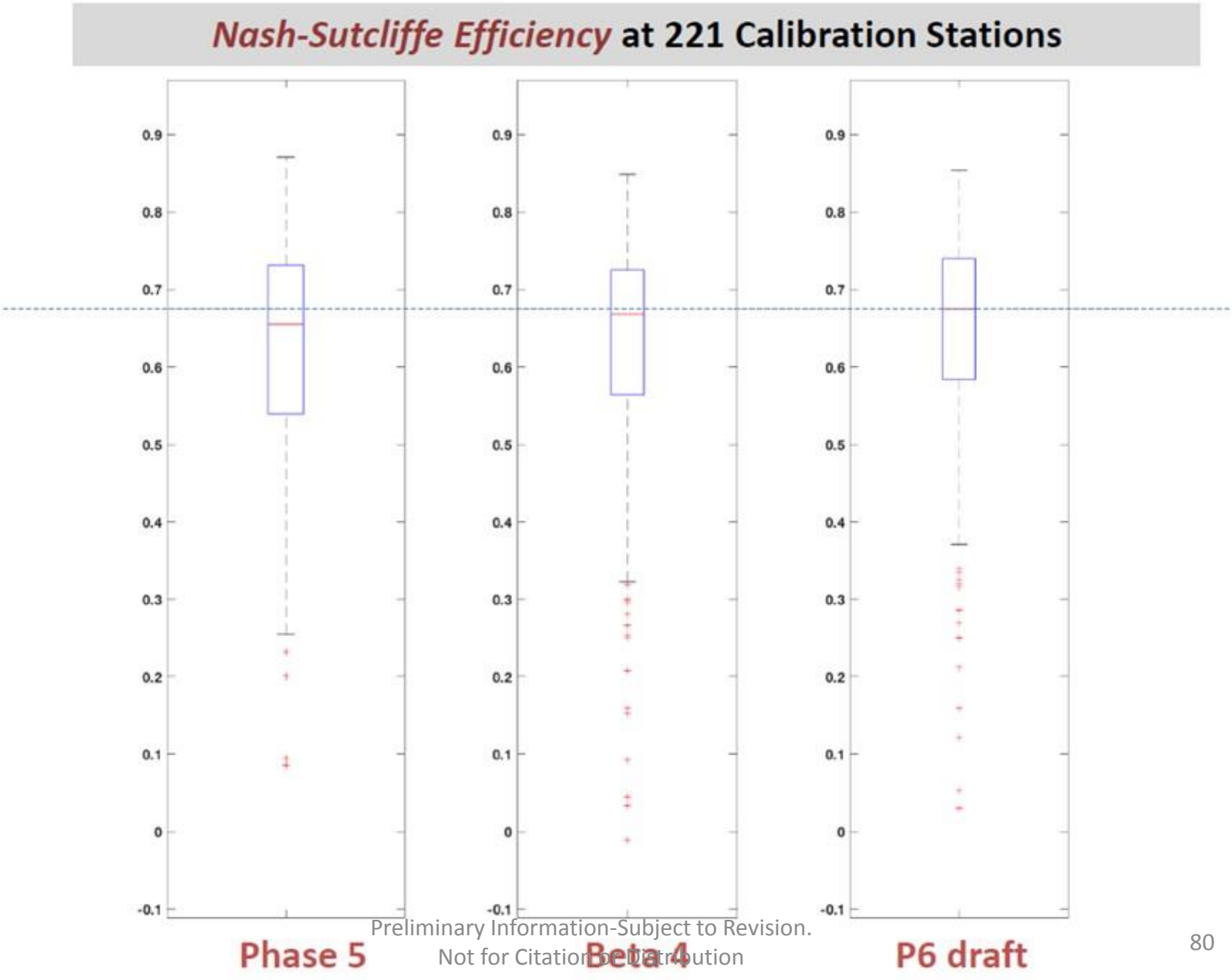
…

Evapotranspiration
Infiltration
Surface stormflow vs subsurface stormflow

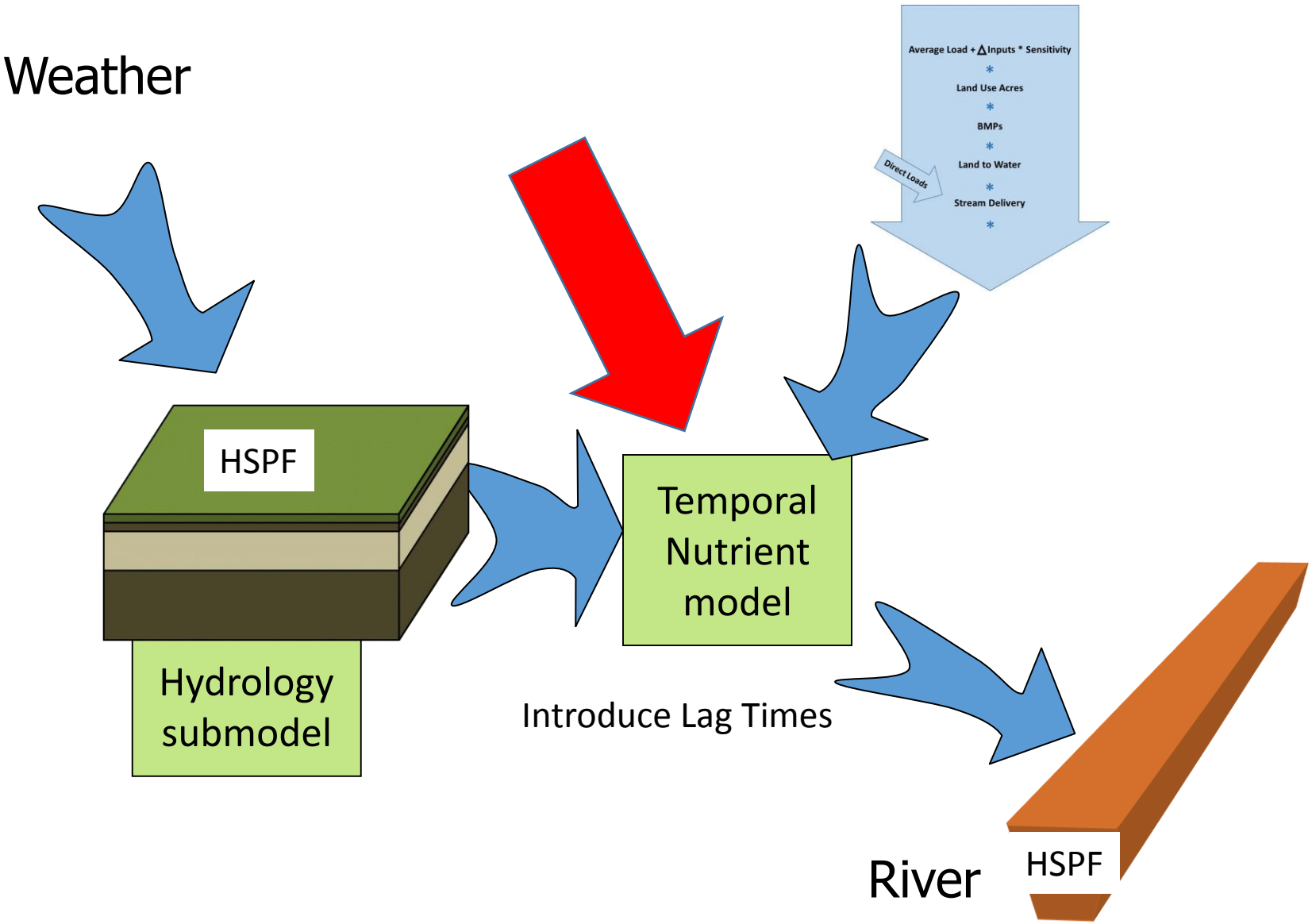
…



P6 draft - Hydrology calibration

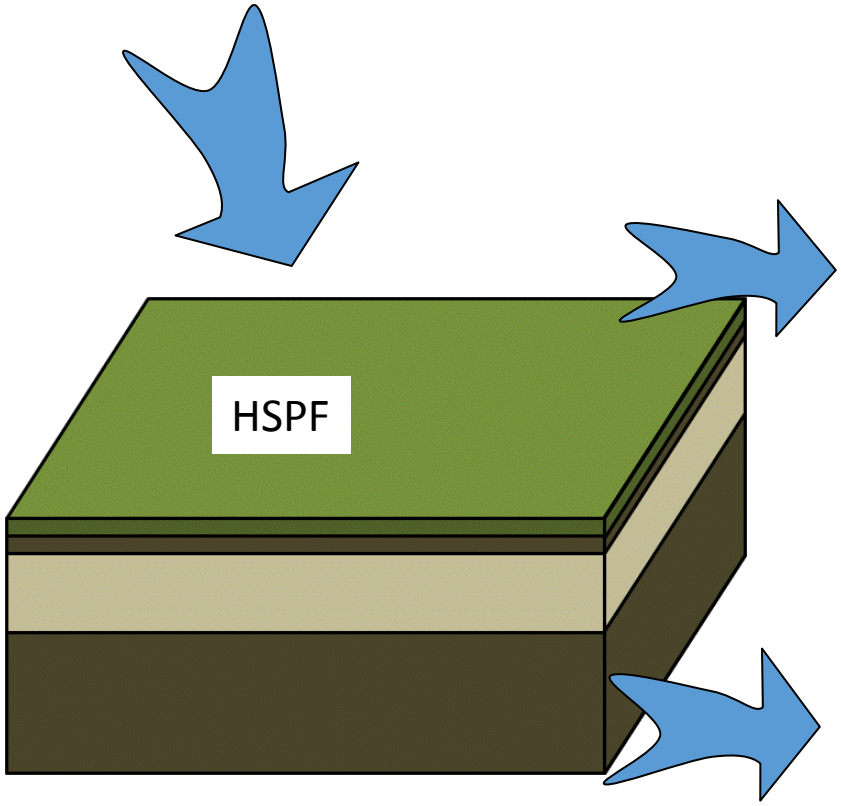


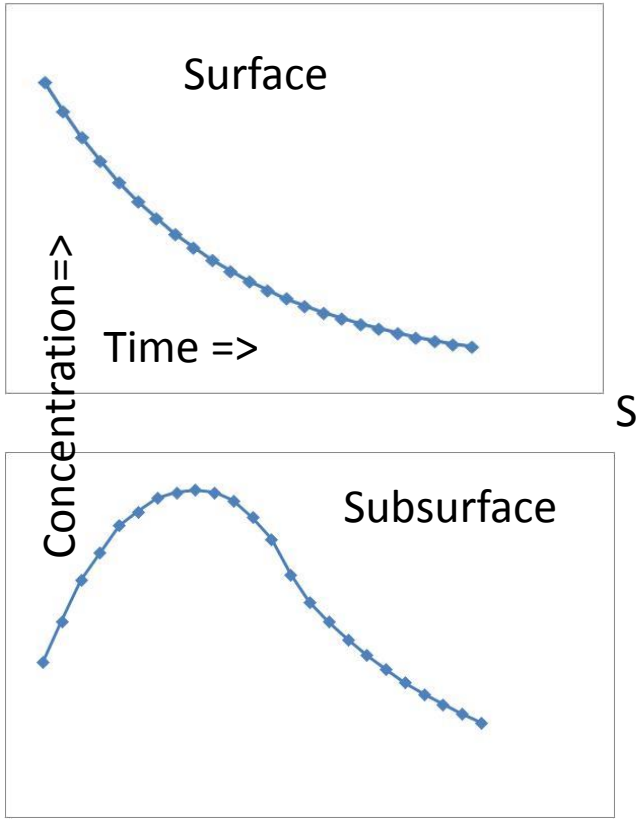
Temporal nutrient model



Lag Models - Nitrogen

Each Loading Event



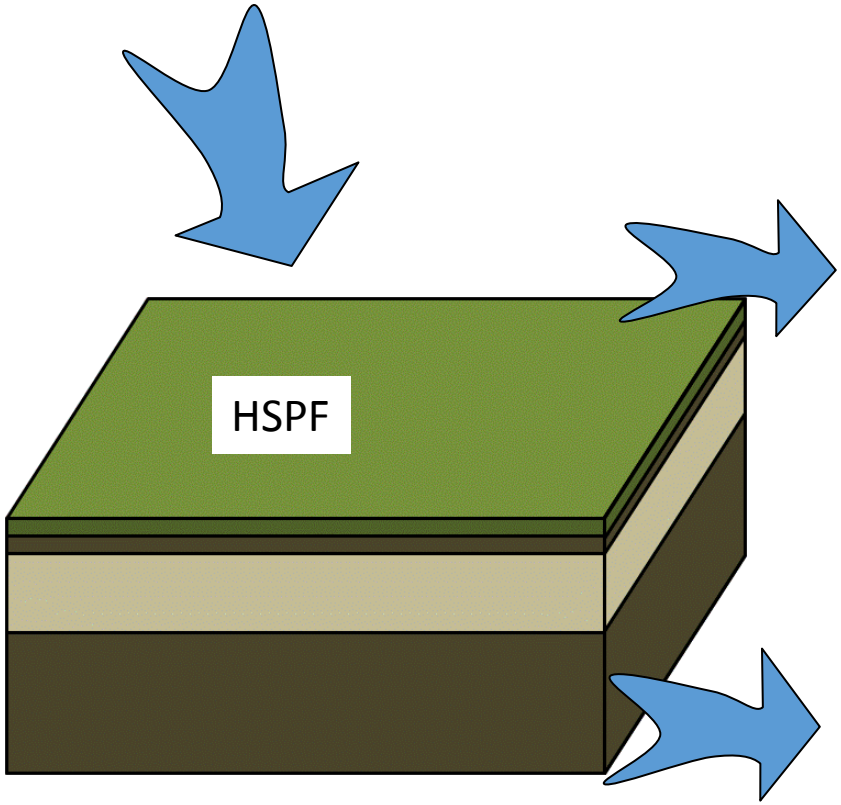


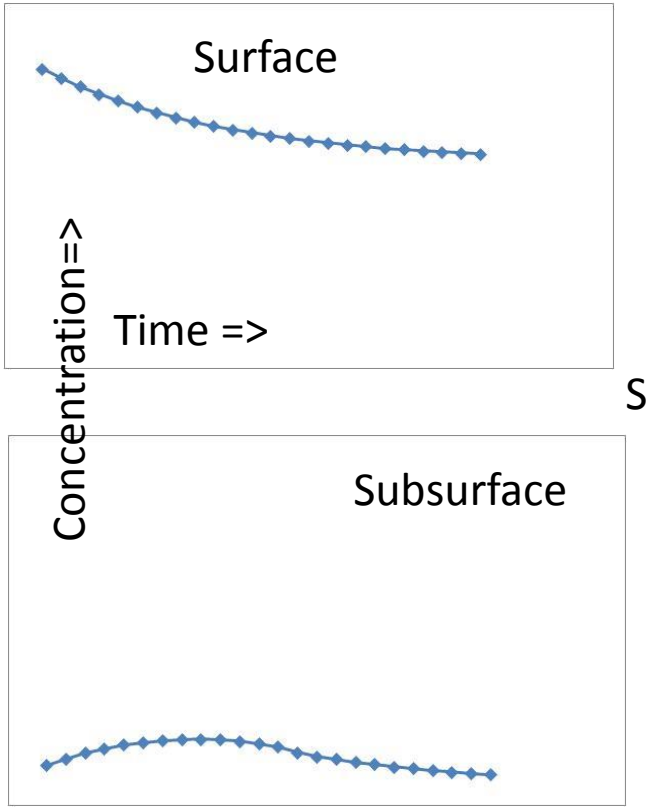
Sum=

Nutrient Submodels

Lag Models - Phosphorus

Each Loading Event





Sum=

Nutrient Submodels

Lag Models

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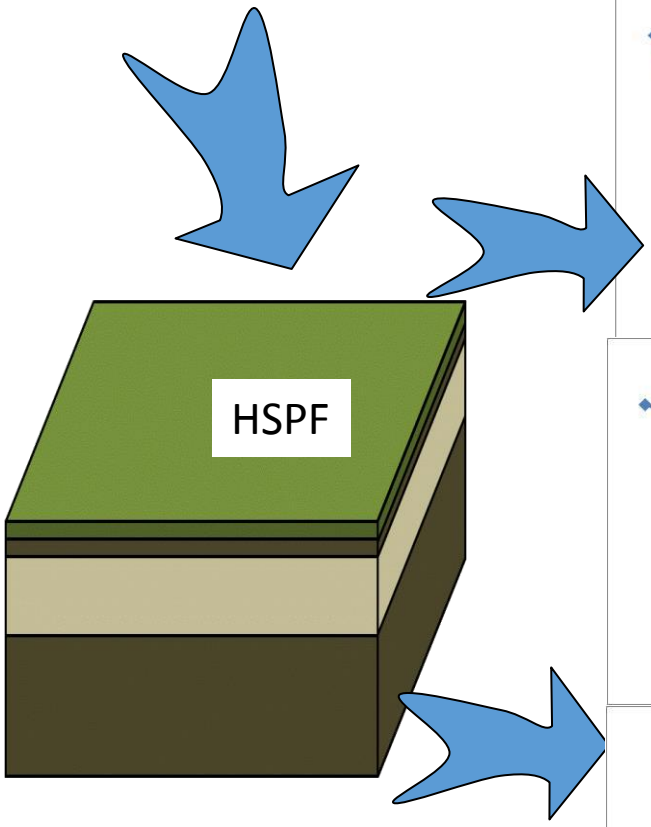
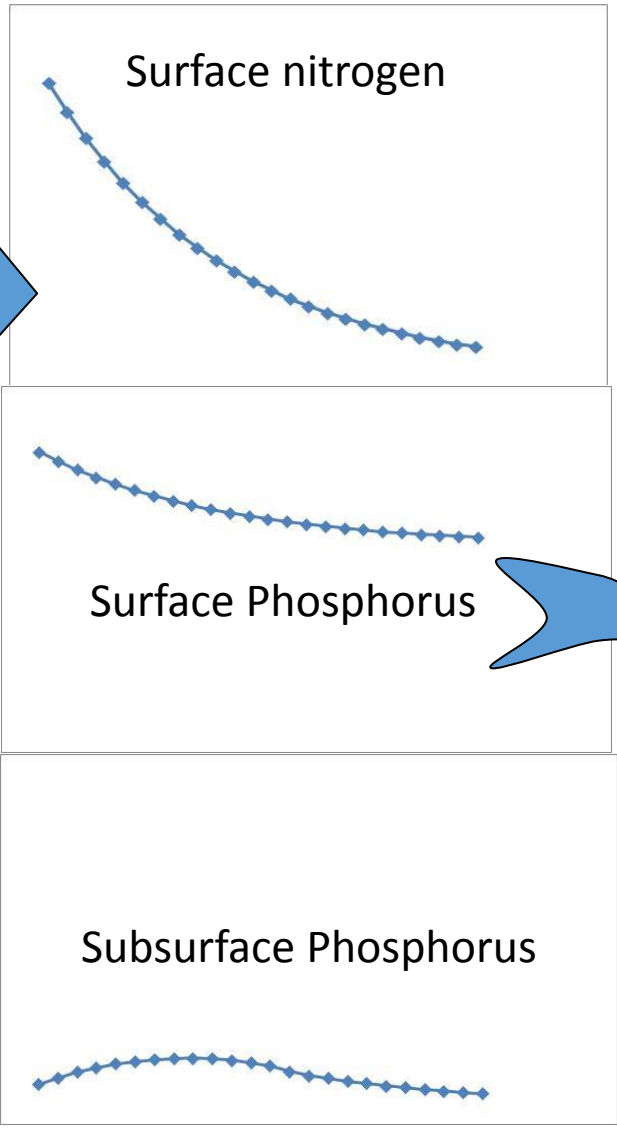
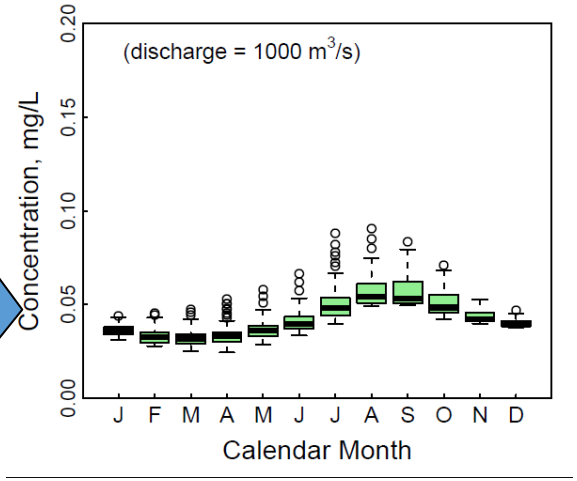


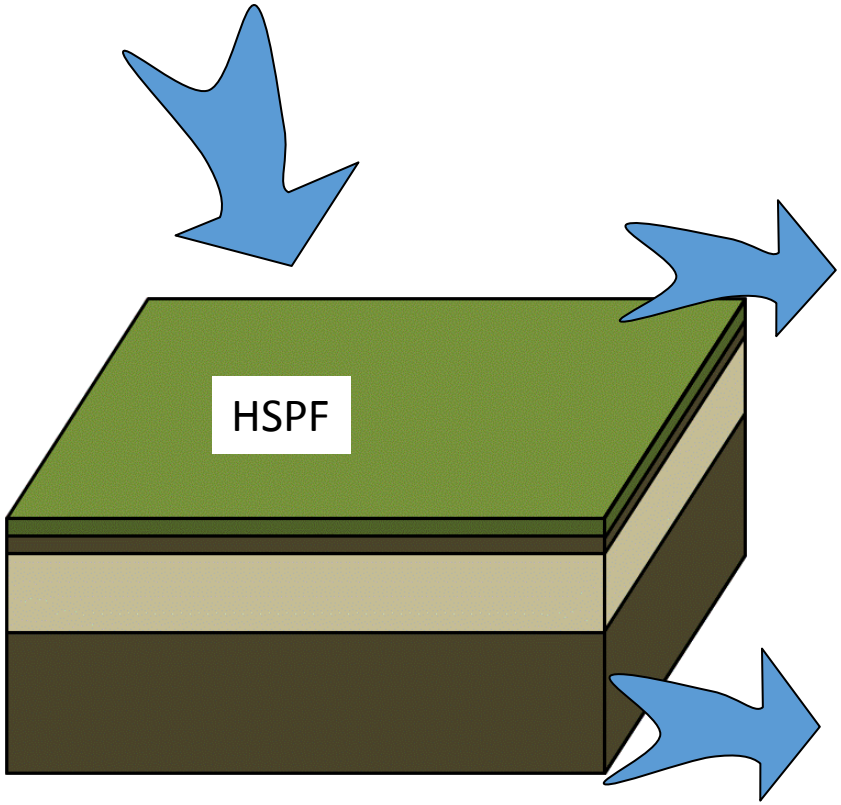


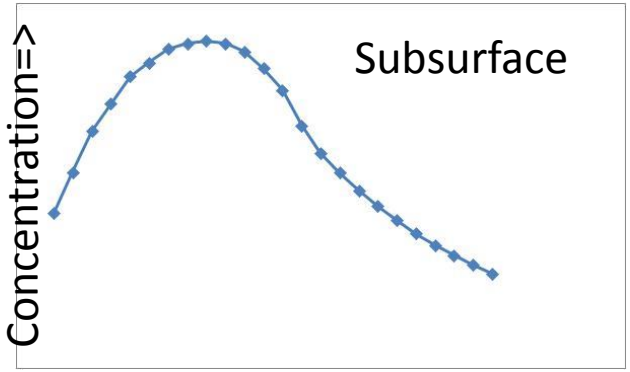
Calibrated to match
Observed seasonality



Lag Models - Nitrogen

Each Loading Event



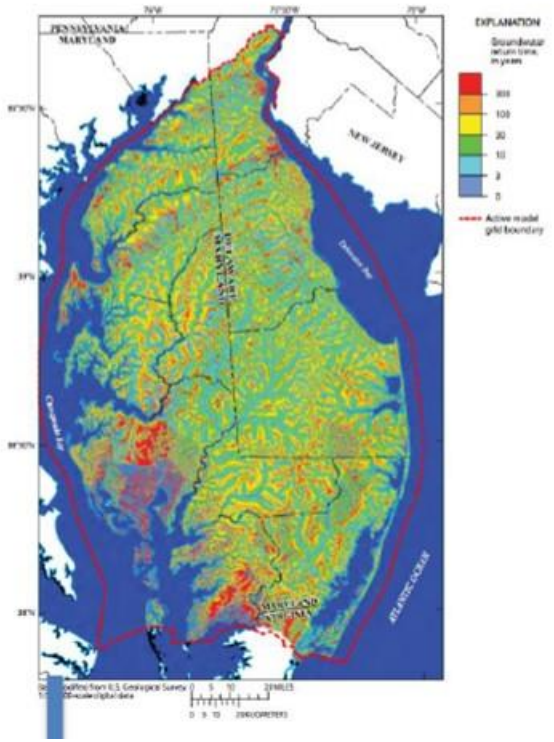


Estimates of Lag Time

Nitrogen Groundwater Lag

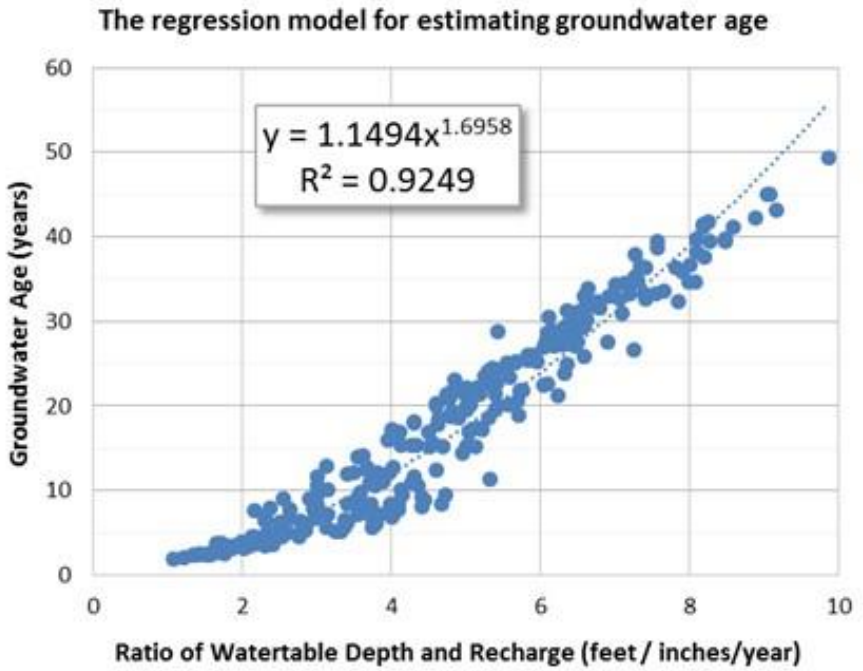
USGS MODFLOW

Ward Sanford et al

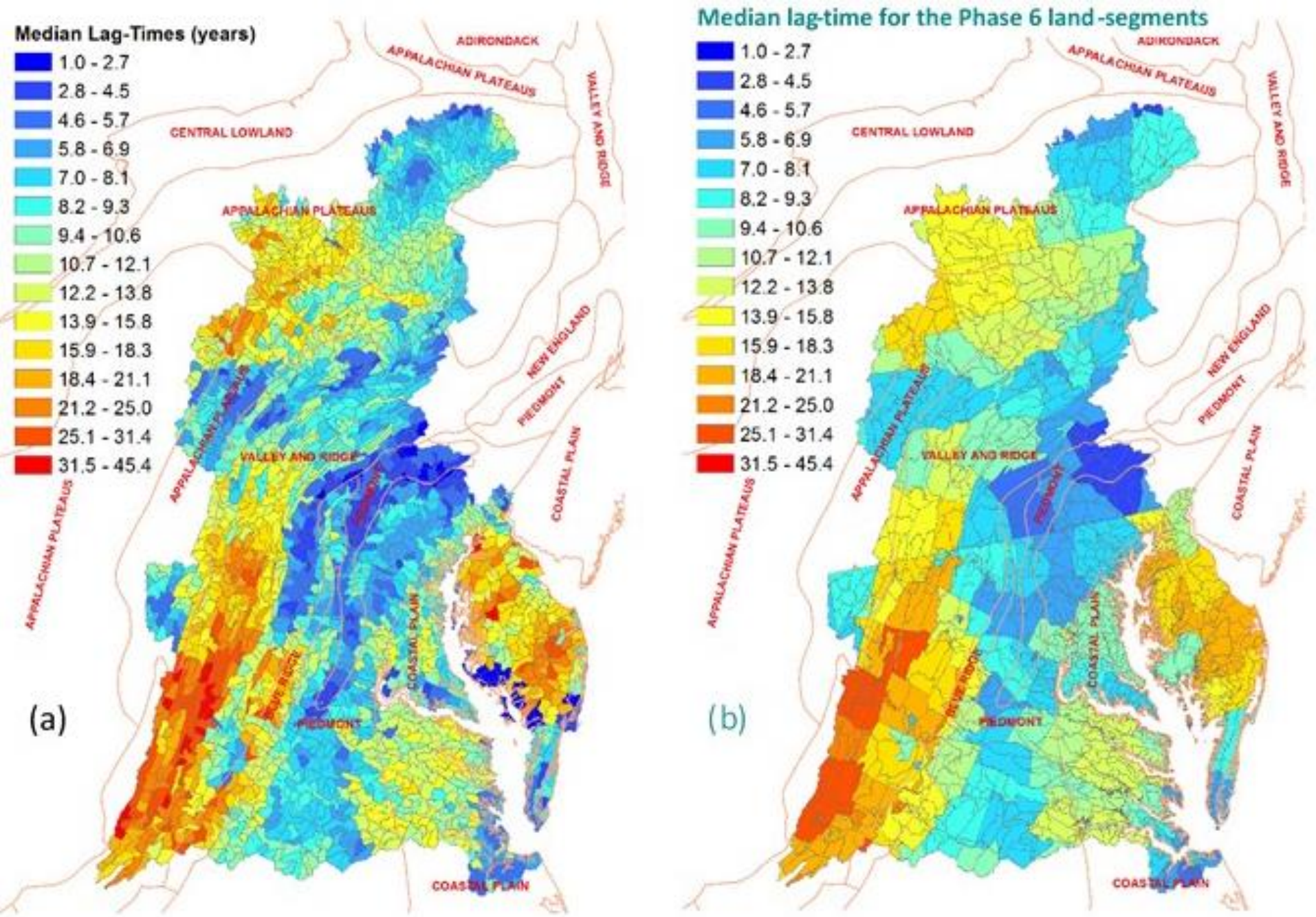


Eastern Shore and Potomac Models

+



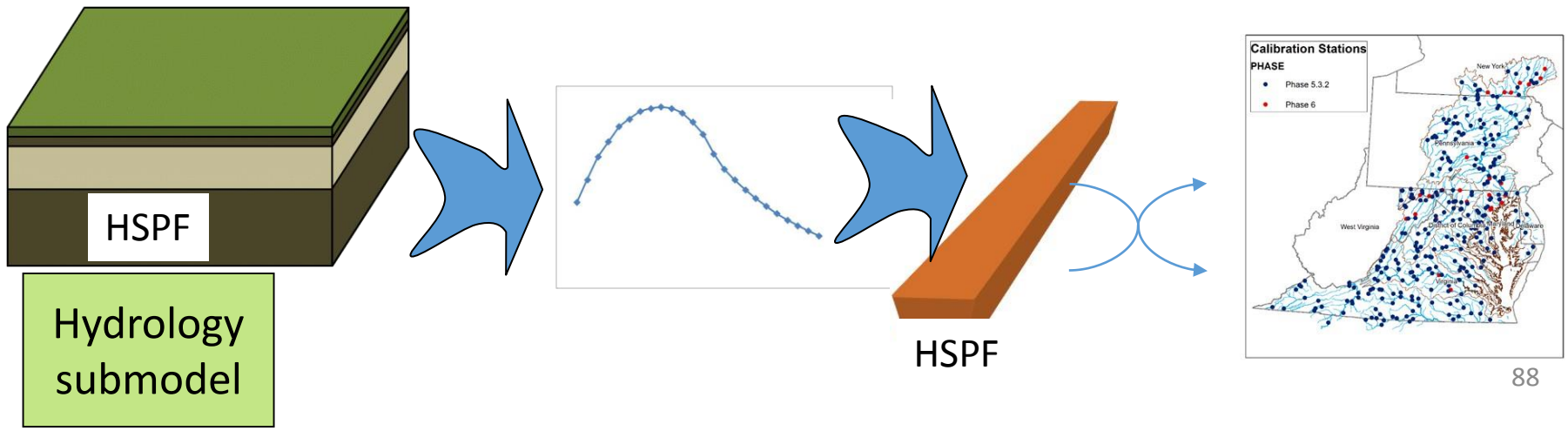
Relationships between measurable landscape features and lag time



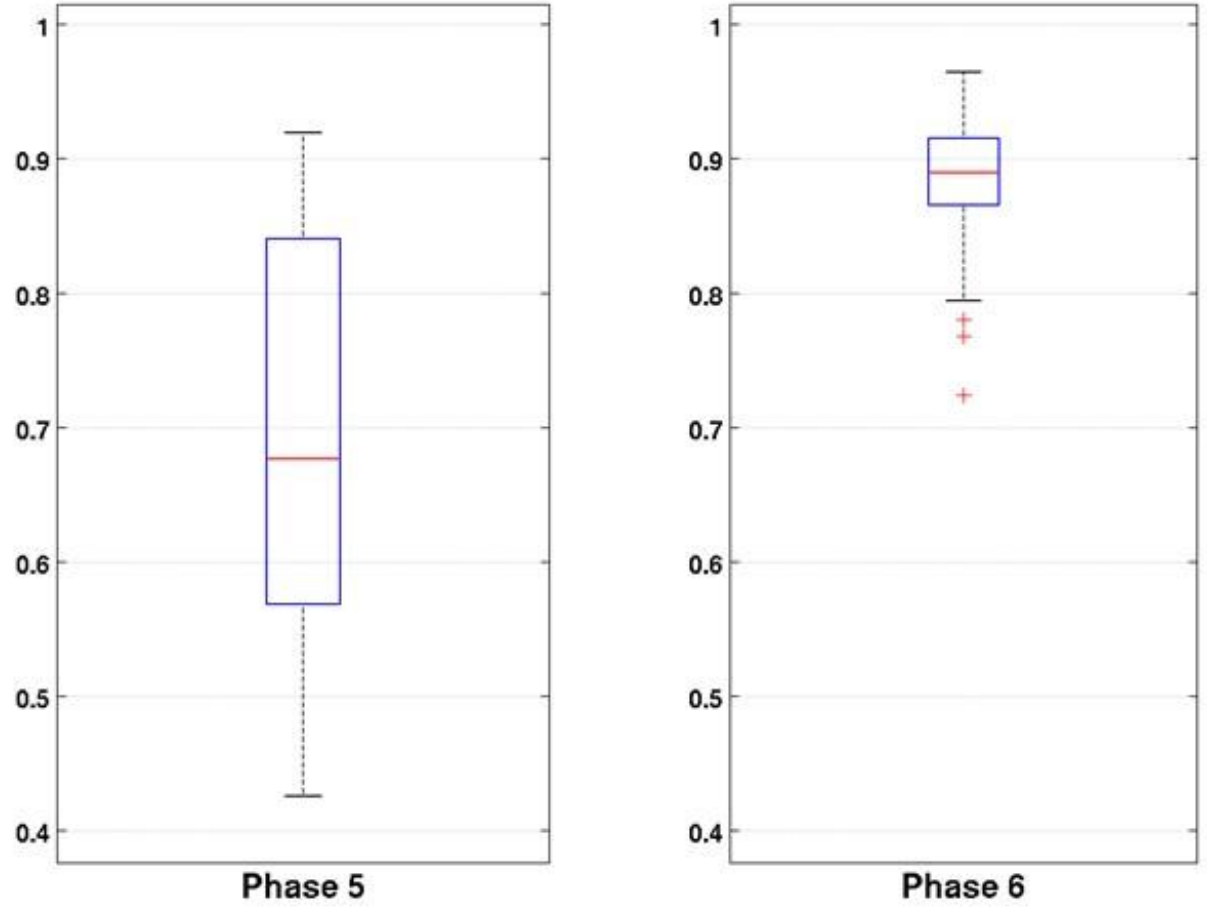
Water Quality Calibration

Metric → **Informs** → **Process**

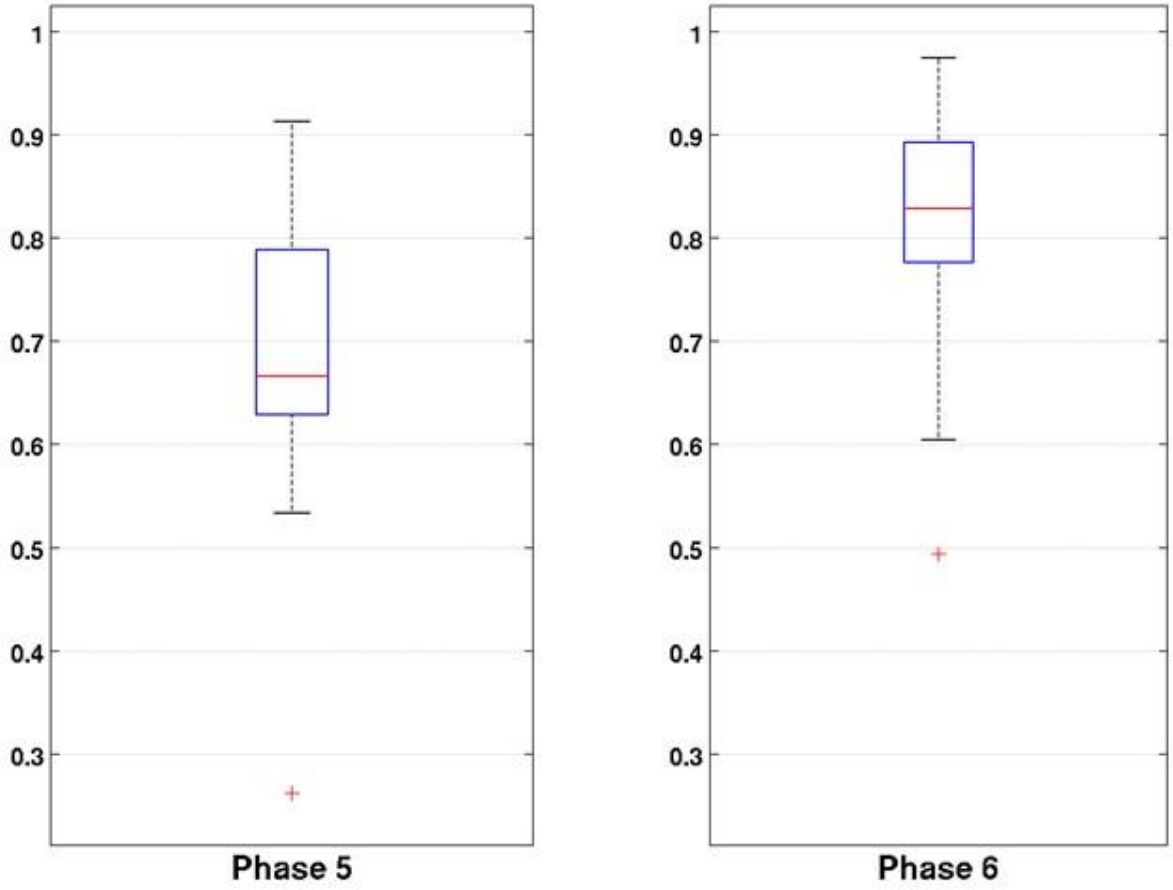
Highest P concentrations	Erodibility
Lowest nitrate concentrations	Denitrification
Average oxygen concentration	Reaeration coefficient
…	…

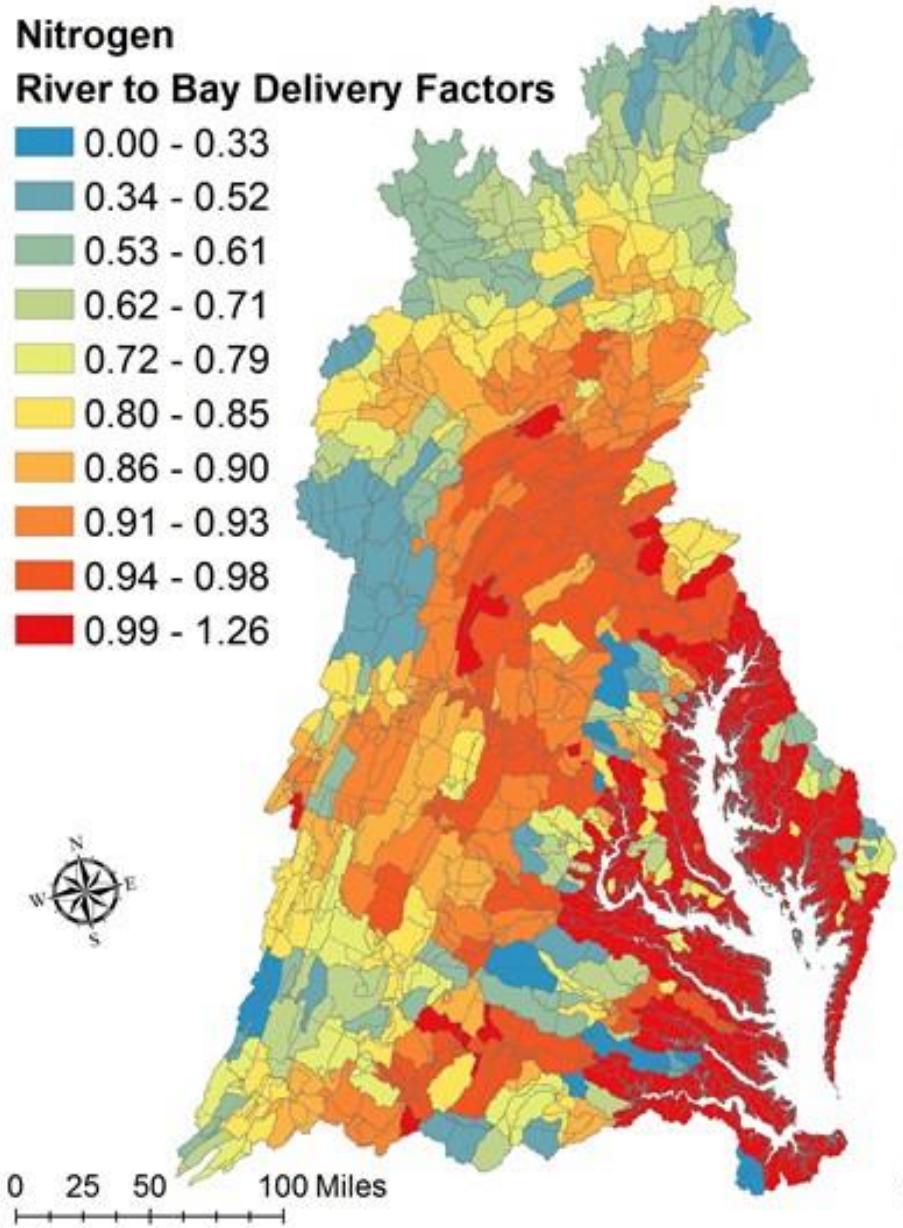


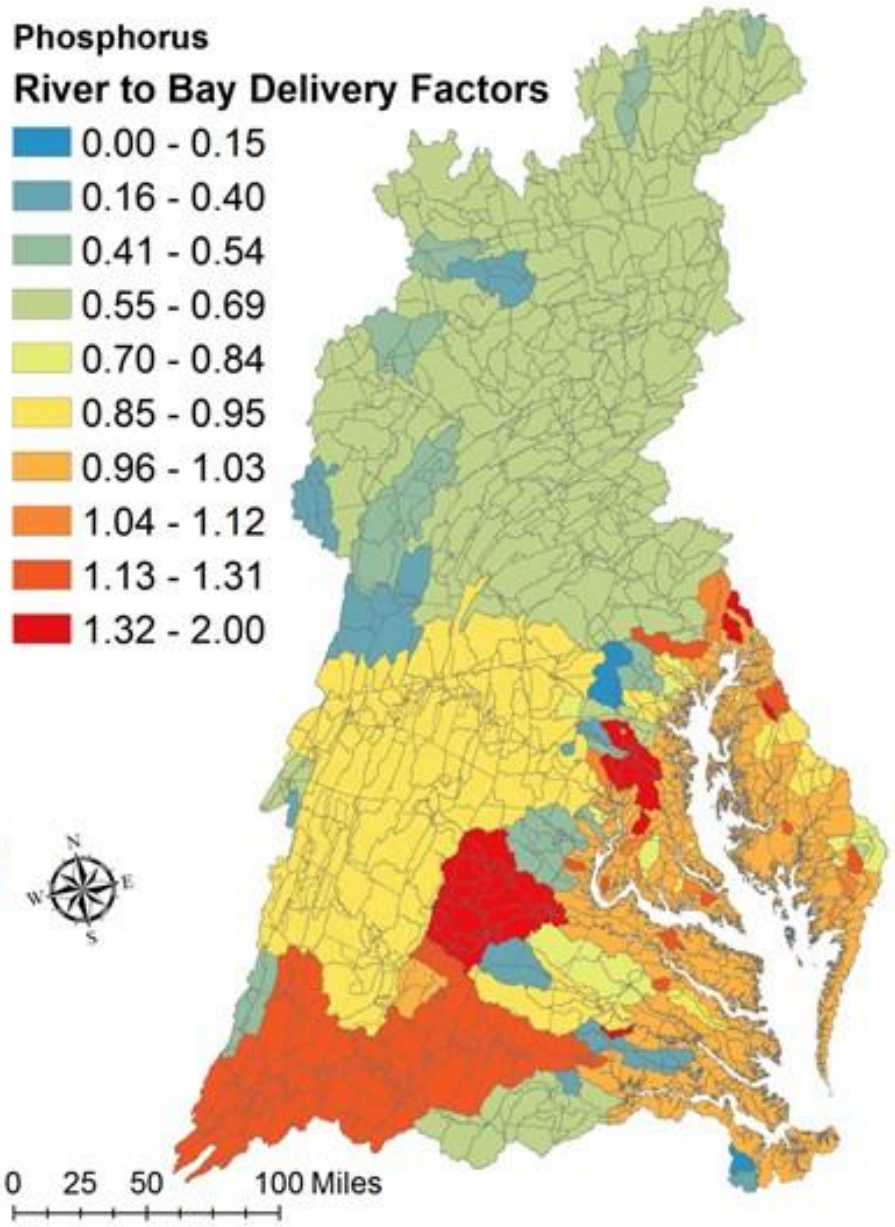
Monthly Correlation Coefficient Nitrogen



Monthly Correlation Coefficient Phosphorus







Conowingo

Significant New Monitoring And Research Since 2011 Indicate <u>Conditions have Changed</u>

- U.S. Geological Survey (USGS) (2012, 2014, 2015)
- U.S. Army Corps of Engineers (2015)
- Johns Hopkins University (2013, 2015, 2016)
- CBP Scientific and Technical Advisory Committee (2014, 2016)
- Enhanced Monitoring and Modeling funded by Exelon and conducted by Gomez and Sullivan, University of Maryland and USGS (2014-2016)

Multiple models and lines of evidence

- Direct Use
  - HDR / Gomez & Sullivan / Exelon Model
  - WRTDS Statistical Analysis
- Supporting Evidence
  - Langland studies
  - LSRWA
  - Observations
  - STAC publications
  - Older publications

Conowingo

MWG Decisions

- What is the current state of the Conowingo Pool?
  - There is overwhelming evidence that the Conowingo Pool is in dynamic equilibrium
    - HDR Model
    - WRTDS
      - USGS
      - Johns Hopkins
    - LSRWA
    - STAC workshop and review of LSRWA

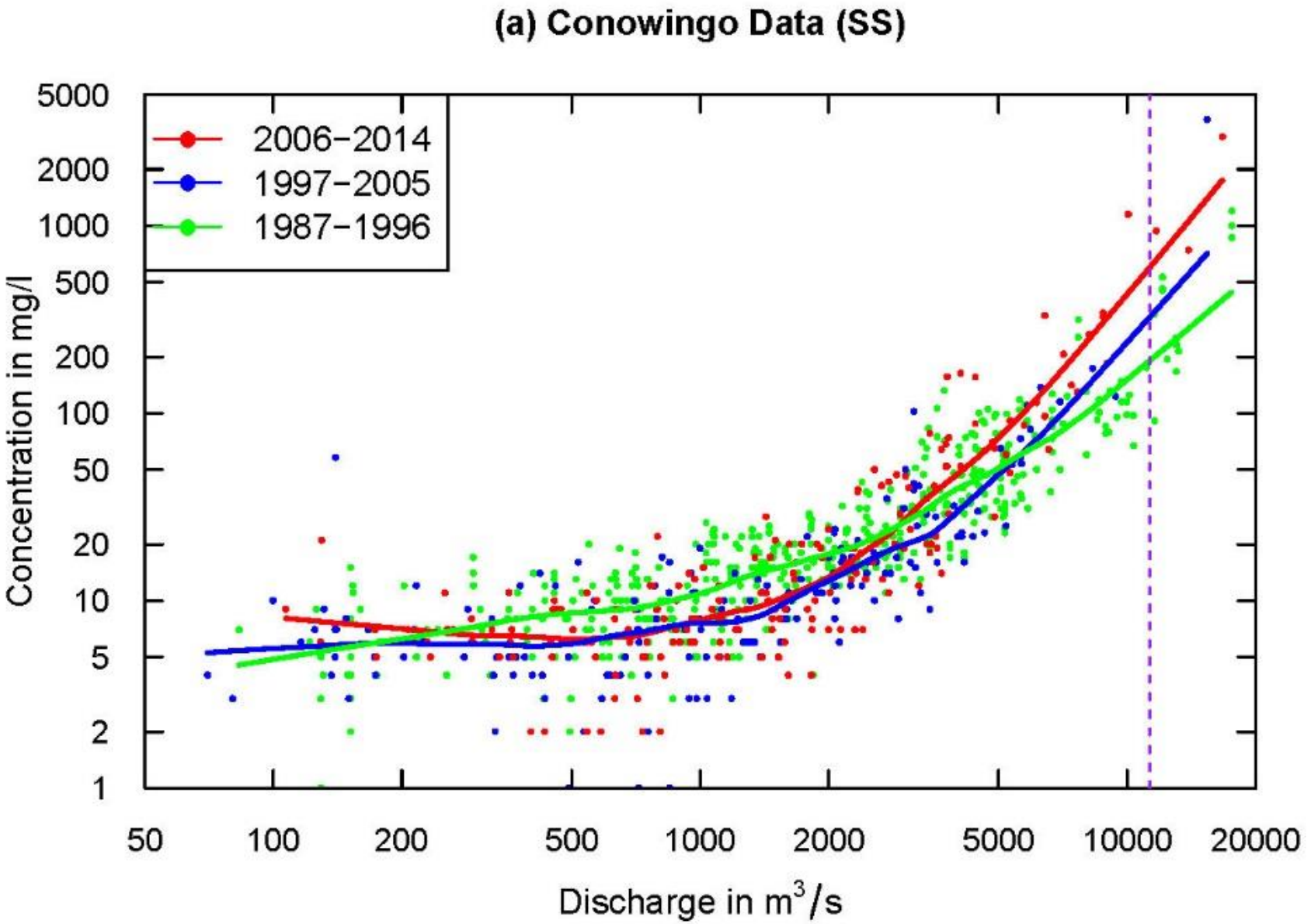
Conowingo

MWG Decisions

- How does the scour and deposition change with time?
  - The Phase 6 watershed model can be calibrated to WRTDS annual loads, since WRTDS matches the observed change in the reservoir behavior over time

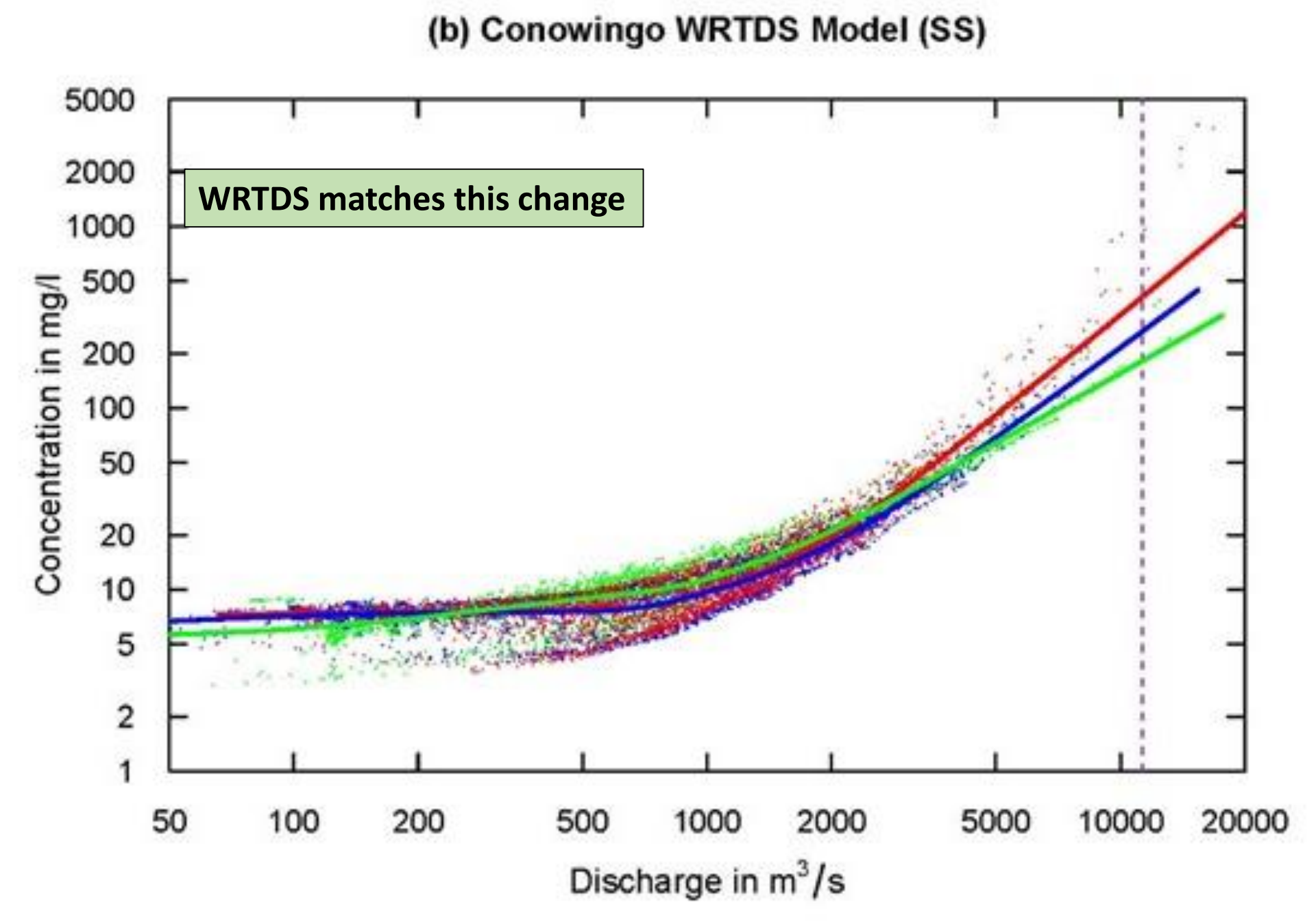
Conowingo

Analysis by Qian Zhang, UMCES/CBPO



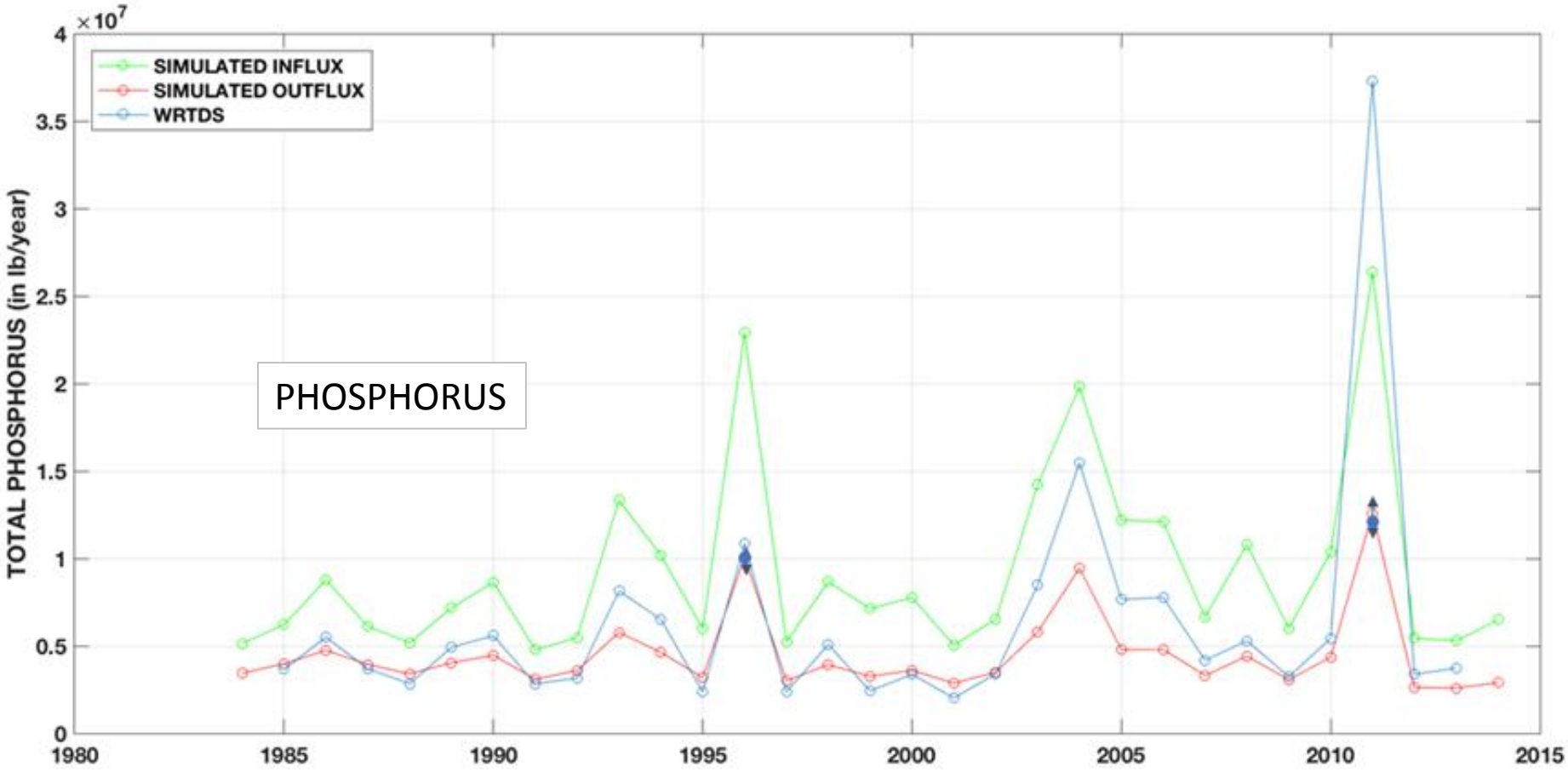
The high flow concentrations have been increasing over time

Analysis by Qian Zhang, UMCES/CBPO



Step 1: Estimate the 1990s condition

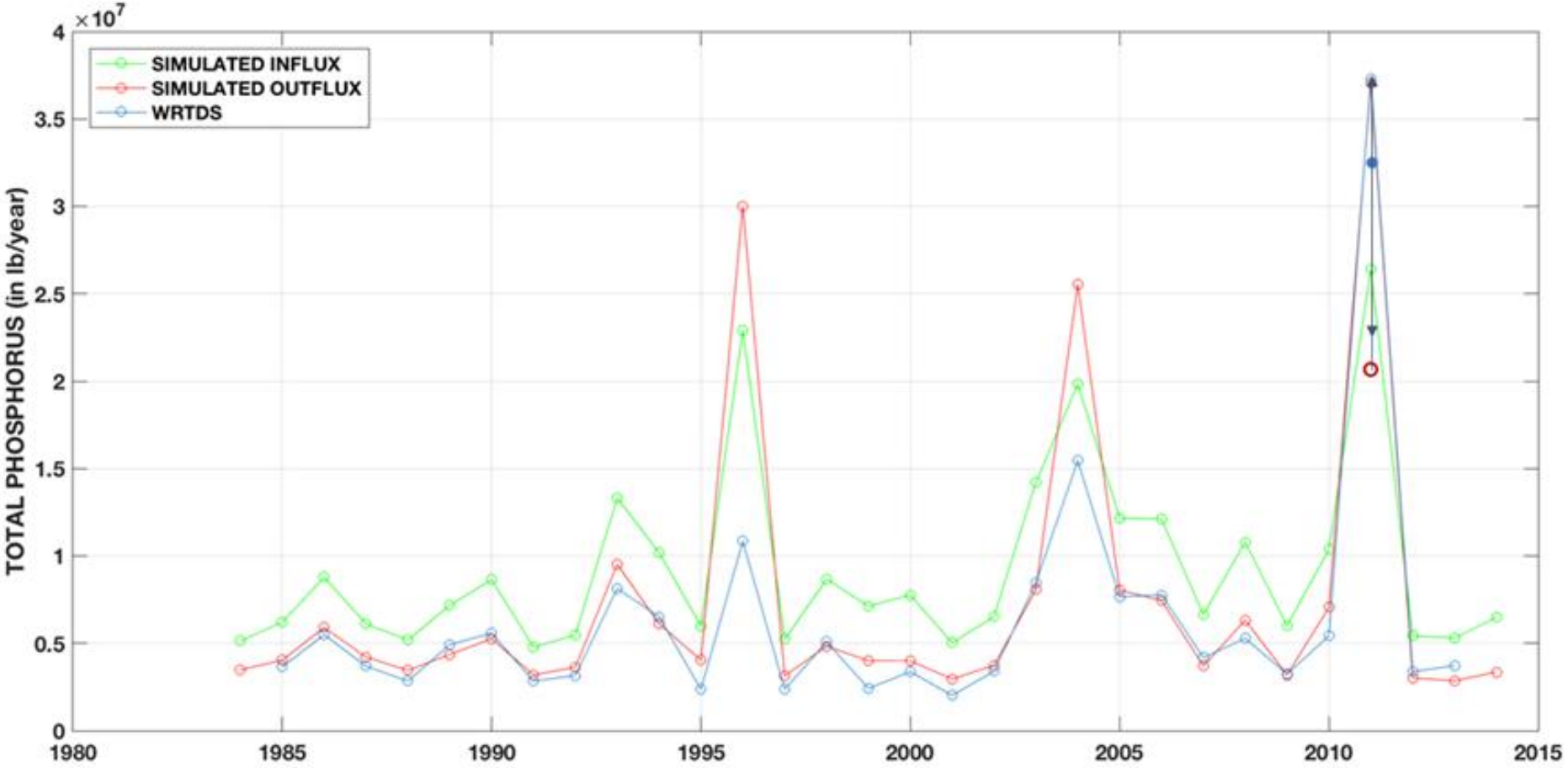
Conowingo



[1] Zhang, Hirsch, and Ball ES&T 2016

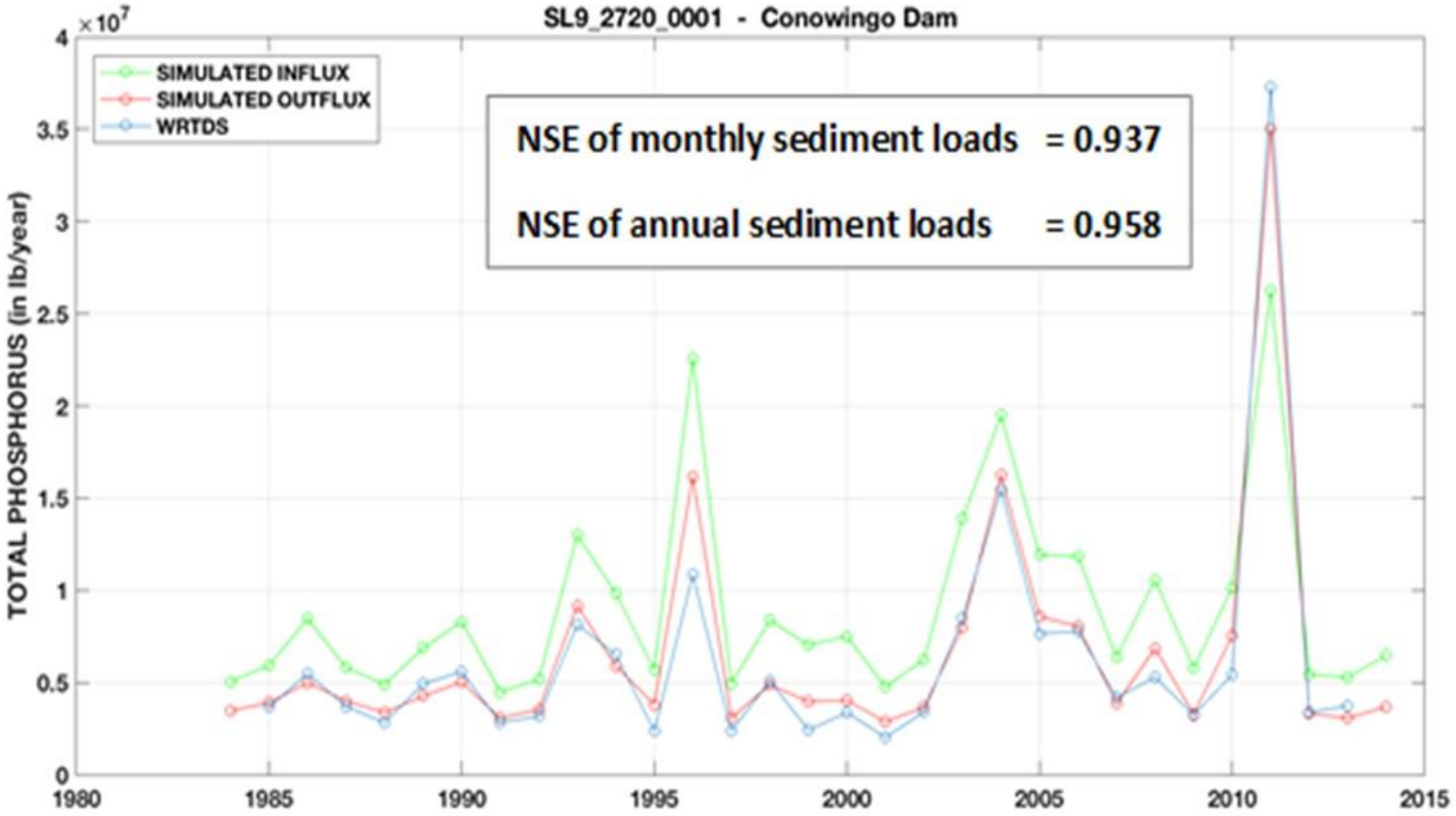
Step 2: Estimate the 2010s condition

Conowingo



Step 4: Apply the change through time

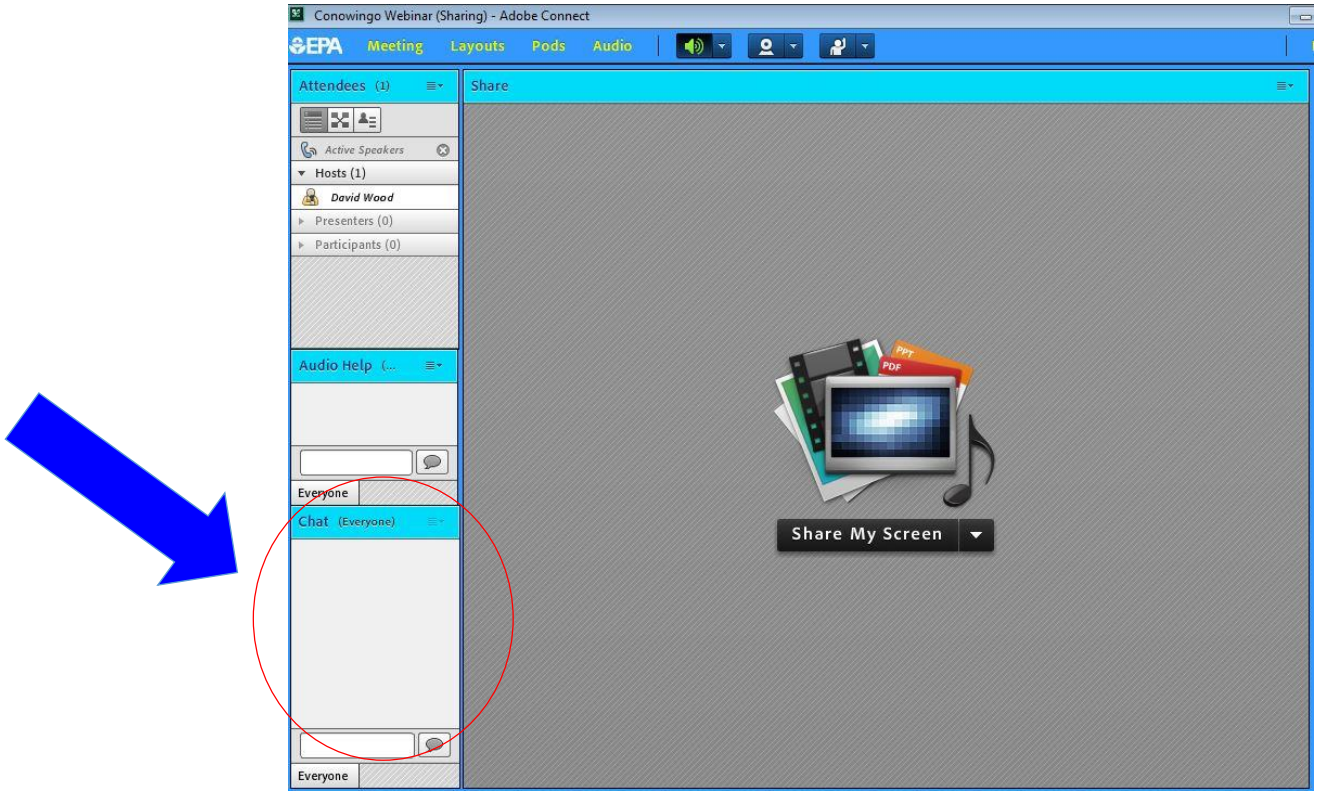
Conowingo



Nash-Sutcliffe Efficiency (NSE)

Questions and Answers Session

- To Ask a Question
  - Submit your question in the chat box, located in the bottom left of the screen.







Phase 6 Model Structure

Average Load + Δ Inputs * Sensitivity

*****

Land Use Acres

Spatially differentiated by land use and input load effects
5/25/17 and 6/1/17 Webinars

Phase 6





Phase 6 Model Structure

Spatially differentiated by
BMPs and point sources
Data-driven

BMPs

Direct Loads

Phase 6





Phase 6 Model Structure

Spatially differentiated by
Transport effects
Today's Webinar

Land to Water

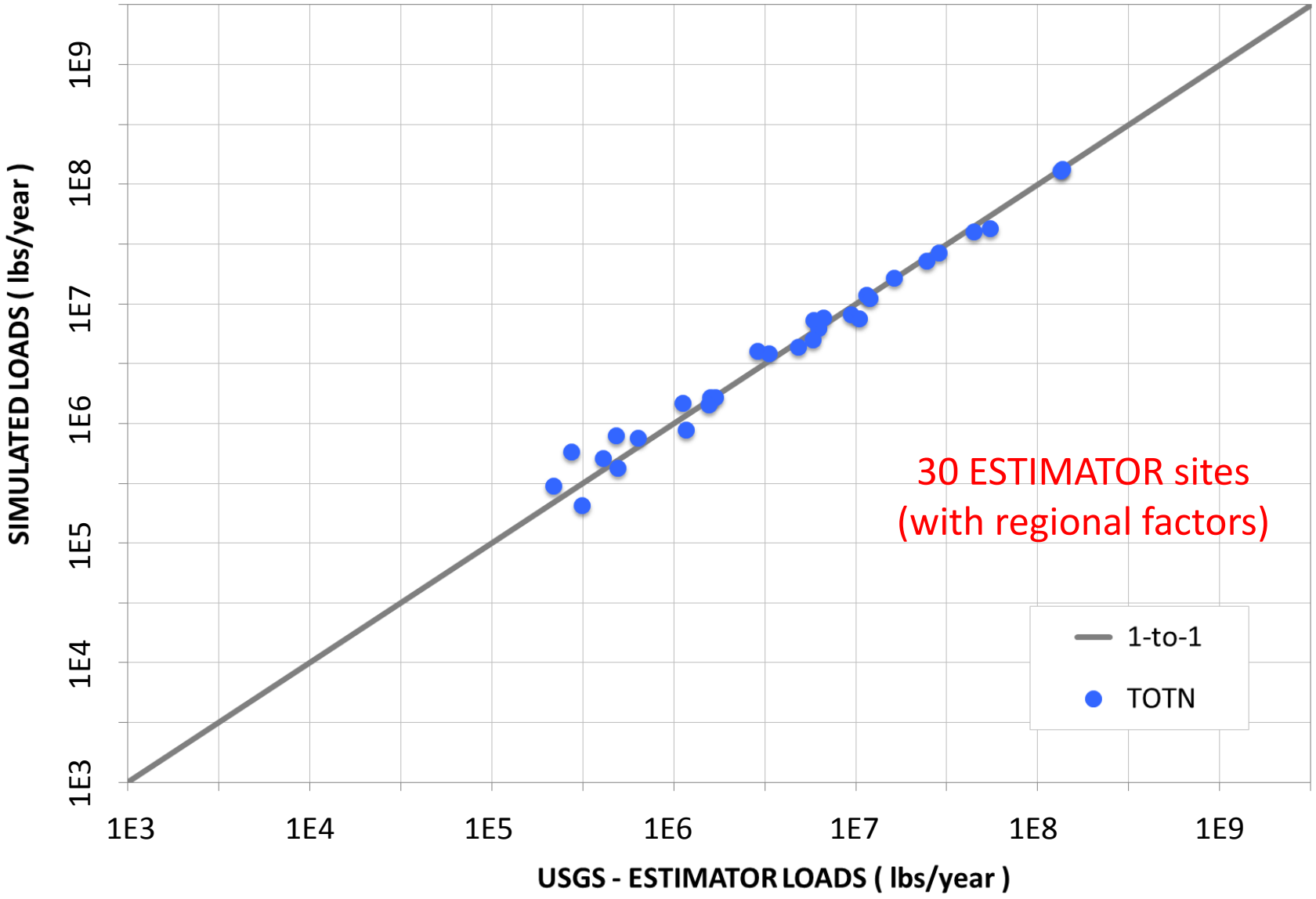
*

Stream Delivery

*

River Delivery

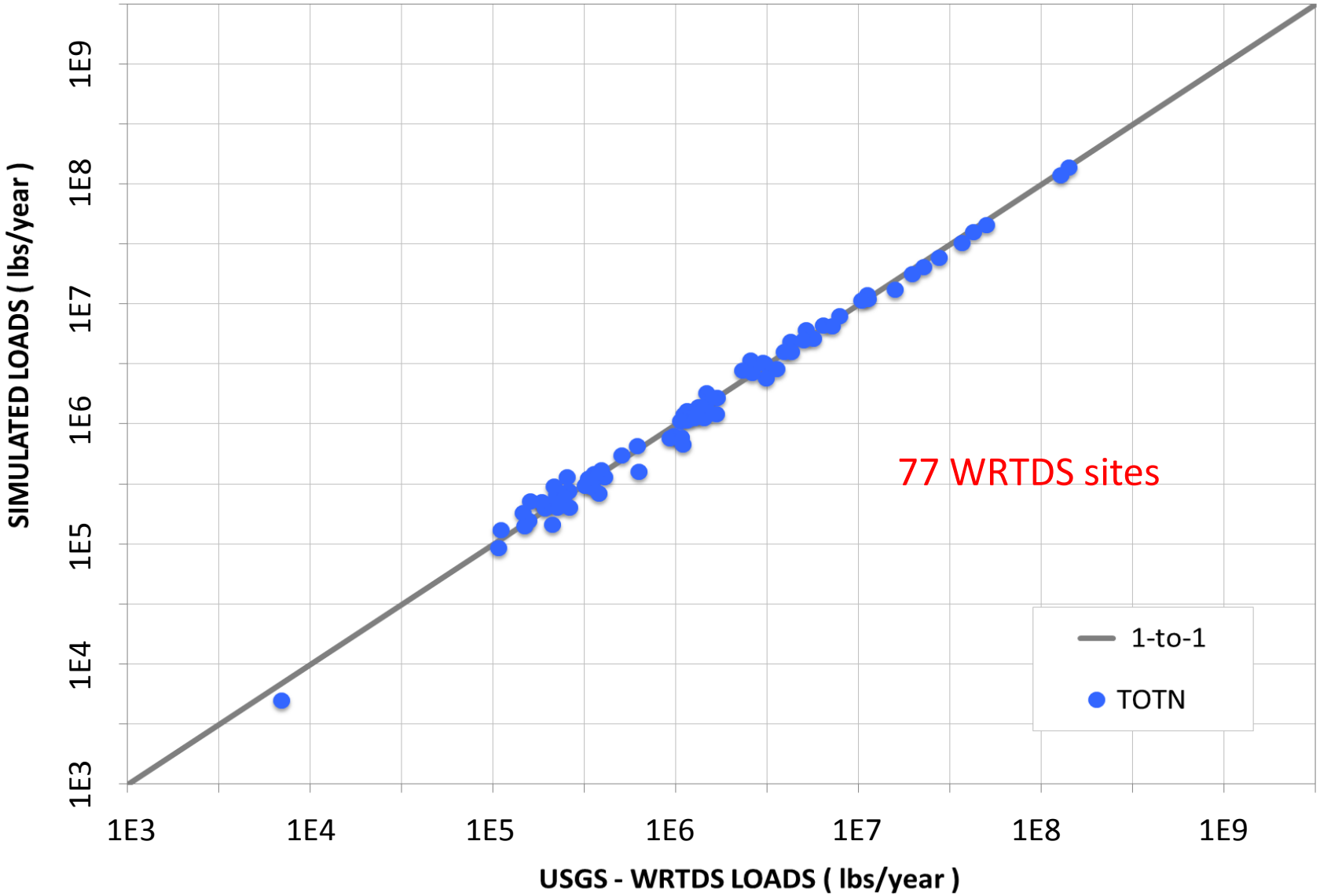
Phase 6

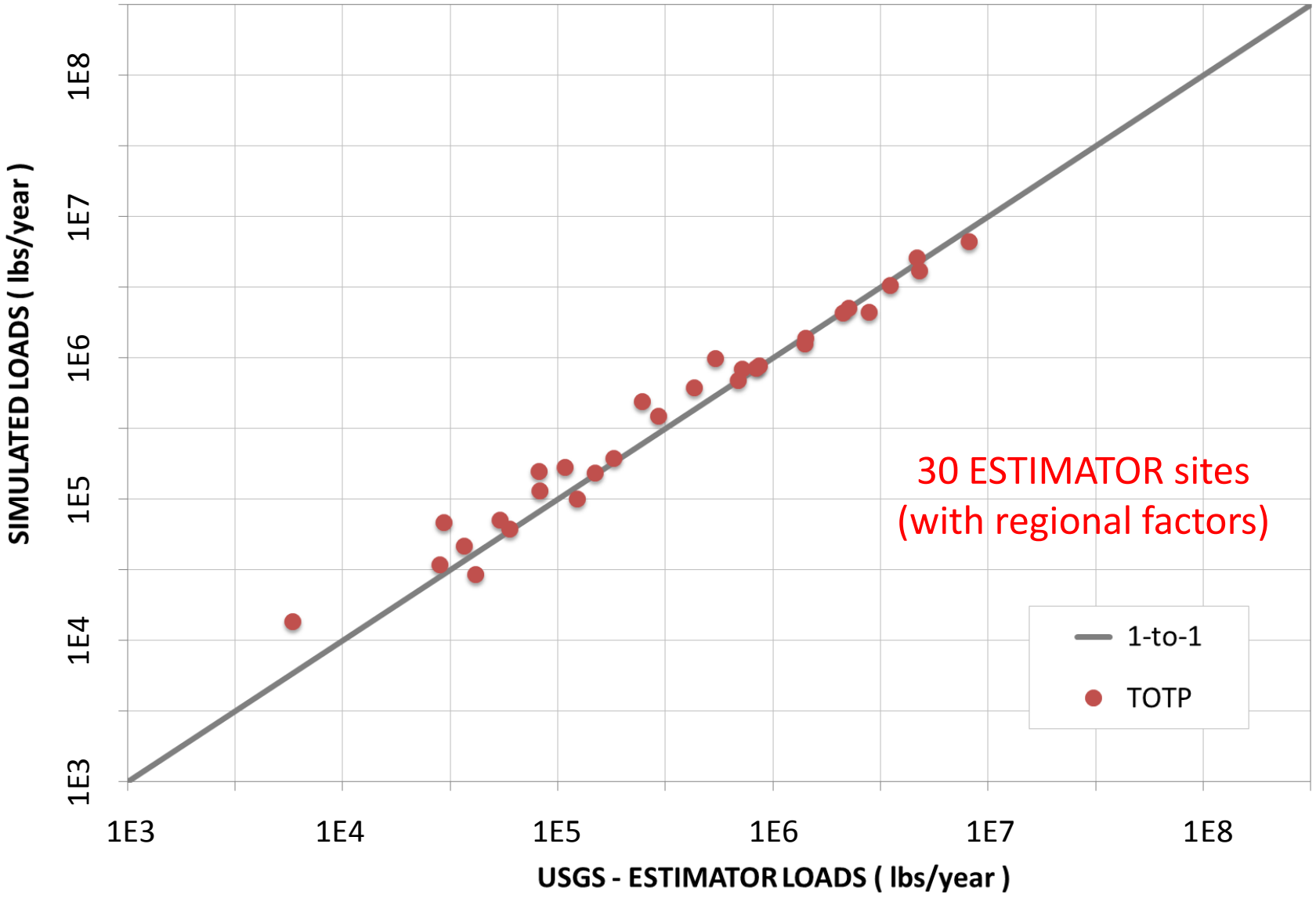

SIMULATED LOADS (lbs/year)
1E3
1E4
1E5
1E6
1E7
1E8
1E9
USGS - ESTIMATOR LOADS (lbs/year)
30 ESTIMATOR sites
(with regional factors)
1-to-1
TOTN

DRAFT 6

Revised inputs, model refinements, and calibration methods

NITROGEN

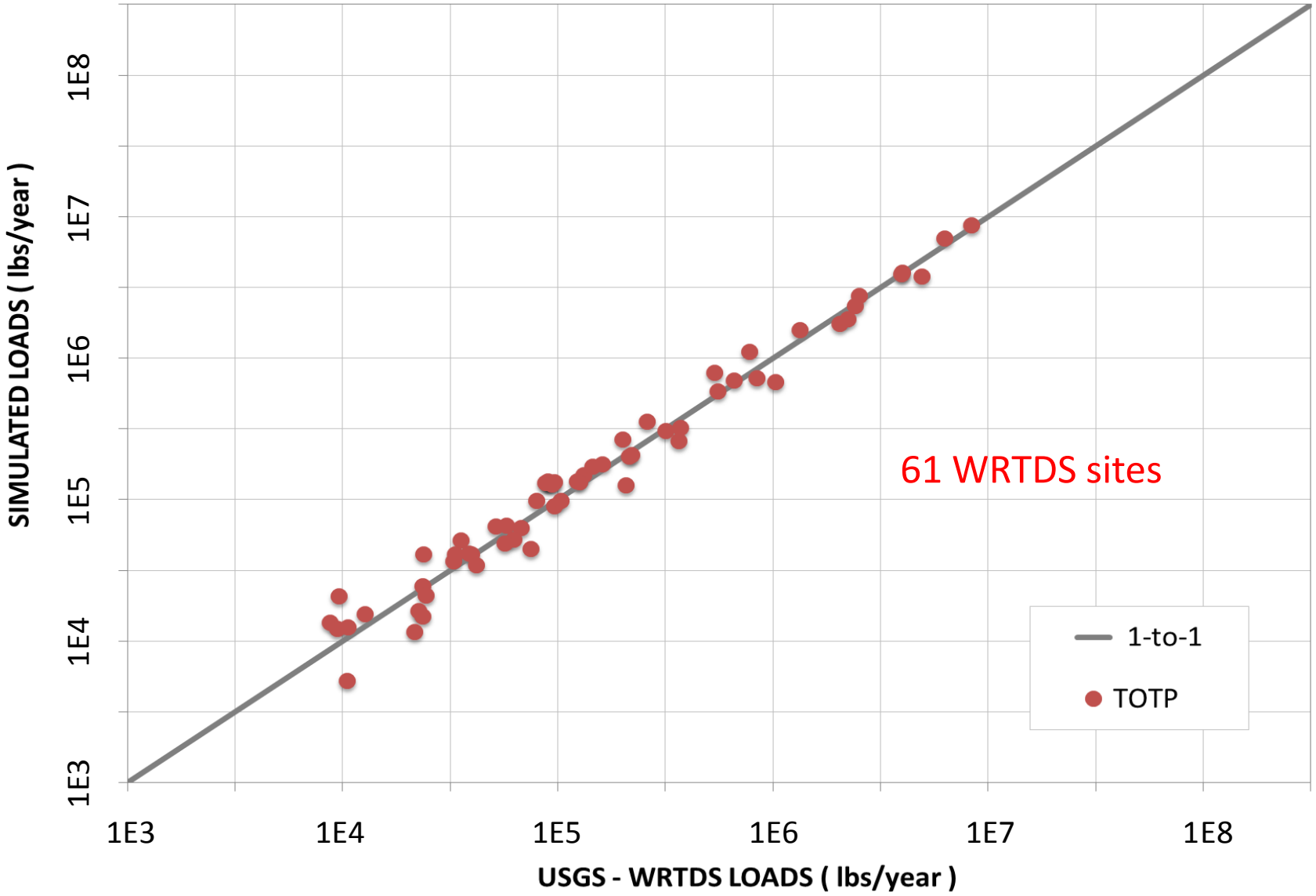


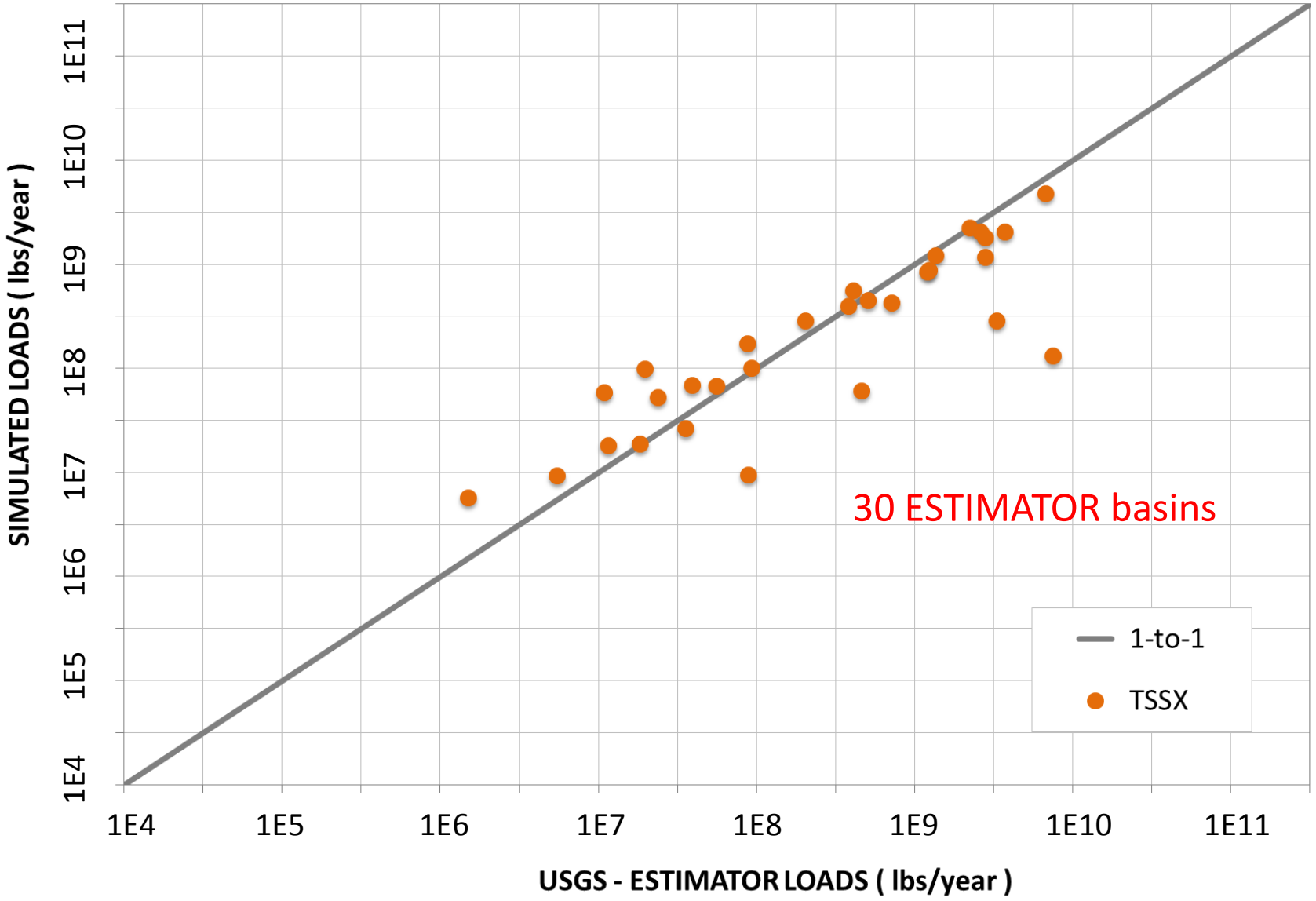

SIMULATED LOADS (lbs/year)
1E8
1E7
1E6
1E5
1E4
1E3
1E3
1E4
1E5
1E6
1E7
1E8
USGS - ESTIMATOR LOADS (lbs/year)
30 ESTIMATOR sites
(with regional factors)
1-to-1
TOTP

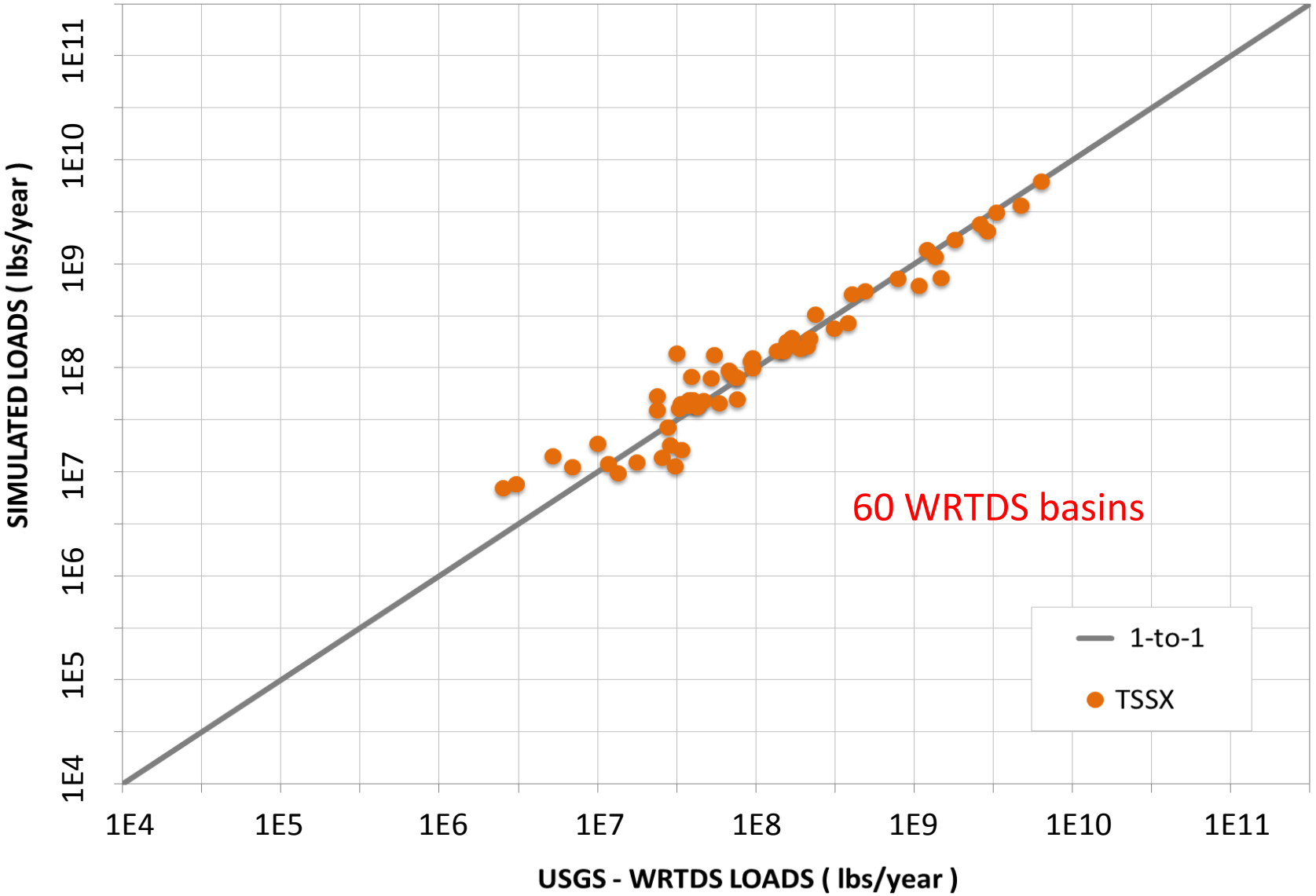
DRAFT 6

Revised inputs, model refinements, and calibration methods

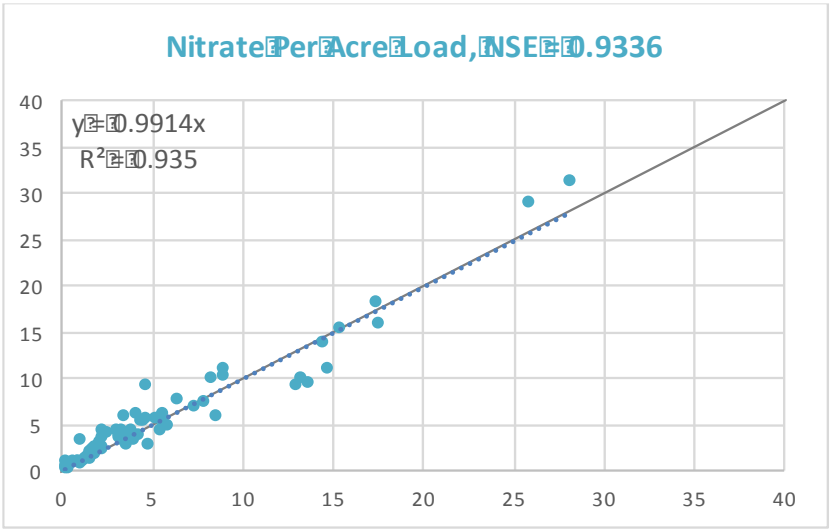
PHOSPHORUS

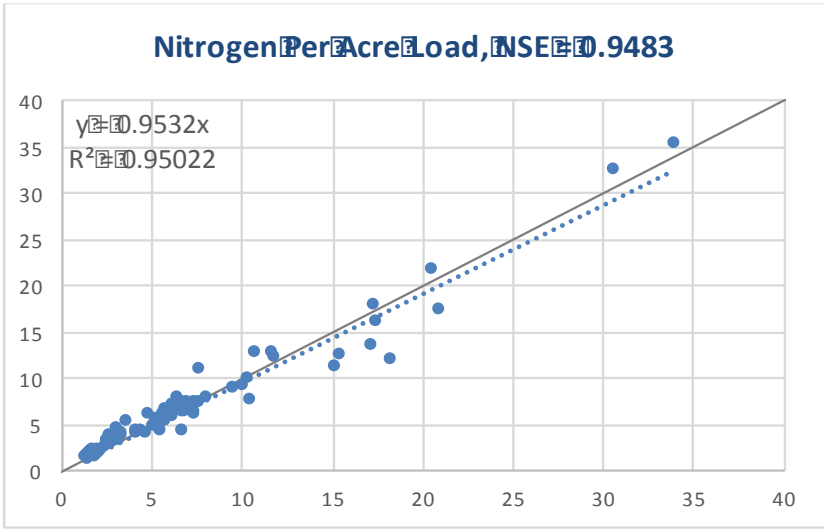


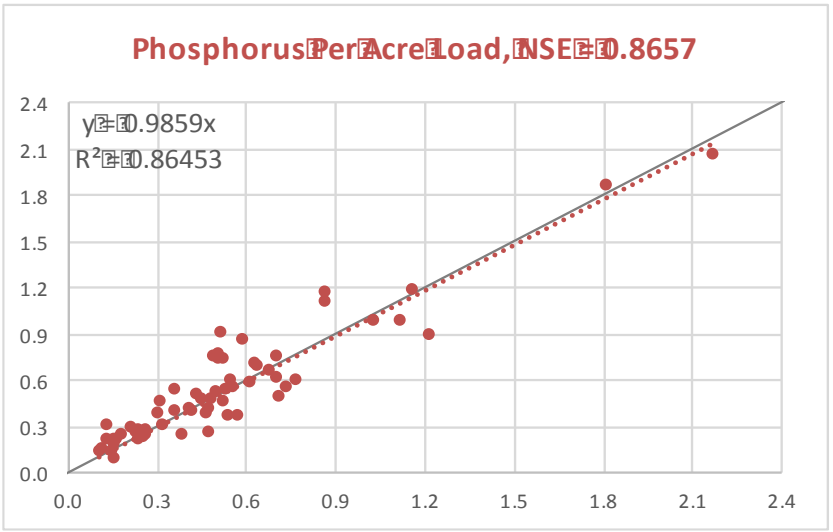

SIMULATED LOADS (lbs/year)
1E4
1E5
1E6
1E7
1E8
1E9
1E10
1E11
USGS - ESTIMATOR LOADS (lbs/year)
1E4
1E5
1E6
1E7
1E8
1E9
1E10
1E11
30 ESTIMATOR basins
1-to-1
TSSX

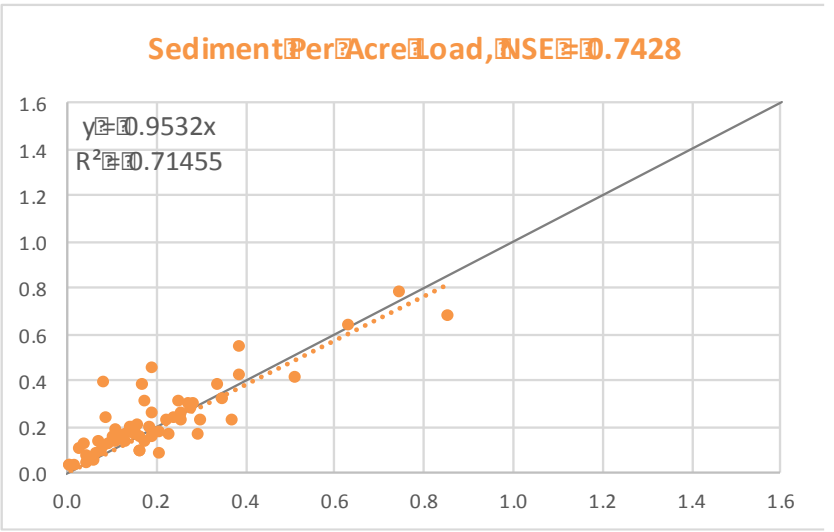

SIMULATED LOADS (lbs/year)
1E4
1E5
1E6
1E7
1E8
1E9
1E10
1E11
USGS - WRTDS LOADS (lbs/year)
1E4
1E5
1E6
1E7
1E8
1E9
1E10
1E11
60 WRTDS basins
1-to-1
TSSX

Draft Phase 6 – geographic efficiencies









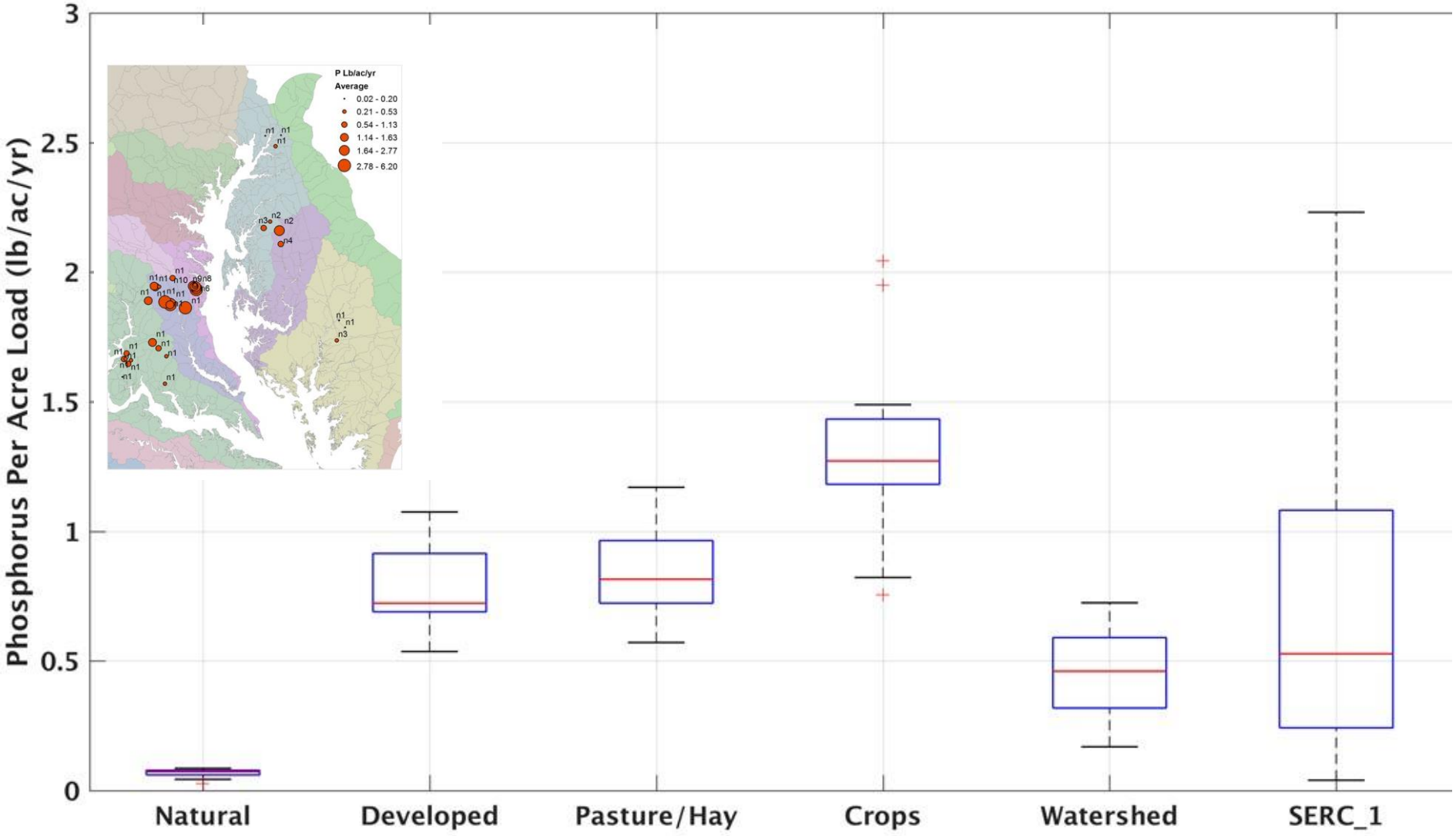
Simulated Per Acre Load

WRTDS Per Acre Load

Summary of geographic efficiencies

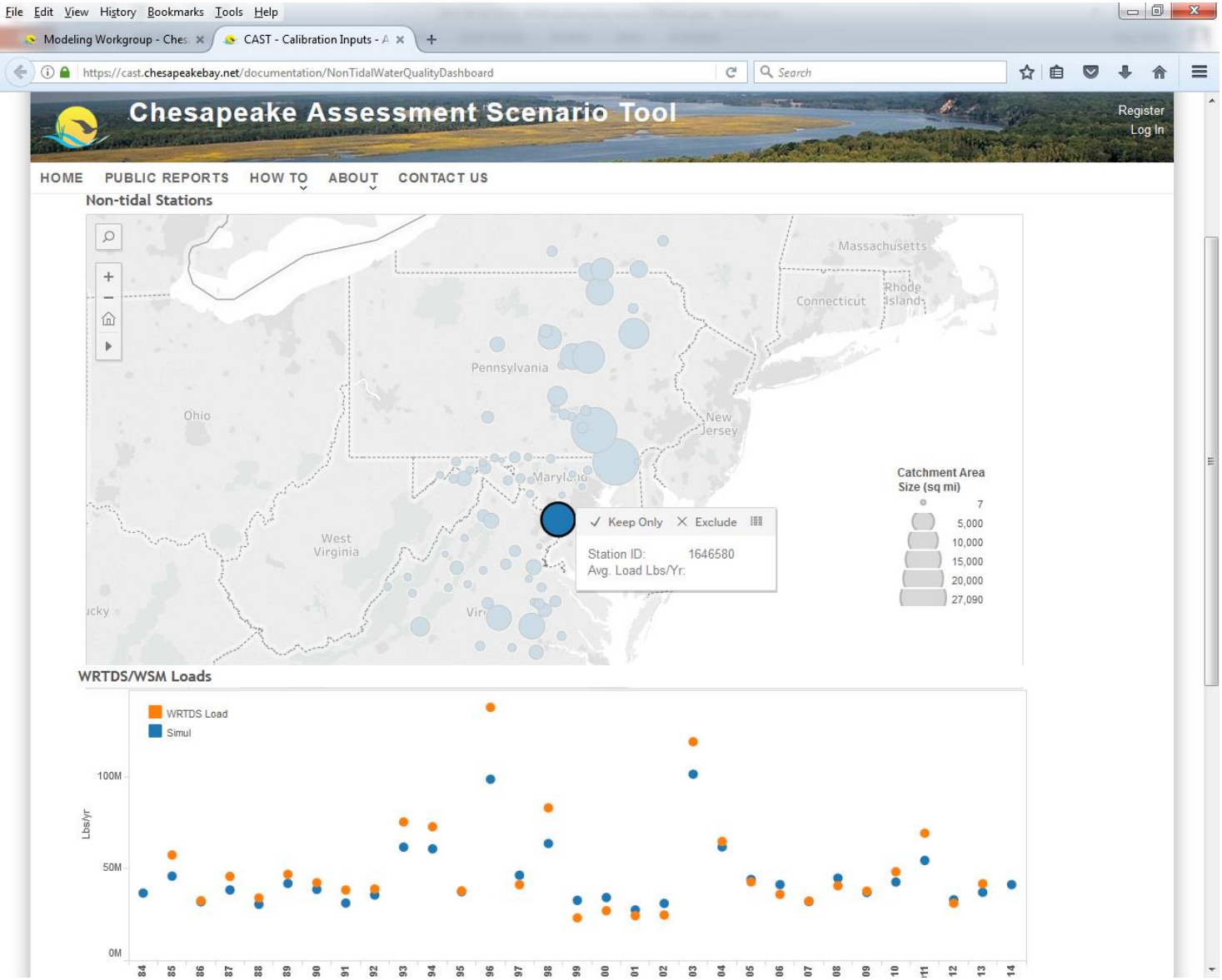
Constituents	**Phase 5**	**Draft Phase 6**
Nitrate	0.8284	0.9336
Nitrogen	0.8704	0.9483
Phosphorus	0.6321	0.8657
Sediment	-0.0770	0.7428

Coastal Plain Phosphorus



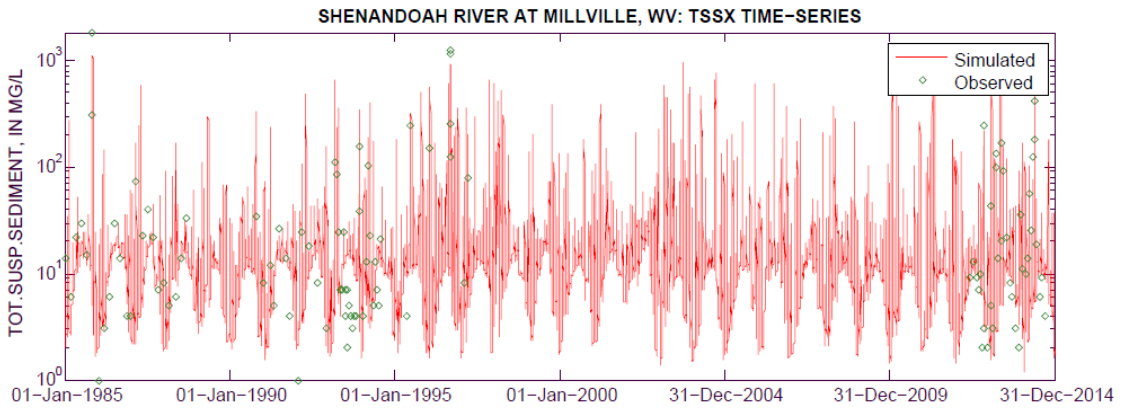
SERC_1 – phosphorus per watershed acres

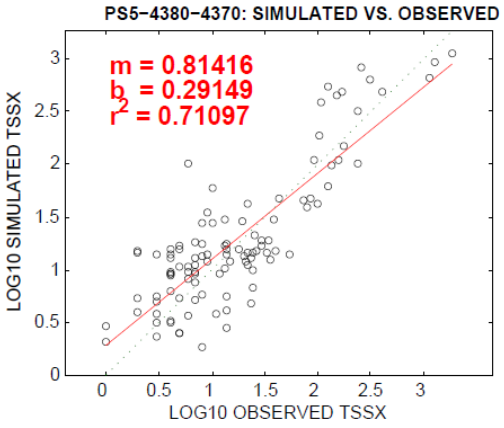
Calibration

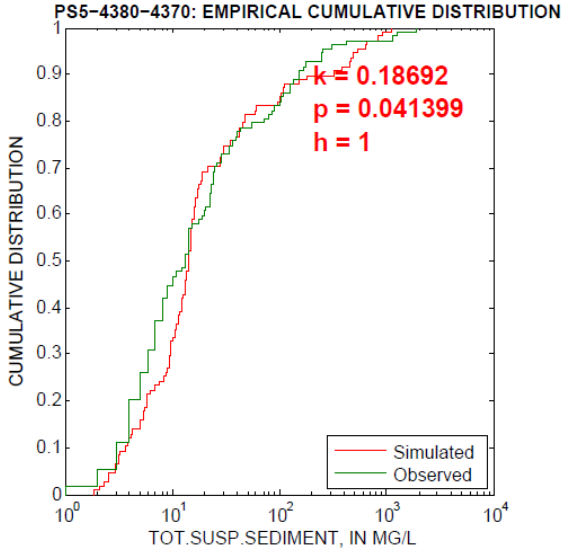


Comparison of WRTDS and WSM Annual Loads

Calibration







DATA SELECTION

scenario	file
P620170331WQ	TSSX.calib

plot: TSSX - total suspended ...

Dates 1/1/1985 12/31/201

Drive	Directory	Observed
N/A	model	OBS20161101

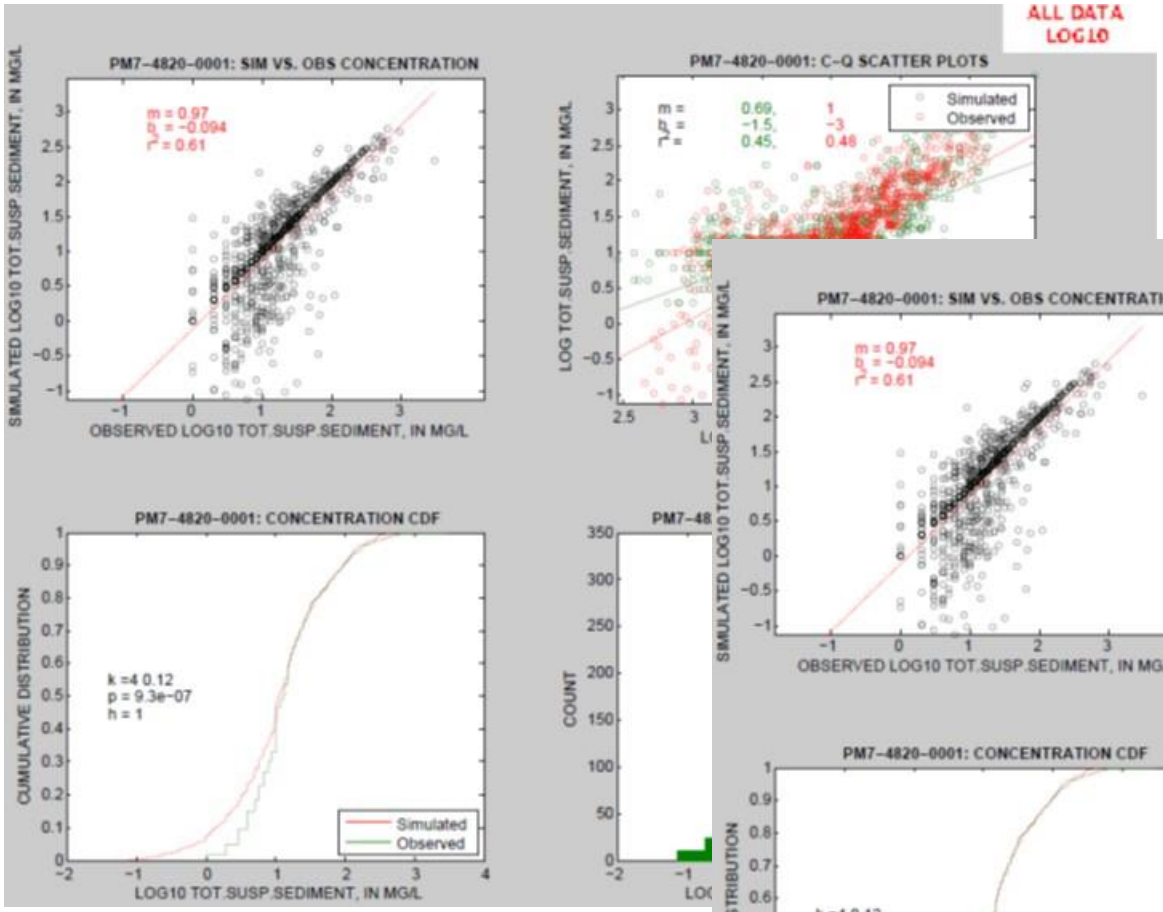
STATISTICS

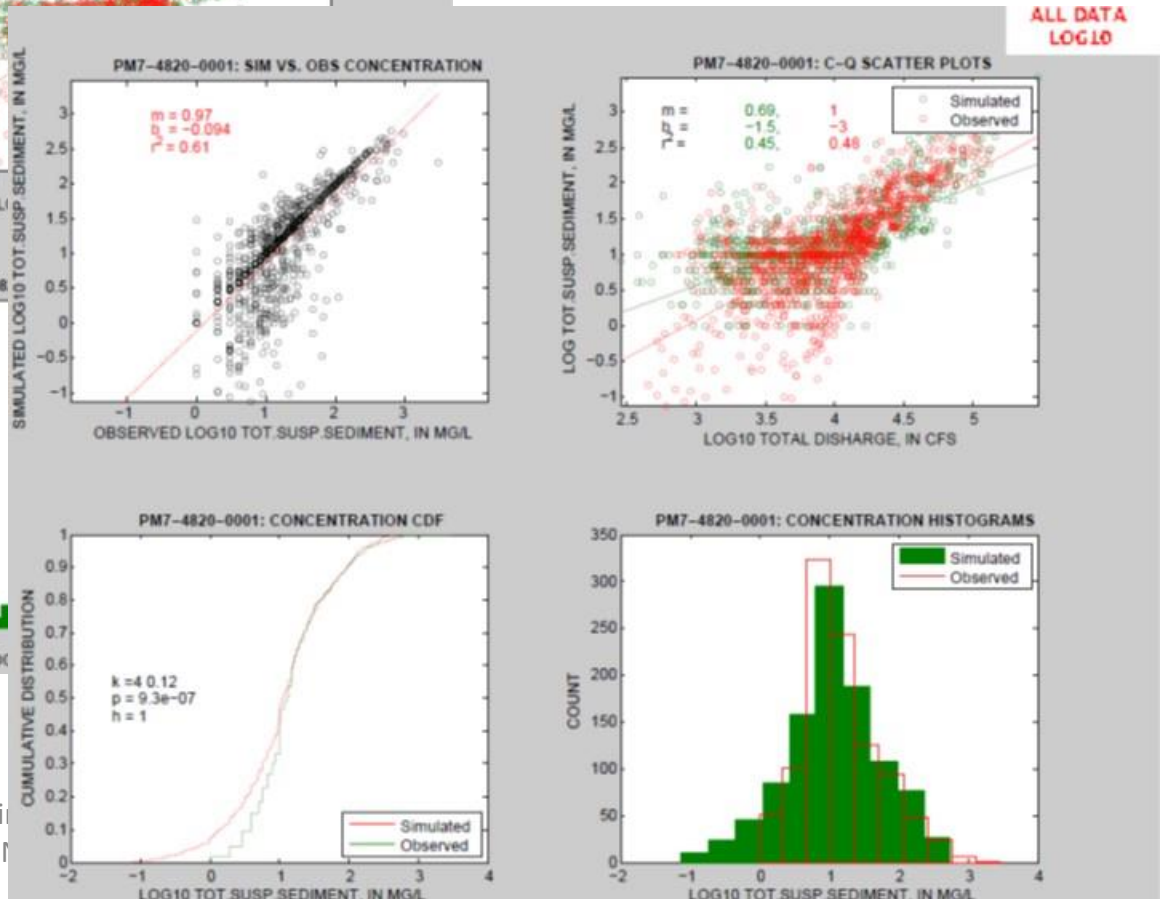
n	107	107
	observe	simulate
min	1	1.8899
	0	0.276439
mean	79	83.8722
	1.21965	1.28448
media	13	14.088
	1.11394	1.14885
max	1850	1125
	3.26717	3.05115
varian	59483.4	39454.3
	0.455503	0.42468
JB	0.001	0.001
	0.009402	0.003061
	ra	log
%	6.16728	5.31553
err.va	16982.9	0.142719
rel.std.err	0.285507	0.313322
mod.eff	0.714493	0.686678

VERSION

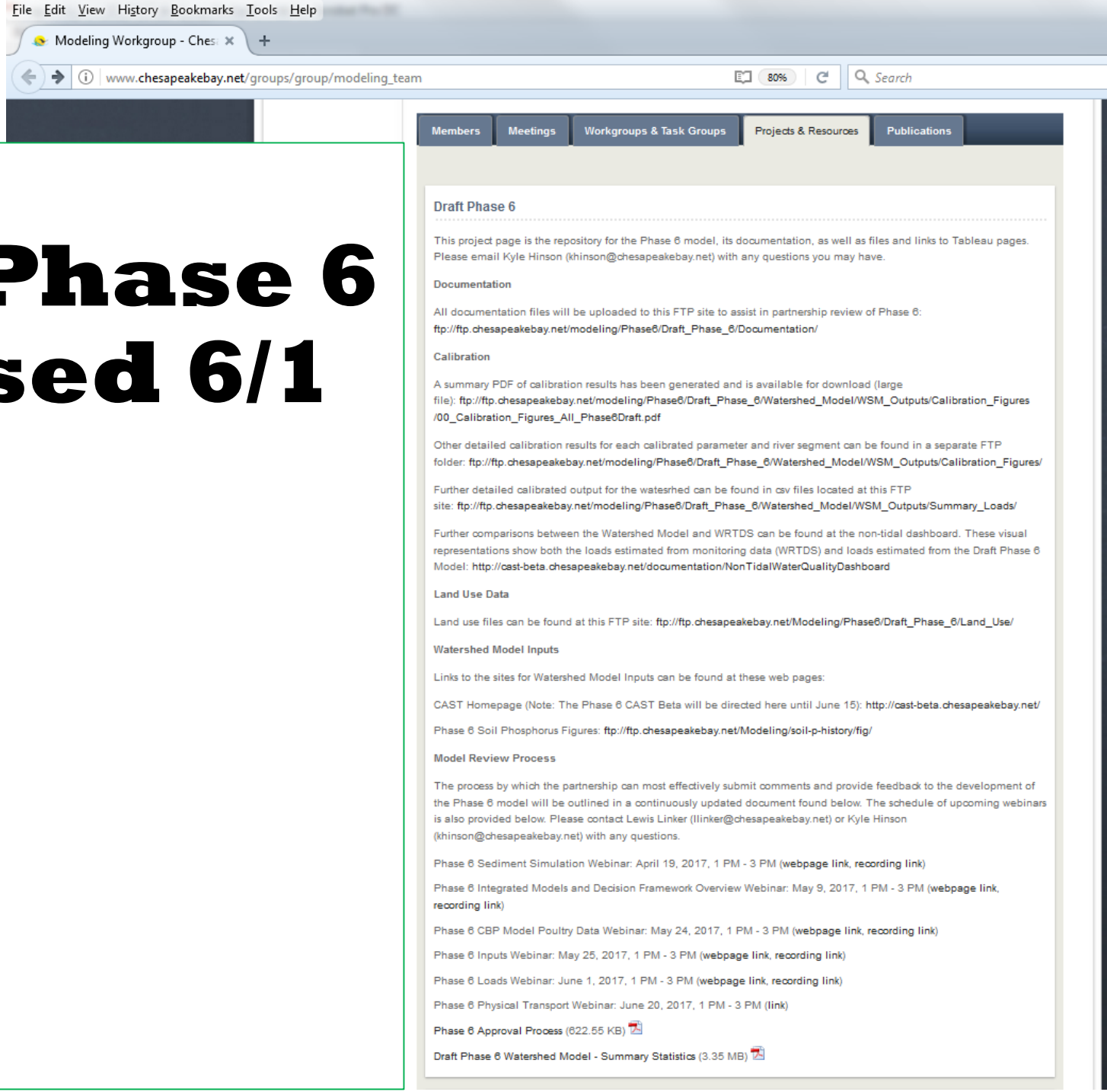
4985 Plots in one file
4985 separate files

Nutrient results





Draft Phase 6 Released 6/1



Phase 6 Webinars

- Sediment Simulation: April 19, 2017
- Integrated Models and Decision Framework Overview: May 9, 2017
- CBP Model Poultry Data: May 24, 2017
- Inputs: May 25, 2017
- Loads: June 1, 2017
- Physical Transport: June 20, 2017

Summary

- The CBP partnership built the Phase 6 model using a simplified structure
- Load differences between regions are based on the best available information supported by multiple lines of evidence
  - USGS Sparrow is used for land-to-water and stream delivery factors
  - HSPF is used for river delivery factors
- The resulting model is better able to match spatial differences in monitored stream loads.

Questions and Answers Session

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